Lomborg and the Litany of Biodiversity Crisis: What the Peer-Reviewed Literature Says

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Abstract: Lomborg’s (2001) book has generated passionate discussion about the state of the global environment. We performed a bibliometric evaluation of the peer-reviewed primary scientific literature to determine whether there is any consistent evidence that “things are getting better.” The global literature primarily reported negative impacts on biodiversity caused by human actions, although Europe appeared to be doing better than the rest of the world. These results cannot be explained by publication bias alone because rejection rates of papers indicating improvements in the environment would have to be unrealistically high to change our results. There were nonrandom distributions of papers showing environmental recovery in developed countries and for ecosystems not strongly subjected to conservation-development conflicts. Although the literature did not paint a picture of universal gloom, the empirical evidence clearly showed growing environmental crises.

Key Words: biodiversity, environmental crisis

Introduction

In general, scientific revolutions occur when a paradigm is first questioned and subsequently replaced by another, different paradigm (Kuhn 1970). Lomborg’s (2001) optimistic assessment of the state of the environment described in The Skeptical Environmentalist attempts to debunk the current “ecological/environmental crisis” paradigm. As expected, it generated a vigorous and well-publicized response from ecologists and conservation biologists (Pimm & Harvey 2001; Moomaw 2002; Raven 2002; Giles 2003). The strong resistance of the scientific community to challenges to widely held points of view is well known, but in this case we think that both scientists...
critical examination of the selected abstracts. The remaining abstracts (n = 904 abstracts published after 1989) represented approximately one-fifth of all ISI published papers that contained the key words anywhere in the title and abstract. Finally, we recorded the following data from each study: ecosystem category (terrestrial, freshwater, marine, or estuarine); spatial scale (local, regional, or global); country where the study was conducted (after categorizing into biogeographic regions, Table 1); and year. We also recorded whether results showed an improvement or a deterioration in the attribute analyzed (e.g., species richness, pollutant concentration, population density). In this last process, once again many studies (approximately 55%) were not included in our analyses, because information presented in the abstract was not explicitly clear about things getting better or worse for a given attribute.

We standardized the number of papers published each year (total number of papers retrieved using key words, divided by total number of papers published in a given year recorded in the ISI database, multiplied by 1000). This ensured that only temporal trends discovered in the analyses would not be a spurious consequence of the overall increase in the scientific literature (Peters 1991). The impact factor of each journal (approximately 300) in the year 2000 and the name of the journal were also recorded, providing a gross approximation of the current prestige and subject specialty of journals in which papers were published. The impact factor of a journal is often used to rank and evaluate journals and as a surrogate for judging the quality and importance of an individual researcher’s publication. It is a measure of the frequency

Table 1. Number of papers reporting environmental changes by biogeographic region and by ecosystem category.*

<table>
<thead>
<tr>
<th>Biogeographic region</th>
<th>worse</th>
<th>better</th>
<th>none</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>7</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Oriental</td>
<td>26</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Neotropical</td>
<td>101</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Palearctic</td>
<td>102</td>
<td>26</td>
<td>3</td>
</tr>
<tr>
<td>Ethiopia</td>
<td>30</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Neartic</td>
<td>49</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>More than one</td>
<td>11</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Global</td>
<td>8</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>354</td>
<td>38</td>
<td>3</td>
</tr>
<tr>
<td>Category of ecosystem</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>freshwater</td>
<td>107</td>
<td>26</td>
<td>1</td>
</tr>
<tr>
<td>marine</td>
<td>76</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>estuarine</td>
<td>5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>terrestrial</td>
<td>180</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>several</td>
<td>4</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>total</td>
<td>372</td>
<td>39</td>
<td>3</td>
</tr>
</tbody>
</table>

*Shown for each category is the number of papers published in the period from 1990 to 2002 that indicated either improvements or deteriorations in environmental quality.

Methods

We analyzed the scientific literature from 1970 to 2002 to test whether, as Lomborg (2001) claims, there are detectable signs adding up to a theme that things are getting better. We focused on biodiversity and habitat degradation. We used the ISI Web of Science database (http://isi3.isiknowledge.com/portal.cgi) to search for articles with the following key words (using the option “title only”): freshwater pollution, eutrophication, biodiversity loss, deforestation, habitat conversion, habitat loss, biological extinction, and ecological extinction. Both the key words we used and the title-only option restricted our search to papers focused on environmental quality and biodiversity losses. This option keeps the comparability of the time series because abstracts and key words are available only for papers published from 1991 forward. Although our search was not exhaustive, considering the huge size of the literature, it furnished a representative sample of the studies on the subject. Also, our search method eliminated most papers on other aspects of basic ecology and evolution not directly related to these issues, such as theoretical measurements of diversity, local assessments of fauna and flora, and descriptions of new species.

We eliminated a few more abstracts not related to ongoing biodiversity crisis (e.g., past mass extinctions) with a...
with which articles in a journal have been cited in a particular year (Garfield 1972). Despite some recent and justified criticisms (Garfield & Welljams-Dorof 1992; Glänzel & Moed 2002; Colquhoun 2003; Jones 2003; Lawrence 2003), we considered this index, recorded in 2000, to adequately estimate the relative importance of journals in the field.

Results and Discussion

In the last three decades, the standardized number of papers devoted to threats to biodiversity and habitat degradation increased \( (R^2 = 0.67; \text{standardized number of papers} = -4.55 + 0.002 \times \text{Year}; \text{Fig. 1}) \). Also, the average impact factor of the journals that published these papers was initially high but decreased and leveled off after the mid-1970s (although maximum impact factors have remained high over all years; Fig. 2).

The initially high impact factors in the early 1970s probably indicate that as the environmental crisis was beginning to be recognized, scientists published largely in renowned journals of broad interest. The subsequent decrease of impact factors could, in principle, reflect a reduction in importance of the crisis with time. If impact factors reflect the broad interests of the scientific community (and not necessarily science quality), however, it is likely that once the scope of the biodiversity crisis was recognized, new empirical data and results began to be targeted to more localized and specialized journals. This decrease then almost certainly reflects a general aspect of the progression of scientific knowledge.

Furthermore, this temporal trend in impact factors would be expected if studies of environmental effects and biodiversity losses increasingly focus on more local scales, and efforts to compile these many local results and provide broad-scale evaluations, which may be interesting to a more general public, are sporadic (e.g., Myers et al. 2000). As expected under this reasoning, global-scale studies were published in journals with significantly higher average impact factors \( (F_{2,629} = 16.0; p < 0.001; \text{Fig. 3a}) \). Also, the number of local and regional studies increased, whereas global studies were nearly stable over time (Fig. 3b). Global-scale studies were less frequent because they are hard to execute, although we forecast that they will become more frequent in the future because of the accumulation of local and regional results that can yield reliable quantitative or qualitative data.

The proportion of papers that support the continued degradation of the environment over the last 13 years is much higher than those reporting the opposite \( (t_{12} = 7.93; p = 0.000013, n = 13 \text{ years}) \). This would be expected if the scientific community exhibits a strong resistance to good news. As a result, it is also important to try to evaluate whether there would be potential effects of rejection bias (Hedges & Olkin 1985; Moller Jennions 2001) toward papers that show nonsignificant results (i.e., not supporting biodiversity crisis).

We did this by estimating the potential number of rejected papers that would show biodiversity recoveries, multiplying the total number of papers published in a given year by a global rejections rate of all journals. We then performed the paired comparison between this estimated number of papers (which were hypothetically rejected only because they showed biodiversity recoveries) and the actual number of papers supporting biodiversity crisis. The estimated number of papers was recalculated using successively increasing rejection rates. The observed results would be changed only if more than 85.5% of papers showing biodiversity recoveries had been systematically rejected for publication in all peer-reviewed journals.
ISI indexed journals, clearly an overestimate of the average rejection rate for the field (Peters 1991). Also, according to Cassey and Blackburn (2003) most papers rejected at first are published later, sometimes in a lower-ranked journal. Thus, the very high rejection rate needed to change our conclusions is even more unrealistic under Cassey and Blackburn’s (2003) findings, although this effect of initial rejection could create a difference in average impact factors of journals that publish papers supporting or rejecting biodiversity crisis.

However, we found no place-of-publication bias because there was no significant difference (Mann-Whitney U test; $p = 0.3252$) between mean impact factors of journals that published papers with negative (getting worse) and positive (getting better) results. Koricheva (2003) similarly showed that there is no evidence of publication bias or time-lag bias and only limited evidence of place-of-publication bias against nonsignificant results across many ecological topics. Thus, even if a small bias exists, it would hardly explain the magnitude of the differences in publication rates. Rather, simple counts reveal that the biodiversity crisis persists and is probably worsening.

**Consistency of Biodiversity Crisis across Biogeographic Regions**

We also evaluated the state of the environment in more detail by counting the number of papers supporting or rejecting the biodiversity crisis across eight regions and six ecosystem types. For the biogeographic regions (Table 1), the highest proportion of studies (around 33%) reporting biodiversity recovery is in the Palearctic (primarily Europe; G test $= 71.88$; df $= 14$; $p = 0.00001$). More studies showing biodiversity recovery in this region may reflect higher levels of economic commitment and societal consciousness about ecological problems, generating positive effects on biodiversity. Declines in population density in Europe and the fact that this continent has been subjected to agricultural and industrial activities for the longest period of any continent, creating simultaneously serious environmental problems and higher level of concerns about them, may also account for these results.

In contrast, we did not observe increased evidence for recovery in the Nearctic, despite the economic power of the United States. We also found little evidence of environmental improvement in the developing countries in the Neotropical and Ethiopic regions, raising the possibility that Lomborg’s (2001) “global tendencies” might be biased by overrepresentation of examples taken from Europe.
A comparison of patterns in different ecosystem categories (Table 1) should show higher proportions of studies documenting the biodiversity crisis in ecosystems subjected to stronger conflicts between conservation and human development. The frequency of studies indicating a biodiversity crisis was higher for terrestrial ecosystems (G test = 22.17; df = 8; p = 0.0046), as expected given high turnover rates of terrestrial habitats into human-modified landscapes (Sala et al. 2000). On the other hand, the highest proportion of studies showing biodiversity recovery was on freshwater ecosystems. This may reflect the importance of water to human development and the recognition of freshwater as a key limiting resource on Earth (Cohen 1995; Vorosmarty et al. 2000; Brown 2002). It is also possible that freshwater ecosystems experienced more profound degradation earlier than terrestrial ecosystems, precipitating earlier responses because of the importance of this resource for humans.

Conclusion

The primary scientific literature strongly supports the ideas that we are in the midst of a global environmental crisis, and that degradation rates far outstrip recovery rates. We believe that Lomborg’s (2001) secondary sources fail to recognize that biodiversity losses frequently occur at small spatial scales and/or over longer periods of time, restricting the number of studies that detect such changes. Our results support warnings that extrapolations to global scales should be conducted carefully (Tilman 1999). The distribution of studies across biogeographic regions and ecosystem categories also strongly supports the existence of a globally deteriorating situation because the limited number of recoveries are primarily in (1) regions where political and social forces generate large investments for biodiversity conservation and environmental education, (2) ecosystems subject to relatively low conflicts between conservation and human use of natural resources, or (3) locations where the resource is of overriding importance (e.g., water). Finally, the literature supports the idea that conservation ecologists and environmental activists have been successful in calling attention to an eventual future environmental crisis of large proportions, so Lomborg’s claims should be better interpreted “…as a tribute to the effectiveness of environmental police” (Grubb 2001).

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