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Journal of Environmental Economics and Management 52 (2006) 615–626

JOURNAL OF ENVIRONMENTAL ECONOMICS AND MANAGEMENT

www.elsevier.com/locate/jeem

Search, bioprospecting and biodiversity conservation

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Received 12 July 2005
Available online 14 September 2006

Abstract

To what extent can private-sector bioprospecting incentives be relied upon for the protection of biological diversity? The literature contains dramatically different estimates of these incentives, from trivial to quite large. We resolve this controversy by isolating the fundamental source of the discrepancy and then providing empirically defensible estimates based on that analysis. Results demonstrate that the bioprospecting incentive is unlikely to generate much private-sector conservation. Thus, other mechanisms are likely required to preserve the public good of biodiversity.

Keywords: Bioprospecting; Biodiversity; Conservation; Efficient search; Information

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1. Introduction

To what extent can the private-sector be relied upon for the protection of biological diversity? Bioprospecting, the search for valuable products such as pharmaceuticals in biological organisms, is one incentive mechanism that has received much recent attention (see, e.g. [22,23,16]). An important controversy has emerged from this literature. Simpson et al. [28] argue that bioprospecting incentives are likely vanishingly small, less than \$21/ha. In contrast, Rausser and Small [26] argue that bioprospecting incentives are likely quite large, perhaps \$9177/ha, because information facilitates a more efficient search process. This latter result suggests that perhaps we can rely on the private-sector for biodiversity conservation and has received a great deal of attention from subsequent academic and practitioner literatures (for example see [13,4,20,9,29]).

This controversy is important for two reasons. First, the practical implications for biodiversity conservation are enormous. Second, the *cause* of the discrepancy in final estimates is of great consequence itself. If information fundamentally changes conservation incentives, then re-allocating scientific resources to provide such information may be the most efficient way to induce private conservation.

This paper makes three contributions. First we show, contrary to the conclusions of Rausser and Small, that information has only a trivial effect on conservation values in this important application. Second, we carefully examine the two models to illuminate the true source of the discrepancy in estimates of private-sector

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doi:10.1016/j.jeem.2006.04.001

conservation incentives. We find that the main source is simply different parameter choices. However, the key parameter choices are not defended in this literature. Third, we close this gap by assembling a defensible range of model parameters from a review of the scientific literature, biodiversity databases, government reports, and laboratory interviews. Based on these parameters, we resolve the outstanding question of the private-sector conservation incentives from bioprospecting.

2. Impact of an "organizing scientific framework"

Simpson et al. (SSR) couple a clever analytical argument with an empirical case study, to argue that land in biodiversity hotspots has a bioprospecting marginal value of less than \$21/ha—far too small to offset the opportunity cost of development. The authors further argue that the values would always be small, regardless of the probability that any given species will lead to a new product. Under low probability searches, any research "lead" is unlikely to produce a successful innovation, and therefore has low value. But under high probability searches, research leads are redundant, so scarcity rent is decreased, and any given lead has low value.

The subsequent estimate of \$9177/ha by Rausser and Small (RS) was therefore surprising—especially since it was based on the same data used by SSR. The high values accruing to infra-marginal leads illustrates RS's theoretical point that scientific information lowers search cost and thus increases value. An "organizing scientific framework" allows a collection of leads to be searched in the most efficient order, rather than in effectively random order, as in SSR. Under informed search, rents accrue to the most promising leads because searching these first may allow researchers to avoid future, less productive searches. Efficient search, RS suggest, is responsible for the dramatic increase in marginal values. If the large discrepancy between results does, in fact, derive from efficient search, one would expect random (or otherwise inefficient) search to obtain values similar to those in SSR.

RS analyze theoretically the value of optimally ordered sequential search of a collection of research leads of differing quality, where search terminates upon the first success. For each lead tested, a cost c is incurred. Lead k yields a success worth R with probability p_k. The key theoretical distinction from the approach of SSR is in allowing the probabilities p to differ across leads, reflecting prior information about lead quality.

In this search model, the value of a collection of research leads is

$$\sum_{i=1}^{N} a_i(p_i R - c), \tag{1}$$

where $a_i = \prod_{j=1}^{i-1}(1-p_j)$. Here, the term $p_i R - c$ represents expected return from searching lead i. The term a_i is the probability of searching lead i, or equivalently of failing to find an earlier success. The marginal value of a research lead, k, is simply the difference between the value of the ordered collection containing lead k and the value of the same collection excluding lead k. RS derive an iterative formula to calculate the marginal value of a research lead via backwards induction. That formula can equivalently be expressed as

$$v_k = \underbrace{R a_{N+1} \frac{p_k}{1-p_k}}_{revenue\ component} \underbrace{- c\left[a_k - \frac{p_k}{1-p_k}\sum_{j=k+1}^{N} a_j\right]}_{cost\ component}. \tag{2}$$

In their bioprospecting example illustrating this theory, RS treat each area of land in a biological hotspot as a research lead.[1] To calculate a net present marginal value per hectare of land, RS multiply (2) by the number of tests per year, discount, and divide by 1000 (to convert the value per kilohectare to a value per hectare), yielding the final marginal value formula:

$$mv_k = v_k \frac{\lambda(1+r)}{1000r}, \tag{3}$$

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[1] SSR treat each species as a research lead, a difference to which we return.