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The Bioprospecting Question: Should the United States Charge Biotechnology Comapanies for the Commercial Use of Public Wild Genetic Resources?

by

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Comment

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It is a simple truth that technology develops faster and further than policy.

—Vice President Al Gore[1]

INTRODUCTION

The history of public land use in the United States is primarily one of natural resource extraction.[2] This notion brings to mind classic images of the American West, such as miners panning for gold, lumberjacks felling timber, and ranchers grazing their cattle. Recently, a new type of natural resource use, known as "bioprospecting," has emerged in the United States. Bioprospecting is the search of biodiversity for valuable wild genetic resources—the genetic and

1. Albert Gore, Jr., *Planning a New Biotechnology Policy*, 5 HARV. J.L. & TECH. 19, 19 (1991).

2. *See generally* GEORGE CAMERON COGGINS & CHARLES F. WILKINSON, FEDERAL PUBLIC LAND AND RESOURCES LAW 1-46 (2nd ed. 1987) (discussing the history of federal public lands and uses to which they have been put).

biochemical information found in wild plants, animals and microorganisms.[3] The growing biotechnology industry uses these wild genetic resources to develop new and improved drugs, crop varieties, industrial techniques and other commercial products worth billions of dollars each year.[4]

This new activity raises a controversial question, referred to in this Comment as the "bioprospecting question": should the United States government seek compensation when a commercial enterprise wants to extract wild genetic resources from its public lands in the hopes of developing a valuable commercial product?

The historical answer throughout the world was usually "no." Wild genetic resources were viewed as a "common heritage of humankind," and countries allowed bioprospectors to take these resources from public land free of charge.[5] This view has changed recently, however, and today much of the international community answers the bioprospecting question with a resounding "yes." The Convention on Biological Diversity,[6] a recent international agreement, rejects the "common heritage of humankind" approach and establishes instead that countries have a right to profit from their wild genetic resources in much the same way that they profit from other natural resources, such as mineral deposits and timber reserves. Accordingly, national governments around the world are establishing special contractual relationships with bioprospectors that require the bioprospector to make some form of payment in return for the privilege of extracting the genetic information contained on their public lands.[7]

Despite this international trend, the United States has not yet answered the bioprospecting question with regard to federal public land.[8] Thus far, this question has also escaped the attention of law journal commentary. This may not seem surprising at first, because the notion of "bioprospecting" tends to invoke the image of a khaki-clad scientist struggling to take chemical samples from exotic plants

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3. *See* WALTER V. REID ET AL., WORLD RESOURCES INSTITUTE, BIODIVERSITY PROSPECTING: USING GENETIC RESOURCES FOR SUSTAINABLE DEVELOPMENT 1 (1993) [hereinafter BIODIVERSITY PROSPECTING].

4. *See infra* part I.B.

5. *See infra* part I.C.

6. United Nations Conference on Environment and Development: Convention on Biological Diversity, *opened for signature* June 5, 1992, 31 I.L.M. 818 (1992) [hereinafter Biodiversity Treaty].

7. *See infra* part I.C. For further analysis of the general issues raised by this change in international understanding, see Edgar J. Asebey & Jill D. Kempenaar, *Biodiversity Prospecting: Fulfilling the Mandate of the Biodiversity Convention*, 28 VAND. J. TRANSNAT'L L. 703, 713-19 (1995); Christopher D. Stone, *What to Do About Biodiversity: Property Rights, Public Goods, and the Earth's Biological Riches*, 68 S. CAL. L. REV. 577 (1995).

8. This Comment focuses on federal land, but the analysis applies equally well to land held by state and local governments.

deep in the equatorial jungle, an image that seems far removed from the relatively familiar realm of American public land. A closer look, however, reveals that the United States has a significant level of potentially valuable wild genetic resources and that the amount of domestic bioprospecting activity is greater than one might expect.

A domestic answer to the bioprospecting question is needed because biotechnology companies are currently hard at work removing wild genetic resources from such federal public lands as Yellowstone National Park in possible contravention of the law,[9] and because the domestic bioprospecting rate is likely to increase in the coming decade.[10] Park officials admit they do not know how to approach this issue. With bioprospecting yielding two recent products that have potential billion-dollar markets—a revolutionary technique for replicating DNA, and one of the most promising anti-cancer agents developed in recent years[11]—many commentators are asking why the federal government is not seeking a small share of the proceeds.[12]

This Comment seeks to demonstrate three points: (1) that the United States has enough wild genetic resources and bioprospecting activity to warrant attention by policy makers; (2) that the current federal land laws do not provide sufficient guidance on this issue; and (3) that Congress should seek compensation from the biotechnology companies that extract wild genetic resources from federal land, despite the fact that their activities do not cause immediate environmental harm.[13] Part I establishes the value of wild genetic resources to the biotechnology industry, and discusses international law's approach to the bioprospecting question. Furthermore, this part analyzes the domestic legal framework that currently governs the commercial use of these resources. It concludes that domestic law has not kept up with recent international developments, and does not adequately answer the bioprospecting question. Part II discusses the wild genetic resources found on federal public land, current bioprospecting activity, and future increases in such activity. Part III asserts that Congress should answer the bioprospecting question by passing legislation that seeks an economic return from the commercial use of the wild genetic resources found on federal public land, and discusses the advantages

9. *See infra* part II.B.
10. *See infra* part II.B.
11. *See infra* part II.A.
12. *See infra* part III.A.-D.
13. Bioprospecting differs from such activities as mining and ranching in that it involves the removal of such a small amount of material that it usually does not harm the ecosystem. *See* Stone, *supra* note 7, at 597. *But see* BIODIVERSITY PROSPECTING, *supra* note 3, at 3 (suggesting that bioprospecting may actually harm the environment because of market pressures whereby even removing a small amount for testing may interfere with the species' survival).

and disadvantages of this approach. Finally, part IV suggests some basic components that the new legislation should contain.

I.
AN OVERVIEW OF BIOPROSPECTING AND BIOTECHNOLOGY

This part begins by giving a general overview of the burgeoning biotechnology industry and its use of wild genetic resources to develop extremely lucrative products. It then discusses recent changes in international law's approach to the bioprospecting question and how individual countries have responded to these recent changes. An understanding of this background is a prerequisite to an informed discussion of how the United States should approach bioprospecting on its public land.

A. The Rise of the Biotechnology Industry

Biotechnology is defined as "any technological application that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for specific use."[14] The domestic biotechnology industry has grown rapidly in recent years. Between 1985 and 1990, the number of biotechnology patent applications grew by fifteen percent annually,[15] and it has been estimated that the United States biotechnology industry will have sales of $100 billion by the year 2000.[16] The United States currently is considered the world leader in biotechnology.[17]

Two developments[18] have contributed to the rise of the domestic biotechnology industry. The first is the evolution of our understanding of advanced scientific processes, especially the ability to synthesize complicated chemicals, and to manipulate DNA through genetic engineering.[19] These scientific breakthroughs have created a whole new universe of potential uses of wild genetic resources.

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14. Biodiversity Treaty, *supra* note 6, art. II, 31 I.L.M. at 823.

15. Walter V. Reid, *The Economic Realities of Biodiversity*, ISSUES SCI. & TECH., Winter, 1993-94, at 48, 49.

16. Cheryl D. Hardy, Comment, *Patent Protection and Raw Materials: The Convention on Biological Diversity and Its Implications for U.S. Policy on the Development and Commercialization of Biotechnology*, 15 U. PA. J. INT'L BUS. L. 299, 302 (1994).

17. *Id.* at 317.

18. These two developments—the rise of genetic engineering technology and an intellectual property scheme that allows companies to profit from their use of wild genetic resources—have been extremely controversial and have raised significant moral issues. The resolution of these questions is ongoing. However, this Comment proceeds on the assumption that biotechnology companies will continue to be able to profit from the commercial use of wild genetic resources.

19. Linda Maher, *The Environment and the Domestic Regulatory Framework For Biotechnology*, 8 J. ENVTL. L. & LITIG. 133, 135 (1993).

The second development is the emergence of modern intellectual property law.[20] Without the protection of intellectual property rights, private actors would be unable to recover the costs expended to develop products from wild genetic resources.[21] Although intellectual property laws vary from country to country, the United States provides a very broad range of protection.[22] A patent will be granted for an invention or discovery that requires a notable input of human effort and ingenuity.[23] Federal law provides that "[w]hoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor . . . ."[24]

United States patent law has evolved with the growth of the biotechnology industry. In the United States, patents are not generally issued on unmodified, wild organisms.[25] Instead, they are granted based on the discovery and use of information from these organisms. The U.S. Patent and Trademark Office issued a patent to Louis Pasteur for a vaccine developed from a microorganism in 1873 and regularly granted patents for bacterial and viral vaccines thereafter.[26] The Plant Patent Act of 1930[27] and the Plant Variety Protection Act of 1970[28] extended intellectual-property protection to different breeding techniques in plants.[29] In 1980, the United States Supreme Court held that a genetically engineered bacterium "capable of breaking down multiple components of crude oil" could be patented.[30] Today, the U.S. grants patents on novel DNA sequences, genes, plant parts, plant or animal varieties, and biotechnological processes.[31]

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20. The relationship between biotechnology and intellectual property law is extremely complex, and this Comment provides a very simple overview. For a deeper investigation, see Amy E. Carroll, *Not Always the Best Medicine: Biotechnology and the Global Impact of U.S. Patent Law*, 44 AM. U. L. REV. 2433 (1995).

21. *See* AFRICAN CENTRE FOR TECHNOLOGY STUDIES, BIODIPLOMACY: GENETIC RESOURCES AND INTERNATIONAL RELATIONS 247 (Vicente Sanchez & Calestous Juma eds., 1994) [hereinafter BIODIPLOMACY].

22. *See* BIODIVERSITY PROSPECTING, *supra* note 3, at 21-22. The broad range of protection exists because the United States has a lower standard for granting patents on living material than European countries. *Id.*

23. *See, e.g.*, BIODIPLOMACY, *supra* note 21, at 249.

24. 35 U.S.C. § 101(a) (1994).

25. *See* BIODIVERSITY PROSPECTING, *supra* note 3, at 20, 168 (detailing evolution of growth in patents and showing wild plants and raw extracts are unpatentable).

26. Roger A. Sedjo, *Property Rights, Genetic Resources, and Biotechnological Change*, 35 J.L. & ECON. 199, 206 (1992).

27. 35 U.S.C. § 161 (1994).

28. 7 U.S.C. § 2402(a) (1994).

29. Sedjo, *supra* note 26, at 207. The statute extends protection to asexual reproduction in plants.

30. Diamond v. Chakrabarty, 447 U.S. 303, 305 (1980).

31. BIODIPLOMACY, *supra* note 21, at 249.

In other countries, the level of patent protection varies.[32] While Europe and Japan have intellectual property regimes that are nearly as strong as the United States regime, other countries have weaker schemes.[33] Many "developing countries exclude drugs and/or biological materials from patent protection."[34]

B. How Bioprospecting Drives the Biotechnology Industry

Biotechnology companies use living organisms found on public land in two ways. They use the physical components of an organism either directly to make a product, or for the information those organisms contain.

The former use encourages rivalry because the use of the physical components of an organism prevents another from using them.[35] For example, a pharmaceutical company might harvest from public land thousands of trees that contain a valuable chemical, extract this chemical, purify it, and market it as a drug. This activity is akin to traditional extractive uses—logging, in this example—and can usually be addressed using traditional natural resource laws.

The latter is nonrivalrous because the extraction of information by one individual does not prevent the extraction of the same information by another individual.[36] Most biotechnology companies value living organisms found on public land for the information they contain. Two general types of information are valuable. First, the organism may provide a "chemical blueprint" by producing natural chemicals that provide information and ideas about developing useful synthetic chemicals and compounds.[37] Second, the organism "may be the source of a gene or . . . genes with desired genetic traits," that can be used to develop a new plant or animal through conventional breeding or genetic engineering.[38] When a company values an organism only for the information it contains, it usually needs to remove just one of the organisms from the ecosystem to get this information. For example, if a pharmaceutical company wanted to use a chemical found in a tree as a "blueprint" to enable the company to synthesize the

32. *See generally* Mark A. Urbanski, *Chemical Prospecting, Biodiversity Conservation, and the Importance of International Protection of Intellectual Property Rights in Biological Materials*, 2 BUFF. J. INT'L L. 131 (1995) (discussing intellectual property protection for biotechnology in United States and international law).

33. Carroll, *supra* note 20, at 2441.

34. BIODIPLOMACY, *supra* note 21, at 249.

35. *See* Stone, *supra* note 7, at 597.

36. *Id.*; *see also* BIODIVERSITY PROSPECTING, *supra* note 3, at 3 (challenging the economists' definition of genetic resources).

37. Sedjo, *supra* note 26, at 201. For example, aspirin is a synthesized version of the natural chemical salicylic acid. The Bayer company profited from the exclusive right to this process for an extended period. *Id.* at 201 n.8.

38. Sedjo, *supra* note 26, at 201.

chemical in the laboratory, it might only need to remove one tree, perhaps just one leaf, in order to get the necessary information.[39] Because it is nonrivalrous and does not harm the ecosystem, this type of natural resource use is not akin to traditional extractive uses,[40] and is the focus of this Comment.

Living organisms with valuable genetic information are available from several sources. Some are available through organized *ex situ* conservation programs such as zoos, botanical gardens, and germ plasm banks.[41] However, only a tiny fraction of genetic information has been preserved in this way.[42] Most of the genetic information that is valuable to biotechnology companies remains in the wild.

The search of wild biodiversity for valuable genetic information is known as "bioprospecting."[43] While some bioprospecting takes place on private land, public land offers an often less developed source of biodiversity which harbors a greater variety of wild genetic resources.[44] Most bioprospecting is done by intermediaries—third parties who collect and inventory wild genetic resources and then sell the samples to biotechnology companies.[45] Some intermediaries are nonprofit organizations, which do not seek a direct economic gain from their activities, and often make the results of their bioprospecting available free-of-charge to any interested party.[46] Many biotechnology companies also participate directly in bioprospecting activity.[47] The biotechnology companies then use these genetic and biochemical samples in a variety of ways.

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39. *See* Stone, *supra* note 7, at 597-8.

40. *See, e.g.,* Michael D. Lemonick, *Seeds of Conflict*, TIME, Sept. 25, 1995, at 50.

41. *See* Sedjo, *supra* note 26, at 201-03.

42. *Id.* at 203.

43. This process is also known as "biodiversity prospecting." *See* BIODIVERSITY PROSPECTING, *supra* note 3, at 1. *Cf. Urbanski*, *supra* note 32, at 132, whose use of the term "chemical prospecting" should be distinguished from bioprospecting because strictly speaking it means a search for "new medicinals, agrochemicals, and other substances of use from animal, plant or microbial sources." *Id.* Thus, it is the search for chemicals as opposed to a search for genetic material.

44. *See* Michael Milstein, *Yellowstone Managers Eye Profits from Hot Microbes*, 264 SCIENCE 655, 655 (1994).

45. *See* Sedjo, *supra* note 26, at 209 (explaining that the "three players . . . typically involved [in dealing with wild genetic resources are]: (1) the country in which the genetic resource resides, (2) the user or developer of commercial products that uses genetic resources as an input . . . , and (3) the collector who actually collects and inventories the plants and who may do some preliminary screening for potential uses").

46. *See generally* BIODIVERSITY PROSPECTING, *supra* note 3, at 24-26. While these generous organizations exist, little information exists about to whom they give their results. *Id.*

47. Perhaps the most notable example is the Danish pharmaceutical company Novo Nordisk. One publication reports that employees are encouraged to take soil-collection kits with them on their international vacations in order to gather enzyme-producing microbes. Julia Flynn, *Novo Nordisk's Mean Green Machine*, BUS. WK., Nov. 14, 1994, at 72, 72.

The pharmaceutical industry has been one of the major beneficiaries of bioprospecting activity. Approximately thirty-five percent of the medicine used in the United States today derives from plants, animals, or microorganisms.[48] Notable examples include Vincristine and Vinblastine, two anti-cancer agents derived from Madagascar's Rosy Periwinkle plant,[49] Invermectin, an anti-parasitic veterinary drug developed from a Japanese soil microorganism,[50] and Capoten, a new heart drug developed from the venom of the Brazilian pit viper.[51] There also are promising signs that an anti-HIV drug will one day be developed from a natural compound; different plant chemicals from Australia, Malaysia, and Cameroon all have been shown to have properties that inhibit the HIV virus.[52]

These products can be extremely lucrative to the companies that develop and market them. Annual sales of Vincristine and Vinblastine, Invermectin, and Capoten have amounted to $100 million,[53] $100 million,[54] and $1.8 billion respectively.[55] Plant-derived drugs alone accounted for $15.5 billion in sales in 1990.[56]

Wild genetic resources also play an important role in the agricultural industry. These resources have been used in traditional crossbreeding for thousands of years. Genetic material from developing countries is the basis for 95.7% of the global production of the twenty most important food crops.[57] For example, wild potatoes from Peru are used regularly to invigorate and improve existing varieties of commercial potatoes,[58] and an Ethiopian barley plant was used to develop a fungus-resistant commercial strain in America.[59] The value added

48. Nick Tate, *The Ant Man Speaks*, BOSTON HERALD, Apr. 17, 1994, (Magazine), at 9.

49. Joseph Wallace, *Back to Nature: Renewed Attention to Plants as Sources of Medicine*, ACROSS THE BOARD, May 1993, at 34..

50. Michael D. Coughlin, *Using the Merck-INBio Agreement to Clarify the Convention on Biological Diversity*, 31 COLUM. J. TRANSNAT'L L. 337, 357 (1993).

51. *Toad Cure for Cold? Could Be*, CHI. TRIB., Dec. 25, 1994, at C4.

52. *See* Jeff Nesmith, *"Nature is the Supreme Chemist,"* HOUS. CHRON., Jan. 16, 1994, at 6.

53. BIODIVERSITY PROSPECTING, *supra* note 3, at 15.

54. Coughlin, *supra* note 50, at 357 (disclosing that Merck's sales alone for this drug were $100 million in 1991).

55. *See Toad Cure for Cold? Could Be*, *supra* note 51, at 4.

56. Steven M. Rubin & Stanwood C. Fish, *Biodiversity Prospecting: Using Innovative Contractual Provisions to Foster Ethnobotanical Knowledge, Technology, and Conservation*, 5 COLO. J. INT'L ENVTL. L. & POL'Y 23, 27 (1994).

57. BIODIPLOMACY, *supra* note 21, at 52.

58. Sedjo, *supra* note 26, at 205.

59. Karen Anne Goldman, *Compensation for Use of Biological Resources Under the Convention on Biological Diversity: Compatibility of Conservation Measures and Competitiveness of the Biotechnology Industry*, 25 LAW & POL'Y INT'L BUS. 695, 701 (1994).

to the United States agricultural products through crossbreeding with wild varieties of plants is estimated to be $1 billion per year.[60]

Recently, genetic engineering technology has increased the potential value of wild genetic resources to the agricultural industry. Scientists already have "created" forty new species of food and fiber crops through genetic engineering. For example, a frost-resistant tobacco plant has been created by transferring a natural anti-freeze producing gene from a flounder,[61] and new pest-resistant strains of corn, cotton and potatoes have been created by transferring a gene from a soil bacterium.[62] The World Bank reports that world-wide sales of bioengineered agricultural products will be between $10 and $100 billion by the year 2000.[63] Genetic engineering also is being used to create new types of animals, such as laboratory mice with a predisposition to a given disease, and fish with cold-tolerance and rapid growth rates.[64]

Wild genetic resources also have significant promise for a variety of other industries. Already, genetically modified organisms are used to improve mining, wastewater treatment, and bioremediation processes.[65] In addition, the natural-enzyme business, which develops substitutes for synthetic chemicals, is growing rapidly.[66] Chemicals taken from India's Neem tree have been patented as a natural insecticide,[67] and chemicals taken from Africa's Endod berry have been patented as a natural molluscicide.[68] It is likely that still other industries will discover valuable uses for wild genetic resources as technology advances.[69]

Of course, developing a new product from wild genetic resources is a long and complicated process. In the pharmaceutical industry, one commentator likens the screening of natural chemical samples in this instance to playing a lottery; hitting a "jackpot" is not a common occurrence.[70] Generally, "only about one in 10,000 chemicals yields a promising lead."[71] Even when a natural chemical shows promise, company chemists often must modify the structure to improve upon

60. *Id.*
61. BIODIVERSITY PROSPECTING, *supra* note 3, at 14.
62. *E.P.A. Approves Three Genetically Altered Crops*, N.Y. TIMES, Apr. 11, 1995, at A23.
63. Reid, *supra* note 15, at 49.
64. Dorothy W. Bisbee, *Preparing for a Blue Revolution: Regulating the Environmental Release of Transgenic Fish*, 12 VA. ENVTL. L.J. 625, 627 (1993).
65. BIODIVERSITY PROSPECTING, *supra* note 3, at 15.
66. *See* Flynn, *supra* note 47, at 66.
67. Lemonick, *supra* note 40, at 38.
68. Rubin & Fish, *supra* note 56, at 28.
69. Sedjo, *supra* note 26, at 199-200.
70. *Id.* at 204.
71. BIODIPLOMACY, *supra* note 21, at 245.

it.[72] It takes an average of twelve years and $231 million before a drug is ready for market.[73] Other industries require similar expenditures of time and money on research and development. Thus, although nature provides a lot of raw material for the biotechnology industry, substantial effort is required to transform this raw material into commercial products.

C. *The International Legal Framework*

Bioprospecting is a relatively new type of natural resource use, which has raised an interesting legal question: should the government controlling land containing potentially valuable wild genetic resources profit when bioprospectors remove these resources? Traditionally, wild genetic resources were considered a "common heritage of humankind" that should be available without restriction.[74] However, the international understanding on this issue has recently changed.

Historically, collection rights generally were granted for free by the country in which the wild genetic resources were found.[75] Biotechnology companies justified this free access by arguing that their use of these resources led to benefits that accrued to all the people of the world. However, such use also often led to immense profits for private companies. As time passed it seemed that multinational corporations got rich while developing countries saw few benefits from conserving their biodiversity, which was often done only at the expense of promoting other activities, such as logging and agriculture.[76]

Many developing countries thought this situation was unfair, and began to argue for changes. They maintained that they had the right to benefit from their genetic resources, just as countries blessed with large coal or oil deposits benefit from the sale of those materials.[77] One commentator puts it succinctly when he compares bioprospecting and logging, saying "[n]obody would expect a nation to let a private company log its public lands without reimbursing the state."[78]

The country of Costa Rica was an early proponent of such changes. By the end of the 1980s, Costa Rica had abandoned the tra-

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72. *See* Tate, *supra* note 48, at 9.
73. BIODIPLOMACY, *supra* note 21, at 244.
74. Sedjo, *supra* note 26, at 202.
75. *Id.* at 209.
76. Shayana Kadidal, Note, *Plants, Poverty and Pharmaceutical Patents*, 103 YALE L.J. 223 (1993). The story of Vincristine and Vinblastine provides one example of this phenomenon. These anti-cancer drugs were developed from Rosy Periwinkle plants taken from a highly-threatened ecosystem in Madagascar. The Eli Lilly company made hundreds of millions of dollars from these products, and Madagascar received nothing. *See* Rubin & Fish, *supra* note 56, at 27.
77. BIODIVERSITY PROSPECTING, *supra* note 3, at 23.
78. Reid, *supra* note 15, at 53.

dition of providing free and unlimited access to its wild genetic resources. Instead, it had established a non-profit scientific organization, INBio, to regulate such access. A new law allowed INBio and the government to allocate bioprospecting concessions in return for some form of compensation.[79] In 1991, INBio signed a landmark contract with the Merck pharmaceutical company. INBio agreed to provide 10,000 chemical samples from plants, animals, and soil to the pharmaceutical company, which would have the exclusive right to analyze these samples for two years. In consideration, Merck paid INBio $1 million and gave INBio $130,000 worth of scientific equipment. In addition, Merck agreed to pay INBio a royalty on worldwide sales of any pharmaceutical products refined from or based on a compound found in one of the provided chemical samples.[80] Fifty percent of these royalties will be paid to Costa Rica's National Park Fund.[81] The exact royalty provisions are kept secret, but articles report that the royalty payments will vary between five and sixty percent depending on the type of genetic material.[82] The Merck-INBio agreement received considerable attention because it represented a sharp break from the "common heritage of humankind" tradition.

The Convention on Biological Diversity, popularly known as the "Biodiversity Treaty,"[83] sanctioned the basic tenets of Costa Rica's approach, by providing that source countries of valuable wild genetic resources have a right to share the financial benefits resulting from the commercial use of these resources.[84] Such an approach is consistent with three related goals of the Biodiversity Treaty: (1) to promote the worldwide conservation of biodiversity; (2) to encourage the sustainable development of genetic resources; and (3) to ensure that the benefits of this development are shared in a fair and equitable manner.[85]

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79. *See* BIODIVERSITY PROSPECTING, *supra* note 3, at 71-72. The new law was not created for this purpose, however; it merely created the opportunity for INBio to require prospectors to pay the hidden prospecting costs when the government decided to use INBio as a means of regulating access. *Id.*

80. David R. Downes, *New Diplomacy for the Biodiversity Trade: Biodiversity, Biotechnology and Intellectual Property in the Convention on Biological Diversity*, 4 TOURO J. TRANSNAT'L L. 1, 8 (1993).

81. Reid, *supra* note 15, at 50.

82. Neil D. Hamilton, *Who Owns Dinner: Evolving Legal Mechanisms for Ownership of Plant Genetic Resources*, 28 TULSA L.J. 587, 629 (1993).

83. The Biodiversity Treaty was a product of the United Nations Conference on Environment and Development, popularly known as the "Earth Summit," held in Rio de Janeiro in 1992. *See* Coughlin, *supra* note 50, at 341. Treaty negotiations actually began in November 1990 under the auspices of the United Nations Environment Programme. *Id.* at 340-41.

84. *See* BIODIVERSITY PROSPECTING, *supra* note 3, at 294 (discussing Article 15 of the Biodiversity Treaty).

85. *Id.* at 290.

The first sections of the Treaty delineate the steps that each signatory country should take to conserve biodiversity. For example, Articles 8 and 9 encourage a variety of *in situ* and *ex situ* conservation techniques.[86] The latter sections of the Treaty, primarily Articles 15, 16 and 19, address issues particularly relevant to bioprospecting and the commercial use of wild genetic resources.

Article 15 establishes that nations have sovereign rights over their genetic resources, and that the authority to determine access to these resources rests with the individual national government.[87] It then states general principles by which the source country can contract with other entities[88] to provide access to genetic resources. Access must be on mutually agreed terms and requires the prior informed consent of the country that provides the genetic resources.[89] Any agreement must aim to share in a fair and equitable way the benefits accruing from the commercial use of the genetic resources.[90] Furthermore, the source country has a duty to facilitate access to genetic resources for environmentally sound uses by other contracting parties.[91]

Article 16 establishes that signatory countries will undertake to provide access to and transfer technology that is relevant to biodiversity conservation and sustainable development generally,[92] and specifically discusses sharing technology developed from wild genetic resources with the country that provided the resources.[93] Thus, Article 16 treats access to technology in a manner that parallels the provisions for access to genetic resources in Article 15.

Article 19 also discusses technology transfer, and focuses on biotechnology. That section establishes that countries will take measures to include other countries in biotechnology research efforts, especially developing countries that provide genetic resources for such research.[94] It reiterates that technology developed from wild genetic re-

86. *See id.* at 292-93.

87. Biodiversity Treaty, *supra* note 6, art. XV, para. 1, 31 I.L.M. at 828.

88. Although the language is somewhat vague, and refers only to "contracting parties," commentators have argued that the text of the Convention suggests that the negotiators intended the access and benefit sharing provisions to include private actors as well as countries. *See The Convention on Biological Diversity: Hearing Before the Senate Committee on Foreign Relations*, 103d Cong., 2d Sess. 47 (1994) (statement of Dr. Walter Reid, Vice President for Program at the World Resources Institute) (referring to companies, not just countries, being able to make contracts involving genetic resources) [hereinafter Reid Testimony].

89. Biodiversity Treaty, *supra* note 6, art. XV, paras. 4-5, 31 I.L.M. at 828.

90. Some commentators suggest that the Merck-INBio contract provides a good example of such an agreement. *See* Coughlin, *supra* note 50, at 368; Biodiversity Treaty, *supra* note 6, art. XV, para. 7, 31 I.L.M. at 828.

91. Biodiversity Treaty, *supra* note 6, art. XV, para. 2, 31 I.L.M. at 828.

92. *Id.* art. XVI, para. 1, 31 I.L.M. at 829.

93. *Id.* para. 3, 31 I.L.M. at 829.

94. *Id.* art. XIX, para. 1, 31 I.L.M. at 830.

sources should be shared with the country that provided these resources.[95]

The convoluted language of these three articles has been controversial.[96] All three include vague phrases such as "mutually agreed terms" and "as appropriate."[97] The United States initially made a worst-case interpretation of the language, arguing that Articles 16 and 19 mandated the revelation of trade secrets to countries with insufficient intellectual property laws, and would thus cause serious damage to the domestic biotechnology industry.[98] Other industrialized countries did not appear unduly worried about these terms, probably thinking that they were too vague to be enforced.[99] Virtually all commentators read this language as promoting technology transfer rather than absolutely requiring it,[100] particularly because the Treaty is a "framework" document that establishes general obligations for the signatories rather than legally binding targets for specific actions.[101]

The American response to the Treaty has varied. Although 153 nations signed the Convention on Biological Diversity at the Earth Summit,[102] President Bush refused to sign, citing his worries about the vague language.[103] The Clinton administration, while in part sharing this view, signed the Convention on June 4, 1993.[104] The Clinton administration appears to view these controversial sections as advocating monetary payments in return for access to wild genetic resources rather than mandating technology transfer to countries with weak or nonexistent intellectual property laws.[105]

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95. *Id.* para. 2, 31 I.L.M. at 830.

96. *See* BIODIVERSITY PROSPECTING, *supra* note 3, at 295, 299. The ambiguities were probably a result of substantive disagreement or the pressure to hastily conclude negotiations. Coughlin, *supra* note 50, at 344.

97. *See* Biodiversity Treaty, *supra* note 6, art. XV, paras. 4, 7, 31 I.L.M. at 828.

98. BIODIVERSITY PROSPECTING, *supra* note 3, at 295.

99. *But see* Coughlin, *supra* note 50, at 346. Some of these countries submitted their interpretations of controversial language at the time they signed the document. *Id.* at 344.

100. If Article 16 is interpreted as requiring forced technology transfer, then Article 15, with its similar wording, must be interpreted as requiring the forced provision of wild genetic resources. This interpretation should prevent developing countries from making this argument. *See* BIODIVERSITY PROSPECTING, *supra* note 3, at 295.

101. Reid Testimony, *supra* note 88, at 46. Furthermore, the United States could always withdraw from the treaty under Article 38 if it feels that it is being implemented improperly. *Id.*

102. Coughlin, *supra* note 50, at 341.

103. *See* Hardy, *supra* note 16, at 317-19. The Bush administration also was worried about the funding mechanisms of the Biodiversity Treaty. Coughlin, *supra* note 50, at 349.

104. *U.S. Signs Biodiversity Treaty, Urges Global Patent Protection for Biotech*, 16 Int'l Env't Rep. (BNA) 432 (June 16, 1993).

105. Hardy, *supra* note 16, at 320-22. At least one other commentator has suggested that this view is consistent with the Biodiversity Treaty. *See* Coughlin, *supra* note 50, at 361.

The Biodiversity Treaty was enacted internationally on December 29, 1993.[106] After President Clinton signed the treaty, it was sent to the Senate for ratification. The Senate, however, failed to ratify the treaty in 1994[107] or 1995.[108] The United States therefore had "observer" status when the 106 countries that had ratified the treaty by August 30, 1994, met in the Bahamas to discuss implementation in November and December of 1994.[109] This "Conference of the Parties" is expected to be an annual event for several years and should allow countries to work out various details of the treaty.[110] If the Senate ratifies the treaty this session, the United States will be able to participate in future negotiations that interpret the Biodiversity Treaty.

Debate about the Biodiversity Treaty's terms continues, and it will probably be years before consensus is reached on all issues. By stating that source countries have a right to contract for an agreement that will share the benefits of any commercial use of their wild genetic resources, however, Article 15 unequivocally abolishes the "common heritage of humankind" approach, and formalizes instead the new international view that source countries of wild genetic resources can expect some form of compensation for their use.[111]

In the aftermath of the international adoption of the Convention on Biological Diversity, many countries are moving to seek economic returns from the commercial use of their wild genetic resources. Developing countries, which have a disproportionately large portion of these resources,[112] have been particularly enthusiastic about this approach.[113] They, along with environmentalists, hope that bioprospecting fees will provide an economic example of the benefits of biodiversity conservation, and that resulting revenues can be used to

106. BIODIPLOMACY, *supra* note 21, at 12.

107. Most, although not all, industry groups have stopped opposing the Convention after reassurance from the Clinton administration. Daniel H. Cole, *Missing Out on the Biodiversity Action*, INDIANAPOLIS STAR, Oct. 12, 1994, at A9.

108. Tim Hilchey, *Biodiversity Study Sees More Species in Danger*, N.Y. TIMES, Nov. 14, 1995, at C9.

109. *See Parties to Biodiversity Treaty Make Some Progress on Implementation*, BUS. & ENV'T, Jan. 1, 1995, *available in* 1995 WL 8380297 [hereinafter *Parties to Biodiversity Treaty*] (stating that of 167 countries that signed the treaty, "only 106 ratified in time to qualify as parties at this meeting").

110. *See id.* (describing the conference agenda for 1995 and 1996).

111. The Merck-INBio agreement provides a good example of what "appropriate" compensation should be under the Treaty; the agreement includes funds for the Costa Rican institute to purchase scientific equipment and provides for direct royalty payments, but does not require Merck to disclose any trade secrets developed from using the wild genetic resources that Costa Rica provides. *See* Coughlin, *supra* note 50, at 356.

112. *See* BIODIPLOMACY, *supra* note 21, at 52.

113. *See* Goldman, *supra* note 59, at 704-06.

fund further conservation.[114] It is not clear how much money these bioprospecting fees could raise. Some experts believe that initial enthusiasm may have been overstated, pointing out that the actual returns from bioprospecting fees are likely to be modest,[115] although others remain more optimistic.[116] Even a modest return is better than no return, however, and many countries are looking forward to seeing the financial reward that their new bioprospecting regulations will bring.

Mexico, Indonesia, and Kenya all have established their own versions of Costa Rica's INBio.[117] Indonesia even has considered establishing a Biodiversity Commercialization and Marketing Board.[118] Venezuela and Columbia are working to develop similar legal mechanisms for the nations of the Andean Pact.[119] Experts expect that countries will continue to enact legislation to govern bioprospecting and to seek compensation from the commercial use of their wild genetic resources.[120] These countries will face difficult administrative, technological, and enforcement issues as they seek to develop policies and institutions that are charged with this task.[121]

Developing countries are not alone in following Costa Rica's lead. Many industrial countries also are showing that they expect to benefit from the use of their wild genetic resources. For example, Australia has pushed vigorously to receive a share of the commercial benefits that result from any use of a chemical found in one of its shrubs that has shown promise in fighting HIV.[122]

Several United States organizations have taken active steps to support the new understanding that countries should be compensated when their wild genetic resources lead to commercial profit. The National Cancer Institute's Natural Products Branch is one example. This government agency tests plant samples from throughout the

114. *See id.* at 707.

115. For example, Costa Rica's INBio organization has not received any royalty payments from bioprospecting contracts during its first six years in existence. Michael Milstein, *The Microbe Hunt; Costa Rica Stakes Future on Rich Value of Nature*, SAN DIEGO UNION-TRIBUNE, March 27, 1996, at E1.

116. *See* BIODIPLOMACY, *supra* note 21, at 244-46. For example, because the likelihood of finding a successful commercial product is much higher for natural products than chemicals, expected gains could be much higher than anticipated, with receipts from the royalty estimated at $46 million for a "blockbuster" drug. *Id.* For an explanation of "blockbuster" see *infra* part III.A.

117. Reid, *supra* note 15, at 51.

118. *Id.*

119. The Andean Pact is an economic agreement uniting Venezuela, Colombia, Bolivia, Ecuador, and Peru. *Parties to Biodiversity Treaty*, *supra* note 109.

120. Reid, *supra* note 15, at 51-54.

121. BIODIPLOMACY, *supra* note 21, at 54-56.

122. Reid, *supra* note 15, at 51.

world for anti-cancer potential.[123] The organization's policy is to return a portion of the profits made on any new drug developed from a plant to the area where the plant grows, and it expresses this policy through a formal letter of intent.[124] Shaman Pharmaceuticals is another example. This private company seeks to develop pharmaceuticals from natural sources using ethnobotanical knowledge, and has created a non-profit organization to return a portion of its profits to source countries.[125]

Despite the recent international developments in this area, the United States government has not yet addressed the bioprospecting issue with regard to domestic land. It is time for it to do so. Although the United States does not possess the stunning biodiversity of a tropical rainforest country,[126] recent developments suggest that it has a significant level of potentially valuable wild genetic resources, and that the amount of domestic bioprospecting activity is greater than one might think.[127]

D. Domestic Law

Federal land law is comprised of agency mandates to manage particular lands and particular resources, as well as more general environmental statutes.[128] Taken together, these laws do not provide clear guidance on the bioprospecting issue, largely because they were enacted before modern technology made such activity so potentially lucrative. The vast majority of public land is under the control of the Department of the Interior or the Department of Agriculture.[129]

1. Agency Mandates

The Department of Agriculture and three agencies of the Department of the Interior—the Bureau of Land Management, the National Park Service, and the Fish and Wildlife Service—exercise significant control over federal land. Each group is responsible for determining the range of appropriate activities that can occur on the land under its control.

The Department of Agriculture manages the National Forests through the Forest Service.[130] National Forests were originally "re-

123. Wallace, *supra* note 49, at 34.
124. *Id.* at 36.
125. Asebey & Kempenaar, *supra* note 7, at 732-33.
126. The United States has been characterized as a "gene-poor" nation. Hardy, *supra* note 16, at 317.
127. *See infra* part II.
128. Marla E. Mansfield, *A Primer of Public Land Law*, 68 WASH. L. REV. 801, 802 (1993).
129. *See id.* at 832-52 (describing the jurisdiction for public lands).
130. *Id.* at 838-42.

served" from the public domain in order to protect watersheds and produce timber.[131] The National Forest Management Act of 1976[132] expanded these original purposes to allow "multiple uses," including recreation, grazing, wildlife preservation, and mineral exploration, although timber and watershed considerations are still considered to be the primary purposes.[133]

The Bureau of Land Management (BLM) manages the portion of the public domain that has not been reserved for other purposes.[134] In 1976, Congress passed the Federal Land Policy and Management Act (FLPMA)[135] in an attempt to provide direction to the BLM. FLPMA establishes an open-ended "multiple use" goal, and identifies the major uses of BLM land as "[d]omestic livestock grazing, fish and wildlife development and utilization, mineral exploration and production, rights-of-way, outdoor recreation, and timber production."[136] The BLM is directed to manage land for multiple and diverse resource uses that take into account the long-term needs of future generations for renewable and nonrenewable resources.[137]

The National Park Service manages National Parks, Monuments, Recreation Areas and certain other properties.[138] The Congress or the President designates federal land to be placed under the Service's control and provides formal guidelines for management.[139] The National Park Service Organic Act[140] provides additional guidance. It limits the uses of national parkland to preservation and recreation, and prohibits hunting and mining.[141]

The Fish and Wildlife Service manages the National Wildlife Refuge System. The National Wildlife Refuges, like the National Parks, are created by specific government guidance and subject to general legislation[142] such as the National Wildlife Refuge System Administration Act of 1966.[143] Generally, the Fish and Wildlife Service must give priority to wildlife preservation, but can authorize a variety of

131. *Id.*
132. 16 U.S.C. §§ 1601-1687 (1994).
133. Mansfield, *supra* note 128, at 840.
134. *Id.* at 832.
135. 43 U.S.C. §§ 1701-84 (1994).
136. *Id.* § 1702(l).
137. *Id.* § 1702(c).
138. Mansfield, *supra* note 128, at 842.
139. *Id.*
140. 16 U.S.C. §§ 1-4 (1994).
141. Mansfield, *supra* note 128, at 844.
142. *Id.* at 846-48.
143. 16 U.S.C. §§ 668dd-668jj (1994).

secondary uses when appropriate.[144] Unlike the National Parks, the refuges support hunting and mining.[145]

These individual agencies are responsible for determining the range of appropriate activities that can take place on the land under their control. For example, each agency must determine if logging is appropriate on any given parcel of land under its control, and if it is appropriate, then how the activity should be managed. Such a decision is often controversial, especially because promoting one type of activity on federal land may preclude or reduce another type of activity. For example, promoting backpacking and camping is generally incompatible with promoting open-pit mining in the same area.

How do the land management agencies regulate various activities on their lands? First, they look to the statutes that give specific authorization and direction to their agency. Thus, the National Park Service looks to the Organic Act of 1916, the Forest Service looks to the National Forest Management Act of 1976, the Bureau of Land Management looks to the FLPMA, and the Fish and Wildlife Service looks to the National Wildlife Refuge Administration Act of 1966.[146]

2. *Congressional Legislation*

Congress has passed legislation that addresses specific activities on federal land, and that cuts across agency boundaries. For example, the Mining Law of 1872[147] applies to BLM lands and the National Forests.[148] That law allows the exploration and purchase of federal land containing valuable mineral deposits.[149] The Wilderness Act[150] is another example. That act allows Congress to direct any of the four management agencies to manage certain lands under their control with the express purpose of preserving the land's wilderness character.[151] The act specifically forbids most commercial enterprises.[152] Other laws target one agency in particular. For example, the National Forest Ski Area Permit Act of 1986[153] gives the Forest Service particular direction with regard to that activity.

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144. Mansfield, *supra* note 128, at 846-48.

145. *Id.*

146. *See generally* COGGINS & WILKINSON, *supra* note 2, at 160-65 (describing the divisions of the four principal federal land management agencies).

147. 30 U.S.C. § 22 (1994).

148. Mansfield, *supra* note 128, at 832-42.

149. 30 U.S.C. § 22 (1994). The only limitation on exploration is from the standard statutory clause "except as otherwise provided." *Id.* Some minerals are no longer covered by this Act. COGGINS & WILKINSON, *supra* note 2, at 421.

150. 16 U.S.C. §§ 1131-1136 (1994).

151. Mansfield, *supra* note 128, at 848-50.

152. 16 U.S.C. § 1333(c) (1994).

153. 16 U.S.C. § 497b (1994).

Given the multifarious sources of federal land law, one can only surmise its position on bioprospecting. Current laws probably authorize bioprospecting as a commercial natural resource use on BLM land and in the National Forests because these agencies are given great discretion to promote multiple uses of the lands under their control. Current law probably authorizes bioprospecting on National Wildlife Refuges, because the Fish and Wildlife Service has a fairly open-ended directive as well.

However, current law does not appear to authorize bioprospecting in National Parks and Wilderness Areas. The relevant laws generally forbid commercial natural resource extraction in these areas.[154] To the extent that bioprospecting is viewed as a commercial natural resource extraction, current law probably does not authorize it in National Parks and Wilderness Areas. Yellowstone National Park provides an example. Yellowstone land managers currently allow bioprospecting in park hot springs,[155] apparently characterizing this activity as "scientific research," for which free permits traditionally have been granted.[156] But the federal statute that created Yellowstone National Park prohibits "the wanton destruction of the fish and game found within the park . . . for the purposes of merchandise or profit."[157] When biotechnology companies remove thermally adapted microbes from the park with the express aim of using these microbes to develop million-dollar products, they probably violate this command. The current bioprospecting activity in Yellowstone may be illegal, although no one has brought a legal challenge thus far.

Even where current law seems to authorize bioprospecting, it does not give clear guidance on whether and how bioprospectors should be charged for this activity. If Congress does not provide authoritative direction on the issue, individual agencies may characterize bioprospecting as "hunting," "mining," "logging," or "scientific research." The permissibility of the use, and the degree of compensation sought for such activity, might vary widely depending on the characterization. Such a result would be confusing to both bioprospectors and the biotechnology industry.

Clear guidance is needed on the domestic bioprospecting issue. The current situation in Yellowstone alone demands attention. Researchers from various biotechnology companies are taking living organisms of tremendous commercial value from Yellowstone hot

154. *See id.* § 1133(c) (generally prohibiting commercial enterprises in Wilderness Areas, except for previously-existing uses or to further recreational purposes).

155. See *infra* part III.B. for a discussion of this situation.

156. *See* Michael Milstein, *Research in Park Under Scrutiny*, BILLINGS GAZETTE, Jan. 2, 1995, at 1.

157. *See* 16 U.S.C. § 22 (1994).

springs, and park managers admit that they do not know how to approach this issue.[158] Federal land managers will probably face similar questions in the future as biotechnology becomes more advanced and our knowledge about domestic biodiversity grows.

II.
BIOPROSPECTING IN THE UNITED STATES

This part begins by establishing that—perhaps contrary to expectations—biotechnology companies recently have been hard at work extracting wild genetic resources from United States public land, already have developed valuable products from these activities, and are likely to continue to do so in the future. The purpose of this overview is to convince the reader that the bioprospecting question is an important domestic public land use issue, rather than an academic question of interest only to tropical rainforest countries. This part continues by investigating how current federal land laws address this situation. It concludes that current law does not provide adequate guidance on this issue, and that current law may even provide that some current bioprospecting activity is illegal.

A. Recent History

The notion that the United States does not have any valuable wild genetic resources is belied by recent history. Within the last decade, biotechnology companies have begun to market two products developed from domestic wild genetic resources.

The first product is "polymerase chain reaction" (PCR), a revolutionary DNA copying process. A microbe taken from Yellowstone National Park played a key role in the development of this product. In 1983, an employee of the Cetus corporation isolated an enzyme in *Thermus aquaticus*, a thermally-adapted microbe discovered in Yellowstone's Mushroom Spring.[159] Because the novel enzyme could survive repeated cycles of heating and cooling, it was central to the development of PCR, a new and improved way to copy DNA.[160] This

158. *See* Frank Clifford, *Simpson Case Boosts Microbe Conservation*, L.A. TIMES, Aug. 31, 1994, at A1.

159. The researcher, Kary Mullis, who later received the Nobel Prize for his discovery, obtained the microbe from a national repository of cell samples in Maryland, where a sample of *Thermus aquaticus* had been placed by the researcher who first discovered the microbe. This, then, was a case where a bioprospector made his discovery available to any interested party free of charge. *See* Michael Milstein, *PCR Molecular Technique is Hot Stuff Among Microbe Detectives*, SAN DIEGO UNION-TRIBUNE, June 1, 1994, at E1 [hereinafter *PCR Molecular Technique*].

160. *Id. See also* Alex Barnum, *How Winner of Nobel Spawned an Industry*, S.F. CHRON., Oct. 15, 1993, at B1.

process has revolutionized medical and criminological techniques.[161] The Cetus corporation obtained a patent on the isolated enzyme and on the PCR process.[162] In 1991, it sold these patent rights to the Swiss pharmaceutical firm Hoffman-Larouche for a record-breaking $300 million.[163] Hoffman-Larouche does not disclose its PCR revenues, but industry analysts estimate that sales of PCR products should top $1 billion by the late 1990s.[164]

The second product is taxol, the potent anti-cancer compound found in the bark of the Pacific Yew, a tree found primarily on federal land.[165] In the 1960s, plant collectors from the U.S. Forest Service sent samples from the bark, needles, and twigs of the Pacific Yew to the National Cancer Institute.[166] Shortly thereafter, researchers discovered that a compound in the Yew bark inhibited cancer activity.[167] Intermittent government research continued over the next thirty years, and led to the development of taxol.[168] Today, taxol is approved for treatment of some forms of ovarian and breast cancer, and clinical trials on a number of different cancers are underway.[169]

Taxol can be produced in a number of ways. The most basic way is to refine it directly from the bark of the Pacific Yew. This is the method used by Bristol-Myers Squibb to produce the drug.[170] This traditional extractive method is not the type of bioprospecting that this Comment seeks to address. However, numerous companies are experimenting with other production methods based on the "information" contained in a Pacific Yew. These methods include production from tissue cultures, semi-synthetic production and fully-synthetic production.[171] In the future, these techniques probably will be the primary method of taxol production.[172] Regardless of the production technique used, however, the taxol example provides further evidence

161. *Id.*

162. These patents withstood a major legal assault in 1991. *Id.*

163. Resa King, *A Gene Machine Starts Cloning Cash*, BUS. WK., Nov. 22, 1993, at 132.

164. *See* Barnum, *supra* note 160, at B1.

165. Douglas Daly, *Tree of Life*, AUDUBON, Mar. 1992, at 76, 78; Ralph Nader & James Love, *Looting the Medicine Chest*, PROGRESSIVE, Feb. 1993, at 26.

166. Daly, *supra* note 165, at 78.

167. *Id.* at 79.

168. *Id.* at 78-80.

169. *Id.* at 80.

170. Bristol-Myers Squibb has an effective government-granted monopoly on this means of production, since it has the exclusive rights to harvest Pacific Yews on Forest Service and BLM lands, and exclusive rights to use the extensive federal research on taxol. These exclusive rights were granted by the Bush Administration and were justified as necessary to encourage the commercial development and marketing of taxol. Nader & Love, *supra* note 165, at 26, 28.

171. Daly, *supra* note 165, at 83-84.

172. *See generally* David Perlman, *Scientists Synthesize Rare Cancer Drug*, S.F. CHRON., Feb. 11, 1994, at D4 (describing two methods of taxol synthesis developed by research teams in California and Florida).

that the Unites States harbors significant wild genetic resources. Taxol is one of the most potent anti-cancer agents discovered to date.[173] Some observers think that the annual market for taxol will eventually grow to $1 billion.[174]

B. Current Bioprospecting Activity

In light of the valuable products that already have been developed from domestic wild genetic resources, it is not surprising that bioprospectors are currently hard at work on federal lands. There is no way to determine the exact current bioprospecting rate because the federal government does not keep comprehensive records of this activity. No system tracks the eventual disposition of biological samples taken from federal land, and it seems likely that a great deal of biological samples taken from federal lands for pure scientific "research" purposes are analyzed for commercial potential without government knowledge.[175]

Although there is no way to determine the exact current domestic bioprospecting rate, the following anecdotal evidence suggests that it is significant. Yellowstone National Park is currently the subject of particularly intense activity because of its unique microbial communities. Congress established Yellowstone National Park in 1872 for people to enjoy, aiming to preserve the "wonderful forms of nature, the ever-varying beauty of the rugged landscape, and the sublimity of the scenery."[176] Unlike similar thermal fields in other areas of the world, the Yellowstone geysers have protected status and thus were not altered to generate electricity.[177] Today, Yellowstone harbors one of the world's last undisturbed thermal fields of its kind.[178]

Although Congress was not aware of this when it created Yellowstone, the park's hydrothermal springs are teeming with thermally-adapted microbes—tiny organisms that thrive in extremely hot water. Until the discovery of a bacterium in a Yellowstone hot spring in 1965, it was thought that no living thing could live in such a hot environ-

173. Tate, *supra* note 48, at 9.

174. Gene Koprowski, *Cancer-Fighting Yew Drugs May be Produced in Michigan*, GANNETT NEWS SERVICE, Mar. 29, 1995, *available in* 1995 WL 2890943.

175. This is exactly what happened with the *Thermus aquaticus* microbe. The University of Wisconsin professor who discovered the microbe simply was seeking to further human understanding of biology rather than profit, but eventually his discovery was used in a commercial way by a biotechnology company. *See PCR Molecular Technique*, supra note 159.

176. DYAN ZASLOWSKY & T.H. WATKINS, THESE AMERICAN LANDS: PARKS, WILDERNESS AND THE PUBLIC LANDS 17-19 (1994).

177. Ken Miller, *Tiny Critters Become Huge Issue for Yellowstone National Park*, GANNETT NEWS SERVICE, Oct. 7, 1994, *available in* 1994 WL 11240222.

178. *Id.*

ment.[179] Over the years, scientists have continued to discover a variety of microorganisms that populate Yellowstone's hot springs.[180]

Yellowstone's hot spring microbes were initially nothing more than a scientific curiosity. The rise of the modern biotechnology industry changed this view, however. Because these organisms have an unusual ability to withstand high temperatures, scientists hope to put them to a variety of commercial uses, ranging from oil-spill remediation, to pharmaceutical development, to improved mining techniques.[181] PCR is the first example of a commercial product that has been developed from a Yellowstone microbe, but it probably will not be the last.

Today, about forty individuals and organizations—including Promega, New England Biolabs, Novo Nordisk, Eli Lilly, and Dupont—currently have permits to take microbial samples from Yellowstone hot springs,[182] hoping that the organisms they find and study will lead to patents as lucrative as the ones that the Cetus corporation developed from *Thermus aquaticus*. Many large biotechnology companies have, or have had, these free permits.[183] Because it is reported that less than one percent of Yellowstone microbes have been identified and isolated,[184] their hopes probably will be fulfilled. One company already has a contract with the Navy to provide a non-toxic paint stripper developed from Yellowstone microbes,[185] and the energy department has patented another microbe that converts plant matter into ethanol.[186] Even well into the 1990s, researchers did not pay anything to collect these samples, and their eventual disposition was largely unregulated.[187] Recently, however, park officials have begun to talk about seeking some sort of payment from these biotechnology companies, but the process has been slow and seems hampered by the fact that current law does not provide guidance on this issue and park officials admit that they do not really know what to do.[188]

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179. *PCR Molecular Technique*, *supra* note 159.

180. Milstein, *supra* note 156, at A1.

181. *See* Miller, *supra* note 177.

182. Michael Milstein, *Yellowstone Managers Stake a Claim on Hot-Springs Microbes*, 270 SCI. 226, 226 (1995) [hereinafter *Claim on Hot-Springs Microbes*]; Miller, *supra* note 177.

183. Milstein, *supra* note 44, at 655.

184. *See* Miller, *supra* note 177.

185. *Id.*

186. *Yellowstone Microbes Yield Profits*, ROCKY MTN. NEWS, Dec. 8, 1993, at 48A.

187. *Id.* Milstein states that "[p]ark collecting permits now sanction commercial development of Yellowstone microbal strains, but only with an agreement that cuts the government in on any revenue. While no rate structure has been set . . . options run from fees or royalties to a request that companies donate 1% of profits from Yellowstone discoveries back to the park." *Claim on Hot-Springs Microbes*, *supra* note 182, at 226.

188. *Claim On Hot-Springs Microbes*, *supra* note 182, at 226.

What about bioprospecting on other federal land? One article reports that scientists are investigating bacteria from at least two other national parks, Carlsbad Caverns and Mammoth Cave, for their commercial potential.[189] Another article reports that the University of Arizona has had contracts to provide various desert plants found in the United States to pharmaceutical companies in return for direct payments,[190] although it is not clear whether or not these plants were taken from public land.

Thus, perhaps contrary to expectations, it is clear that the United States has a significant level of valuable wild genetic resources. Bioprospectors are hard at work in Yellowstone National Park and on other federal lands, and this type of activity probably will increase in coming years.

C. The Future: Why Domestic Bioprospecting May Increase

The domestic bioprospecting rate is likely to increase over the next twenty years. There are at least two reasons for this. The first is the expected continued improvement of genetic engineering techniques. As technology continues to advance, the potential uses of wild genetic resources probably will increase as well.[191] Species that do not have any current use may come to have significant commercial value in the future.[192]

The second reason is that the level of information about the wild genetic resources of the United States should increase dramatically during the next twenty years. Contemporary knowledge of national biodiversity is surprisingly low. For example, no national park has ever been the subject of a complete biological inventory, and many species remain undiscovered and unknown.[193] Between 1983 and 1993, a handful of national parks added 1,439 vascular plants to their species inventories.[194] If the national parks lack such basic information, it seems likely that the biodiversity of other federal land is understood even less.

Two independent scientific projects have been undertaken which will help remedy this problem. However, the fate of one of these remains in doubt. The first, and more certain, is the anticipated publication of a single comprehensive guide on the range and distribution of

189. *See* Clifford, *supra* note 158, at A1.

190. Sedjo, *supra* note 26, at 209 n.30.

191. Of course, these advances are not certain to result in increased bioprospecting activity, because it is always possible that scientific advances actually will reduce industry need for wild genetic resources. *See* BIODIVERSITY PROSPECTING, *supra* note 3, at 18.

192. Sedjo, *supra* note 26, at 199-200.

193. Bill Sharp & Elaine Appleton, *The Information Gap*, NAT'L PARKS, Nov.-Dec. 1993, at 33.

194. *Id.* at 34.

every plant in North America.[195] The guide, titled "Flora of North America," is to be published in fourteen volumes under the auspices of the Missouri Botanical Garden—the first two volumes have already appeared and the entire series should be completed within the next decade.[196] The extremely detailed guide also will be available on an electronic database.[197]

The second project is the former National Biological Service. An ambitious initiative of Interior Secretary Bruce Babbitt originally organized in 1993 as the National Biological Survey, this agency brought together over 1800 scientists and staff from seven different Department of the Interior bureaus.[198] It had as one of its goals the creation of a catalog of all living things in the United States.[199] This bureau was controversial from the start,[200] having budgets and staffing levels cut for fiscal years 1995 and 1996 and finally being merged into the United States Geological Survey in October 1996.[201] While original estimates had the survey possibly taking place within the next two decades,[202] this goal could be delayed significantly or frustrated entirely by such political maneuvering.

In combination, the publication of "Flora of North America" and the efforts of the U.S. Geological Survey likely will provide a level of information about the national biological makeup of the United States that is unmatched by many countries.[203] The quality of this information probably will encourage bioprospectors to work in the United States because they will be able to identify and locate promising organisms in a quick and efficient manner.

Will the biotechnology industry continue to find valuable wild genetic resources on federal land? There is no way to know for sure, but Thomas Lovejoy, a Smithsonian Institution biologist, is optimistic: "[P]eople don't realize that we really are entering an era when biotechnology makes a lot of these previously esoteric species of enormous potential economic value. If we can inventory what we have, we

195. Keith Henderson, *The Perennial Task of Cataloging Flora Blooms Once Again*, CHRISTIAN SCI. MONITOR, Jan. 11, 1994, at 12.

196. *Id.*

197. *Id.*

198. H. Ronald Pulliam, *The Birth of a Federal Research Agency*, 45 BIOSCIENCE S91 (1995).

199. Marla Cone & Melissa Healy, *Counting America's Creatures*, L.A. TIMES, Oct. 2, 1993, at A1. The Department of the Interior supplies $139 million of the $179 million budget. *Id.*

200. Some lawmakers fear that the National Biological Survey will unduly invade private property rights. Mike Christensen, *Leadership of Biological Survey Puts Georgia Ecologist in the Hot Seat*, ATLANTA CONST., July 7, 1994, at A7.

201. *Interior Recasts Biological Unit as Branch of Geological Service*, INSIDE ENERGY/WITH FED. LANDS, Oct. 7, 1996, at 13.

202. *Id.*

203. *See* Henderson, *supra* note 195, at 12.

could be sitting on a gold mine."[204] Researchers probably will continue to find more modern-day gold mines—like the Yellowstone microbes and the Pacific Yew tree—on federal public land as America enters the twenty-first century.

III.
THE FEDERAL GOVERNMENT SHOULD SEEK COMPENSATION FOR THE USE OF ITS WILD GENETIC RESOURCES

As discussed in part I.D., the federal government has failed to address the bioprospecting issue thus far. Although such activity has led to valuable commercial products, such as taxol and PCR, the government has shown little intention to seek an economic return when products like these are developed from wild genetic resources taken from federal land.

Many commentators have criticized this situation. Roger Kennedy, director of the National Park Service, has been one proponent of change, arguing that taxpayers should get a share of the profits when private industry profits from organisms taken from National Parks.[205] Dan Huff, chief scientist for the National Park Service's Rocky Mountain Region, complains that "[t]he federal government currently has no legislated authority to collect royalties from research conducted on public lands. . . . It would be nice if this could be changed."[206] Thomas Lovejoy believes that the government should negotiate bioprospecting agreements similar to those that have been negotiated in other countries.[207] It is time to answer the bioprospecting question here in the United States.

The commentators are correct. A compensation-seeking system would champion consistency and fairness in federal public land use policy, raise substantial revenue, and provide guidance and encouragement to developing countries that are working to establish policies on this issue. Admittedly, determining the appropriate level of compensation for the commercial use of domestic wild genetic resources might be complicated and costly. Also, a compensation-seeking scheme might discourage biotechnology companies from using domestic wild genetic resources and thus might discourage the development of useful products. However, a compensation-seeking system's economic and sociopolitical virtues eclipse its frailties.

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204. Cone & Healy, *supra* note 199, at A1 (quoting Thomas E. Lovejoy, a Smithsonian Institution biologist and Babbitt's science adviser on the project's start-up).

205. ABC World News Tonight (ABC television broadcast, Sept. 12, 1994) (transcript # 4181-6).

206. Todd Wilkinson, *Panning for Microbes*, POPULAR SCI., June 1994, at 27.

207. Clifford, *supra* note 158, at A1.

A. A Compensation-Seeking Approach Would Champion Consistency and Fairness in Federal Land Use Policy

A compensation-seeking policy would be *consistent* in the way that it treats commercial enterprises that operate on federal public land and *fair* to American taxpayers by discontinuing the present subsidies given to many industries that operate on federal public land. These two principles—consistency and fairness—support a public land use paradigm that would require market-driven fees from all commercial actors, including biotechnology companies, seeking to profit from federal lands. Some biotechnology companies appear to argue that a different paradigm should apply—one that charges market-driven fees for activities that cause environmental harm to public lands, but which subsidizes activities that do not cause such harm. A close analysis reveals that this distinction is flawed, however, and that a biotechnology company should be treated like any other commercial actor operating on federal land.

For purposes of compensation, the federal government currently distinguishes between commercial and non-commercial uses of federal land. The federal government usually seeks little or no compensation when individuals use public land for non-commercial recreational purposes.[208] Recreational access to national forests, BLM land, and national wildlife areas is generally free, and although national parks charge minimal entrance fees, these are insufficient to cover operating expenses.[209] Public opinion generally supports low-cost recreational access,[210] although there have been proposals to increase recreational fees recently.[211]

The federal government usually requires compensation when commercial enterprises seek to extract natural resources or otherwise profit from federal land. Ranchers pay grazing fees for their cattle's grass consumption, timber companies pay for the right to remove trees, and concessionaires pay for the right to operate tourist businesses on federal lands. The Mining Law of 1872 does not require

208. *See* Mark Obmascik, *Price of Recreation Going Up*, DENVER POST, Apr. 11, 1993, at 1A (explaining that plans exist to increase costs substantially); Terry L. Anderson, *Enviro-Capitalism vs. Enviro-Socialism*, 4 KAN. J.L. & PUB. POL'Y 35, 35 (1995).

209. *See* Obmascik, *supra* note 208 (reporting that in 1993 the National Park Service collected $64.4 million in fees, and spent $1 billion in operating expenses).

210. *See id.* (noting that, despite popular support for inexpensive recreational access, conservationists actually favor increases).

211. *Think Tank Wants Higher Fees for Parks*, ROCKY MTN. NEWS, Apr. 11, 1993, at 32A; *You Might Need a Ticket to Hike*, SEATTLE POST-INTELLIGENCER, Nov. 16, 1992, at C7.; Obmascik, *supra* note 208, at 1A.

compensation for extraction, but this law is viewed widely as an anachronism supported by special interest groups.[212]

Virtually all policy analysts agree that it is appropriate for the government to seek compensation from commercial entities that operate on federal land, and many have criticized the federal government for failing to charge enough.[213] They particularly criticize the federal government's policies regarding logging, mining, grazing, and national park concessions. Hard data support the argument that the United States has not sought the appropriate return from the commercial interests that pursue these activities. The current mining laws allowed the mining industry to extract $1.2 billion worth of minerals from federal land in 1990 without paying the government anything.[214] Federal grazing fees do not cover the government's management costs for this activity, and are sometimes as little as ten percent of comparable fees charged by similarly-situated private land managers.[215] Below-cost timber sales cost the taxpayers between $35 and $112 million in 1990.[216] In addition, national park concessionaires paid the federal government under three percent of their revenues in 1991, despite the fact that comparable industry fees outside of the parks run from five to fifty percent.[217]

It is not surprising, in light of these figures, that many observers are calling for change, and are asking the federal government to seek a greater economic return from the private interests that profit from federal land.[218] Lawmakers and the Clinton administration appear to be listening and are considering raising the fees for these activities, although these proposals have met with resistance from the potentially affected industries.[219] Debate on these issues is certain to continue,[220] and although special-interest politics may delay

212. The Mining Law of 1872 may be overturned in the near future. See H. Josef Hebert, *Measure to Overhaul Mining Fees Mired on Capital Hill,* LAS VEGAS REVIEW-JOURNAL, Sept. 19, 1994, at A1.

213. *See, e.g.*, Michael C. Blumm, *Public Choice Theory and the Public Lands: Why "Multiple Use" Failed*, 18 HARV. ENVTL. L. REV. 405, 408-11 (1994); Raymond Rasker, *A New Look at Old Vistas: The Economic Role of Environmental Quality in Western Public Lands*, 65 U. COLO. L. REV. 369, 393-96 (1994).; Anderson, *supra* note 208, at 36-40.

214. Blumm, *supra* note 213, at 409.

215. *Id.* at 409.

216. *Id.* at 410.

217. Beth Lorenzini, *Senate Puts National Park Concession Reform in Gear*, RESTAURANTS & INSTITUTIONS, May 1, 1994, at 39, *available in* 1994 WL 2880867.

218. This issue has united two unlikely allies: environmental groups and conservative taxpayer groups. *See, e.g., Scrutinizing Subsidies: It's Thrifty Being Green*, SEATTLE TIMES, Feb. 1, 1995, at B4.

219. *See, e.g.*, Laura M. Litvan, *A New Battle for the West*, NATION'S BUS., July 1994, at 32.

220. Rasker, *supra* note 213, at 393-97 (suggesting that a market-based approach to public land use would lead to better public land management).

reform,[221] it seems likely that the federal government will increase the fees that these commercial organizations pay to operate on public land in the long term.[222]

The previous discussion suggests an emerging paradigm, which distinguishes between commercial and recreational users of federal land. Recreational users should be charged little or nothing for their activities,[223] while commercial entities should be charged fees that seek to maximize revenue, or at least compare favorably with market rates. Under this paradigm, the answer to the bioprospecting question is clear. Because biotechnology companies are commercial actors seeking economic profit from their use of federal land, they should pay the appropriate market-based fee for this activity.

Many bioprospecting companies argue that a different paradigm should apply to their public land use. This paradigm would distinguish between actors on the basis of the environmental harm caused by their activity. Under this paradigm, the federal government should provide free access to federal land to actors who do not cause environmental harm, but should seek maximum fees from actors whose activities cause environmental harm. This approach still would mandate that the mining, timber, and ranching industries pay maximum fees, because these activities, as currently practiced, are harmful to the environment.[224] This approach would continue to give biotechnology companies free access to federal wild genetic resources, however, because their activity does not harm the environment in an immediate sense. One representative of a company currently bioprospecting in Yellowstone hot springs supports this distinction when he says, "We go in there and take a teaspoonful of water. It's ludicrous to compare us to a mining company that tears up God knows how many acres of soil and rock."[225] Another biotechnology executive sounds a similar theme: "I don't come with a backhoe . . . . I'm not prospecting in the same way the strip miners are prospecting for ore."[226]

Although this distinction seems appealing at first, a closer examination reveals its problems. First, the immediacy and extent of environmental harm should not control the compensation issue. Costs

221. *See generally* Anderson, *supra* note 208 (suggesting that public land management is controlled largely by special interest groups and that a market approach, such as envirocapitalism, would liberate public land management).

222. Blumm, *supra* note 213, at 409 (explaining that the "GAO recommended reforms aimed at achieving fair market returns for authorized uses of federal lands . . . ").

223. Support for recreational subsidies may be waning, however. Obmascik, *supra* note 208, at A1.

224. *See generally*, ZASLOWSKY & WATKINS, *supra* note 176 (discussing in-depth the different national systems and the role of agencies who are responsible for protecting public land against further destruction).

225. Clifford, *supra* note 158, at A1.

226. *Claim on Hot-Springs Microbes*, *supra* note 182, at 226.

incurred by the government to preserve biodiversity for bioprospecting ought to mandate compensation. Second, it is difficult to distinguish between activities that do and do not cause environmental harm.

1. *Bioprospecting Companies Receive Unwarranted Taxpayer Subsidies*

The status quo policy of providing free access to federal wild genetic resources provides biotechnology companies with a significant unwarranted taxpayer subsidy. This is because preserving the biodiversity that is critical for successful bioprospecting is costly. The federal government generally incurs two types of costs when it preserves biodiversity on a parcel of federal land. First, it spends money directly to enforce the laws that govern the parcel of land and to provide an appropriate infrastructure for the parcel. Second, it generally forgoes a certain amount of revenue that might be raised if it did not prohibit certain activities in an attempt to preserve biodiversity.

Again, Yellowstone National Park provides an example. There, the government has spent tax money to create park infrastructure, such as the roads and trails that provide easy access to the hot springs.[227] The government also spends money for rule enforcement and hot springs preservation. Moreover, the government has decided to forgo the revenue that could be raised by allowing a utility company to use the springs as a power source.[228] Bioprospectors taking microbial samples from the Yellowstone hot springs profit indirectly from those government expenditures. There is clearly a cost to preserving the biodiversity of the Yellowstone ecosystem and to preserving the thermally adapted microbes that have so much value to the biotechnology industry.

2. *The Subjectivity of Environmental "Harm"*

All public land use causes some environmental harm. Even traditional recreational uses like backpacking and horseback riding can disturb wildlife and cause erosion. Moreover, some uses that are considered environmentally harmful by most people are extolled by others as beneficial. For example, the logging industry often argues that many of its practices improve forest health.[229] Biotechnology companies are asking the federal government to open a Pandora's box when they argue that the federal government should set natural resource use fees based on the amount of environmental harm an activity causes.

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227. *See* Clifford, *supra* note 158, at A1.

228. *See* COGGINS & WILKINSON, *supra* note 2, at 574 (geothermal leasing is prohibited in national parks).

229. *See Salvage Logging Exemptions*, L.A. TIMES, June 27, 1995, (Letter), at B8.

In any case, it is not clear that bioprospecting is the harmless activity its proponents suggest it is. While most bioprospecting activity does not cause much localized environmental harm, some say the genetically engineered products that often result from such activity are a great environmental threat. Genetic engineering has been attacked as being immoral and dangerous. Some liken it to "playing God."[230] This Comment does not address these global criticisms, as they are more appropriately directed at the evolving intellectual property regime that allows companies to profit from these activities, and not at the notion that the government should seek an economic return when its property is involved with creating such profit. However, these criticisms do imply that bioprospecting may not be as environmentally benign as its proponents assert. In the end, the distinction that bioprospectors want to draw between themselves and other commercial natural resource users does not withstand scrutiny.

B. A Compensation-Seeking Approach Would Procure Government Revenues

The amount of revenue raised depends on two factors: the extent of future bioprospecting activity and the payment-seeking framework that regulates this activity. While it is impossible to know how much revenue would be raised by any given compensation-seeking scheme, it is possible to delineate a range of possibilities based on a few assumptions.

First, for hypothetical purposes, assume that successful bioprospecting can result in the development of either "average" or "blockbuster" products. An average product such as Vincristine or Vinblastine may have annual sales of $100 million, and a blockbuster product such as Taxol may have annual sales of $1 billion.[231] Assume further that each product has consistent sales for ten years after it comes to market. Finally, assume that after careful consideration, policy makers develop a domestic compensation-seeking framework for bioprospecting that has minimal initial fees, but requires royalty payments equal to 2.5% of net sales of products that are developed from the wild genetic resources taken from federal land.[232]

These assumptions then can be applied under "pessimistic," "neutral," and "optimistic" scenarios. Under a pessimistic scenario, domestic bioprospecting never results in any blockbuster products,

230. *See generally*, Downes, *supra* note 80, at 4-5 (listing various sources which espouse opinions on the biotechnological commercialization of biodiversity).

231. These figures were chosen after surveying a variety of publications that described products developed from wild genetic resources. *See supra* parts I, II.

232. See *infra* part IV for a more comprehensive discussion of this proposed royalty system.

and results in an average product only once per decade. Annual royalty revenue in this case would total $2.5 million. Under the neutral scenario, four products are developed per decade, and one of these is a blockbuster. This brings the annual royalty figure up to $32.5 million. Under the optimistic scenario, the rate of product development increases to two average products per year and two blockbuster products per decade. This shoots the royalty figure to $100 million per year.[233]

The significance of these figures depends on context. Indeed, while a compensation-seeking scheme is unlikely to make a dent in the current federal budget deficit, the revenues it might raise could have a significant impact on domestic biodiversity research if used for this purpose. If domestic bioprospecting fees were directed towards research projects like the National Park Inventory and Monitoring Fund, and the National Biological Survey, they could have a real impact. For example, the $100 million raised under the optimist scenario is more than one-half of the National Biological Survey budget in 1994.[234] Even the $2.5 million raised under the pessimist scenario would be enough to match the total inventory and monitoring funding the National Park Service received in 1992.[235]

C. A Compensation-Seeking Approach Would Guide and Encourage Developing Countries Seeking To Implement Similar Schemes

Finally, a compensation-seeking approach would provide guidance and encouragement to developing countries seeking to establish their own bioprospecting policies. As one commentator says, "effective national legislation is the *sine qua non* of the push to harness bioprospecting to conservation, development, and equity."[236] Many developing countries will face various obstacles when they seek to develop policies that will allow them to profit from the commercial use of their wild genetic resources. When the United States adopts a compensation-seeking scheme, it will formulate detailed guidance documents governing this process. These documents could be distributed as models to developing countries to use as they formulate their own policies.

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233. If industry predictions about the markets for taxol and PCR come true, a 2.5% royalty on sales of these products alone would generate $50 million dollars in annual revenue.

234. The 1994 National Biological Survey budget was $167 million. Christensen, *supra* note 200, at A7.

235. Sharp & Appleton, *supra* note 193, at 35.

236. Reid, *supra* note 15, at 53.

More generally, by adopting a compensation-seeking approach, Congress can demonstrate that it is firmly behind the benefit-sharing provisions of the Convention on Biological Diversity, and that it strongly supports the notion that each nation has a sovereign right to control its wild genetic resources.[237] This would send a message to American and international biotechnology companies that "business as usual" is truly over, and that they must be ready to return a small portion of their profits to the countries that supplied their research material.

The United States' adherence to the status quo sends the opposite message, and renders the American signature of the Convention an empty gesture.[238] By failing to seek any economic return from the use of its wild genetic resources, the United States appears to continue to subscribe to the idea that these resources are a "common heritage of humankind." This message could be devastating to developing countries working to establish new policies on this issue, and hoping to use bioprospecting contracts as a means of conserving their biodiversity.[239] Because the United States has enormous influence on international law and policy, a domestic policy that seeks compensation for the use of wild genetic resources would help to solidify the new international view on bioprospecting.

D. A Compensation-Seeking Approach's Virtues Eclipse Its Faults

Critics of a compensation-seeking approach assert that it will have two broad, related disadvantages. First, they argue that any compensation-seeking system will be complicated to create and administer. Second, they contend that any compensation-seeking system is bound to discourage domestic bioprospecting. A close analysis reveals, however, that these disadvantages are overstated, and can be mitigated greatly by creating a compensation-seeking system that is sensitive to these concerns.

1. Opponents Allege that Developing a Compensation-Seeking Approach Will Be Complicated and Costly

Critics assert that the first disadvantage of a compensation-seeking approach is that it will be difficult to develop a fair and rational way to charge "appropriate" compensation. Indeed, policymakers will need to devote time and effort to this issue. They first must decide whether to charge initial "prospecting" fees, whether to seek royalty payments from resulting commercial products, or whether to use a

237. *See supra* part I.C.

238. The status quo also will make Senate ratification of the Convention seem an empty gesture should it take place next term. *See supra* part I.C.

239. *See supra* part I.C.

combination of these methods. If an up-front prospecting fee is sought, it is hard to know how much to charge. If royalty payments are sought, it is difficult to establish a fair percentage, especially since the role that genetic resources play in developing a product varies widely. Finding answers to these questions may not be easy.[240] In addition, even after a framework is established, time and money will be required to publicize and enforce the new rules. To opponents of a compensation-seeking system, these expenditures are not justified when it is unclear that the scheme will actually bring in significant revenue.

These difficulties are not unique to this case, however, and are not insurmountable. The federal government certainly faced similar, if not identical, questions when it had to determine the appropriate compensation for other natural-resource users, such as the logging and ranching industries. It continues to wrestle with a variety of land use questions, all of which are "difficult" in one way or another. It would set a dangerous precedent if the federal government walked away from the bioprospecting question because it is too complicated.

Furthermore, various public interest organizations and national governments have already begun to address this issue through legislation[241] and academic publications.[242] Domestic policy makers can draw on the literature in this area, and will not need to address the issue in a vacuum. This should make the task of developing an appropriate compensation scheme somewhat easier.

2. *Opponents Allege that a Compensation-Seeking Approach Will Discourage Bioprospecting and the Biotechnology Industry*

Critics contend that the second disadvantage of a compensation-seeking scheme is that it is almost certain to discourage some domestic bioprospecting. Depending on the selected compensation-seeking system, companies' concerns include the initial cost of permits, possible royalty payments, the difficulty in tracking myriad samples, and

240. One author has used the history of the development of Vinblastine and Vincrastine, discussed in part I.B. *supra*, as an example of the difficulties raised by this question. Although these drugs were originally developed from Rosy Periwinkle plants growing wild in Madagascar, Eli Lilly quickly began to grow the plant commercially in other countries, and no longer needed to take any plants from the wild to produce the drug. To complicate matters further, investigation of the Rosy Periwinkle actually began due to folklore from the Philippines and Jamaica, where the plant also grows. In this case it is difficult to determine how much compensation should be paid, and to which country. *See* Goldman, *supra* note 59, at 717.

241. For example, the National Assembly of Cameroon passed LAW NO. 94/012 on Forestry, Wildlife, and Fishery (1994), dealing with the inventory and management planning process, prior informed consent, and the equitable sharing of benefits derived from commercial use.

242. *E.g.*, Rubin & Fish, *supra* note 56.

determining when a royalty is due and how much must be paid.[243] These worries would lead to less domestic bioprospecting, and therefore would prevent or at least delay the development of a beneficial product. This would harm both the general public and the domestic bioprospecting industry.

Although a legitimate concern, this argument fails to justify the status quo. Congress can solicit input from biotechnology companies in order to structure a program that seeks to avoid discouraging research. If the companies express fear that they will not be able to afford an up-front permit fee, the system can keep initial fees low and use royalties as the main form of compensation. If, on the other hand, the companies complain that the mechanics of a royalty system will be too complicated, then the system can seek to recover more payments through initial prospecting fees.

E. A Compensation-Seeking Approach Might Discourage Bioprospecting and the Biotechnology Industry

It is true that a compensation-seeking scheme would probably shift some bioprospecting activity away from domestic public land and towards the public land of other countries, private land, or *ex situ* conservation sources. This is because organisms with identical or similar genetic information are often available from a variety of sources. For example, although it is primarily found on federal land, the Pacific Yew tree also can be found in Canada and on private land in the Pacific Northwest.[244] Furthermore, several Yew species contain taxol.[245] Thus, it seems likely that a drug like taxol could have been developed without bioprospecting on federal land. If the federal government adopts a compensation-seeking scheme, biotechnology companies may try to find cheaper sources of genetic material by looking to private landowners, other countries, and *ex situ* conservation sources.

However, this phenomenon is likely to be limited for several reasons. One reason is that the degree of overlap in sources and types of genetic material is limited. It simply is not the case that you always can get similar genetic information from someplace else.[246] As one scientist says, discussing naturally occurring chemicals, "[s]ometimes, if you change a single atom in one of these molecules, you completely

243. *See* Sarah A. Laird, *Contracts for Biodiversity Prospecting*, *in* BIODIVERSITY PROSPECTING, *supra* note 3, at 99-126.

244. *See* Daly, *supra* note 165, at 78, 84.

245. *See id.* at 83.

246. Recent events in Cameroon make this clear. Scientists took samples from closely related vine species in this country, and found that chemicals from one vine were much more effective at destroying strains of the AIDS virus than were chemicals from the other vine. Nesmith, *supra* note 52, at 6.

alter the chemical nature of the substance."[247] Some important genetic information is likely to be found exclusively on federal land in the United States. For example, some types of thermally-adapted bacteria are probably unique to the Yellowstone hot springs.[248] If these species have valuable genetic properties, bioprospecting on federal land will be the only way to access them.

Other factors may further minimize the bioprospecting decrease a compensation-seeking scheme would cause. First, it is not clear that the other sources of valuable genetic resources will be any cheaper to biotechnology companies, as other landowners and *ex situ* sources are equally entitle to charge some form of bioprospecting fee. Second, federal public land may provide conditions especially favorable to bioprospectors. Federal public land generally has a higher degree of biodiversity than domestic private land, so it is more valuable to bioprospectors. And federal public lands are often more accessible than the public land of other countries because of their fairly well-developed infrastructures.[249] Since most biotechnology companies are located in the United States,[250] their research facilities are close to federal lands. Finally, there is often more information about the biodiversity preserved on federal land than the biodiversity preserved elsewhere, and the quality of this information is increasing.[251] These factors, taken together, indicate that many biotechnology companies will find that it remains economical to continue to develop products from the wild genetic resources found on federal land, even if they must pay some form of compensation for this privilege.

Finally, recent events show that this entire concern may be overstated. The Merck-INBio agreement and the current benefit-sharing policies of the National Cancer Institute and other bioprospecting intermediaries show that biotechnology companies can accept and work under compensation-seeking schemes internationally.[252] There is no reason to think that the situation will be appreciably different in the United States.

Adopting a compensation-seeking system will be somewhat complicated and probably will discourage some domestic bioprospecting. But these results can be expected any time the federal government decides to charge fees for allowing a natural resource use to take place on federal land. They do not justify retaining the status quo—contin-

247. *Id.* (quoting Djaja Soejarto of the University of Illinois at Chicago).

248. *See* Miller, *supra* note 177.

249. For example, the National Forests have a road system long enough to circle the earth fourteen times. ZASLOWSKY & WATKINS, *supra* note 176, at 101.

250. *See* Hardy, *supra* note 16, at 302 (stating that more than one thousand dedicated biotechnology companies (DBCs) exist in the United States).

251. *See supra* part II.C. for discussion of the increase in biodiversity information.

252. *See supra* part I.C.

uing to give away the valuable wild genetic resources found on federal land.

IV.
HOW SHOULD A COMPENSATION-SEEKING APPROACH BE STRUCTURED?

A landowner with potentially valuable wild genetic resources on her property can seek to benefit from these resources in two basic ways. First, she can charge some form of "prospecting fee" for the privilege of removing the wild genetic information from the property. Second, the property owner can contract for a right to receive royalty payments from sales of commercial products developed as a result of the agreement.[253]

Individual circumstances generally will determine the best type of compensation-seeking system in a given situation.[254] Much depends on the relative situations of the landowner and bioprospector. Sometimes it may make sense for the property owner to seek large prospecting fees and smaller royalty payments. Such a scheme might be especially appropriate for a landowner with large genetic reserves but small current cash flows. On the other hand, a landowner with smaller genetic reserves and less concern about current finances might well prefer to "gamble" by eschewing current payments but seeking higher royalty payments should a commercial product be developed from the genetic resources she provided.

Which system would be best in the United States? The biotechnology companies, the land-management agencies, and other interested actors should be given a chance to consider the issue and express their views before any substantive decision is reached. A number of proposals follow. However, because of the complex technical issues involved, these suggestions are meant to be a starting point for discussion rather than inflexible prescriptions.

A. Who Should Determine the Nature of the Payment Obligations?

Many potential problems can be avoided by allowing all parties with an interest in this matter to participate in the development of a bioprospecting fee system. Congress thus should establish a forum where views can be expressed and conclusions can be reached. It should invite representatives of the biotechnology companies, the fed-

253. Of course, it is possible for the landowner to use a combination of these methods. The seminal Merck-INBio agreement in Costa Rica is an example of such a hybrid approach. The $1 million Merck initially paid to INBio is an example of a "prospecting fee," and the agreement also included future royalty obligations. *See supra* part I.C.

254. *See* Reid, *supra* note 15, at 52.

eral land management agencies, and various public interest organizations to the table.

B. What Should the Payment Obligations Be?

The government should keep initial permit fees low and should rely primarily on a royalty payment system to achieve the goal of fair compensation for bioprospecting activity. The up-front permit fee should seek only to cover administrative costs. Thereafter, if a commercial product is developed from the extracted wild genetic resources,[255] the royalty obligation should be between one and five percent of total sales.[256] The amount should vary depending on the degree to which wild genetic material is involved in product development. The royalty scheme should be fairly progressive. Commercial products with marginal sales should be subject to little or no royalty obligation, while products that are wildly profitable should be expected to return a greater share of sales to the federal government.

This proposed system would have two benefits. First, it would not discourage the biotechnology companies themselves from bioprospecting, because it would reassure them that they will not have large financial obligations until after they develop and market a viable product. Second, it would avoid discouraging more traditional scientific research. Academic researchers often wish to remove and study wild genetic resources for non-commercial reasons. Sometimes, however, the resources they have removed and studied turn out to have commercial value and are used by biotechnology companies. By keeping initial fees low, this system allows the academic researcher freedom to continue working. By including royalty obligations, it prevents biotechnology companies from unfairly taking advantage of previous academic research.

C. Where Should Bioprospecting Be Allowed?

Some form of bioprospecting should be permitted on all federal land. Because this activity does not cause the immediate environmental damage that other natural resource uses do, the justification for prohibiting it on certain types of federal land, such as Wilderness Areas and National Parks, does not exist. While land managers should be given discretion to restrict certain bioprospecting activities where

255. The royalty obligation would govern resources collected by intermediaries and then transferred to biotechnology companies.

256. This projected royalty range is based on traditional pharmaceutical industry practices. BIODIPLOMACY, *supra* note 21, at 245; Kadidal, *supra* note 76, at 232 (explaining that two pharmaceutical companies contracted with Latin American countries, agreeing to share profits from any resulting products).

appropriate,[257] there should not be a blanket rule that prohibits this activity on any federal land.

D. How Should the Revenue Be Used?

Congress should ensure that any revenue raised by a compensation-seeking scheme is used to further biodiversity study and conservation. This would emphasize the logical connection between biodiversity preservation and bioprospecting. It would also comport with the underlying theme of the Biodiversity Treaty, which seeks above all to study and conserve biodiversity.[258] Finally, it would ensure that the revenue raised under such a system retains its significance, and does not get "lost" in the overall federal budget.

E. Who Should Implement the New System?

A compensation-seeking scheme will require publicity, communication with biotechnology companies, and the development of a standard "bioprospecting permit" for federal land managers to use when individuals seek to remove wild genetic resources from public land. Experience in other countries shows that a special government agency created for this purpose works well.[259] In the United States, however, the creation of a new agency probably is unnecessary. Instead, the Biological Resources Division of the U.S. Geological Survey, which inherited the mantle of the National Biological Service, may be able to incorporate these tasks into its current functions. The National Biological Survey's stated purpose was to conduct research on the full diversity of living organisms in the United States. Thus, the U.S. Geological Survey employees should already possess the requisite scientific sophistication to coordinate logistics with various public land management agencies.[260] Furthermore, the scientists working on this goal are likely to come across organisms that have potential commercial value during their work and thus would be in a perfect position to encourage bioprospecting activity. The U.S. Geological Survey could then work with the Internal Revenue Service to ensure that the widespread biotechnology companies fulfill the negotiated royalty obligations.

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257. For example, Wilderness Area land managers might want to ensure that all bioprospecting is done out of sight of recreational trails to avoid impacting the "wilderness" experience of visitors.

258. *See supra* part I.C.

259. *See supra* part I.C.

260. *See* Boyce Rensberger, *A Budding Work About Native Flora*, WASH. POST, Oct. 4, 1993, at A3; *Vice President Releases Interior Department NPR Report*, U.S. Newswire, Feb. 8, 1994, *available in* 1994 WL 3824036; Christensen, *supra* note 200, at A7.

V.
CONCLUSION

Bioprospecting is a new type of natural resource use that has evolved to meet the needs of the modern biotechnology industry. The current bioprospecting activity in Yellowstone National Park shows that this is not just an issue for the tropical rainforest countries. It is therefore time for federal land law to address this new natural resource use. Congress should follow recent international developments in this regard, and should pass legislation seeking an economic return when bioprospectors want to extract valuable wild genetic resources from federal land.