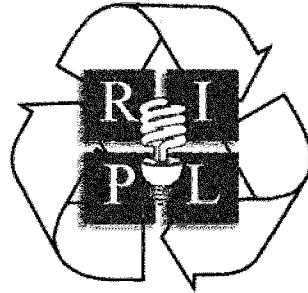


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PATENT LAW, HIPPO, AND THE BIODIVERSITY CRISIS

DR. ANDREW W. TORRANCE

ABSTRACT

Planet earth is host to a dazzling variety of living organisms. This diversity of life, or “biodiversity,” is vital to the survival and prosperity of humanity, supplying such vital amenities as food, clothing, shelter, natural biochemicals useful in medicine, industry, and agriculture, and even irreplaceable ecosystem services, such as clean air and water. Despite the prodigious amount of biodiversity on earth, human activities have been depleting it at an accelerating rate that has now reached the level of a mass extinction event. The five greatest threats to biodiversity can be summarized by the “HIPPO” acronym: (1) Habitat loss, (2) Invasives, (3) Pollution, (4) Population, and (5) Overexploitation. Together, these five factors describe the phenomena largely responsible for the current mass extinction event, and patent law offers valuable assistance in combating each one. Though it cannot offer a complete solution to the biodiversity crisis, the patent system can offer powerful tools to help save biodiversity. On first inspection, patent law might appear an unlikely ally for conserving biodiversity for at least two reasons. First, beyond bioprospecting, patents would seem only tangentially relevant to biodiversity loss. Second, as a tool for promoting economic growth, the patent system might be viewed as contributing to biodiversity loss by those who assume that economic growth and environmental protection are mutually antithetical. However, patents can indeed benefit biodiversity. This article illustrates how patents can combat each of the major threats to biodiversity that constitute the HIPPO acronym. By creating an extinction bar to patentability, patents create incentives for bioprospectors, biopharmaceutical firms, and countries that host abundant biodiversity to prevent habitat destruction. Sovereign immunity provides the federal and state governments with the right to make use of patented inventions useful for countering invasives. Existing compulsory licensing schemes provide models for how patented pollution abatement technologies could be widely disseminated to combat pollution. The incentives created by the patent system can help to create more efficient new technologies capable of counteracting the damage inflicted on biodiversity by human population growth. Finally, the patent system has already proved itself adept at spurring the creation of ingenious inventions capable of alleviating overexploitation of biodiversity. Though far from a panacea, the patent system does have important roles to play in ameliorating the biodiversity crisis.

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PATENT LAW, HIPPO, AND THE BIODIVERSITY CRISIS

DR. ANDREW W. TORRANCE*

INTRODUCTION

Planet earth is host to a dazzling variety of organisms. Moreover, it is this tremendous diversity of life that so sharply distinguishes the earth from all other celestial bodies in the known universe. From unicellular eubacteria and archaea to massive sequoias and whales, from sessile fungi to swift-flying raptors, and from plants that produce their own energy via photosynthesis to shrews that must consume prey every few hours simply to survive, life occupies almost every ecological niche conceivable, and does so in myriad ways. Estimates of the magnitude of biodiversity have ranged from as few as 4 million to as many as 111 million extant species.¹ Since life first appeared on earth about 3.6 billion years ago,² the metaphorical tree of life has sprouted countless branches, each evolving along its own unique trajectory in response to the contingent opportunities afforded by genetic potential and environmental challenges. As Charles Darwin so famously proclaimed in *The Origin of Species*, “from so simple a beginning endless forms most beautiful and most wonderful have been, and are being, evolved.”³

Although there is a prodigious amount of biodiversity on earth, human activities have been depleting it at an accelerating rate that has reached a crescendo of extinction over the last several generations.⁴ Estimated rates of extinction have now reached several orders of magnitude greater than the background rate of extinction that prevailed prior to human domination of earth’s ecosystems.⁵ Edward O. Wilson, selecting “cautious parameters . . . to draw a maximally optimistic conclusion,” has estimated that 27,000 species suffer extinction per annum, corresponding to seventy-four extinctions per day and three extinctions per hour.⁶ Although some have suggested that extinctions might be significantly lower,⁷ and any estimates must

* Associate Professor of Law and Research Associate, Biodiversity Institute, University of Kansas. B.Sc. (Queen’s), A.M., Ph.D., J.D. (Harvard). Prof. Torrance would like to thank Erin Weekley for her invaluable research assistance with this article. Prof. Torrance would also like to thank Erin McKibben for the invitation to participate in *The John Marshall Review of Intellectual Property Law (RIPL)* Green Issue Symposium, Prof. David Schwartz for his encouragement to do so, and Nick Dernik and Erin McKibben for their great talents as editors.

¹ See P.M. Hammond, *The Current Magnitude of Biodiversity*, in GLOBAL BIODIVERSITY ASSESSMENT 113, 118 (V.H. Heywood ed., Cambridge Univ. Press 1995).

² PETER H. RAVEN ET AL., *BIOLOGY OF PLANTS* 844 (6th ed. 1999).

³ CHARLES R. DARWIN, *THE ORIGIN OF SPECIES* 396 (Oxford Univ. Press 1998) (1859).

⁴ RAVEN ET AL., *supra* note 2, at 844.

⁵ BRIAN GROOMBRIDGE & MARTIN D. JENKINS, *WORLD ATLAS OF BIODIVERSITY: EARTH’S LIVING RESOURCES IN THE 21ST CENTURY* 55–58 (Univ. Cal. Press 2002). See generally Andy Purvis & Andy Hector, *Getting the Measure of Biodiversity*, 405 *NATURE* 212 (2000) (“There is no doubt that humans are now destroying [current] diversity at an alarming rate.”).

⁶ EDWARD O. WILSON, *THE DIVERSITY OF LIFE* 280 (1992) [hereinafter WILSON, *DIVERSITY OF LIFE*].

⁷ See BJORN LOMBORG, *THE SKEPTICAL ENVIRONMENTALIST: MEASURING THE REAL STATE OF THE WORLD* 249–57 (Cambridge Univ. Press 2001) (1998). But see generally Thomas Lovejoy,

certainly contemplate significant error bounds, a broad and strong consensus exists among biologists that biodiversity is currently undergoing the sixth great mass extinction event in earth's history, and that anthropogenic causes, both direct and indirect, are to blame.⁸

Patent law might seem an unlikely remedy to mass extinction of biodiversity. After all, patents are usually associated with new technologies and economic growth, rather than conservation of biodiversity.⁹ As an illustration of this perceived disconnect between biodiversity and patent law, neither the word "patent" nor the phrase "intellectual property" appear in the leading casebook of biodiversity law in the United States,¹⁰ the standard treatise of natural conservation law in the United Kingdom,¹¹ or either or the two leading textbooks of conservation biology.¹² Beyond the phenomenon of bioprospecting,¹³ discussion of the patent system and biodiversity seldom intersect.

This article argues that the patent system can indeed play important roles in preserving biodiversity and mitigating its current losses. It highlights five very different roles patents can play to combat the sixth mass extinction. Each of these roles is juxtaposed with each of the five greatest threats to biodiversity: the "HIPPO" factors. Popularized by Edward O. Wilson, "HIPPO" stands for (1) Habitat loss, (2) Invasives, (3) Pollution, (4) Population, and (5) Overexploitation.¹⁴ Together, these five factors describe the phenomena largely responsible for the current mass extinction event, and patent law offers valuable assistance in ameliorating each one. Though it cannot offer a complete solution to the biodiversity crisis, the patent system can offer powerful tools to help save biodiversity.

I. THE BIODIVERSITY CRISIS

A. *What is Biodiversity?*

Biodiversity is a term with as many definitions as there are biologists who study it. Edward O. Wilson has defined biodiversity as

Biodiversity: Dismissing Scientific Process, 286 SCI. AM. 69 (2002) (rebutting most of Lomborg's substantive claims about biodiversity).

⁸ See Lovejoy, *supra* note 7, at 69; see also RAVEN ET AL., *supra* note 2, at 844 ("The twentieth century has witnessed the beginning of the sixth [great extinction], but this one is caused by the activities of a single species, ourselves.").

⁹ See Kenneth W. Dam, *The Economic Underpinnings of Patent Law*, 23 J. LEGAL STUD. 247, 247 (1994).

¹⁰ JOHN COPELAND NAGLE & J.B. RUHL, *THE LAW OF BIODIVERSITY AND ECOSYSTEM MANAGEMENT* (2d ed. 2006).

¹¹ COLIN T. REID, *NATURE CONSERVATION LAW* (2d ed. 2002).

¹² RICHARD B. PRIMACK, *ESSENTIALS OF CONSERVATION BIOLOGY* (3d ed. 2002); MALCOLM L. HUNTER, JR. & JAMES GIBBS, *FUNDAMENTALS OF CONSERVATION BIOLOGY* (3d ed. 2007).

¹³ See generally, e.g., Jim Chen, *There's No Such Thing as Biopiracy . . . and It's a Good Thing Too*, 37 MCGEORGE L. REV. 1 (2006) (discussing bioprospecting in relation to environmental protection and patent law).

¹⁴ EDWARD O. WILSON, *THE FUTURE OF LIFE* 50 (2002) [hereinafter WILSON, *FUTURE OF LIFE*].

The variety of organisms considered at all levels, from genetic variants belonging to the same species through arrays of species to arrays of genera, families, and still higher taxonomic levels; includes the variety of ecosystems, which comprise both the communities of organisms within particular habitats and the physical conditions under which they live.¹⁵

The most commonly used unit of biodiversity is the species despite the fact that precise definitions of what constitutes a species vary widely.¹⁶ Some biologists even doubt the objective reality of any species definition.¹⁷ Charles Darwin himself observed that “I look at the term species, as one arbitrarily given for the sake of convenience, to a set of individuals closely resembling each other”¹⁸

Within a single species there usually exists considerable genetic diversity.¹⁹ And, groups of species can together form myriad different ecosystems.²⁰

B. The Distribution of BIODIVERSITY

Biodiversity is not distributed uniformly across the earth. Instead, it exhibits a starkly uneven pattern, with some areas possessing a hyperdiversity while other areas host hypodiversity. It is possible to discern some general patterns. For example, biodiversity reaches its maximum extent near the equator and is minimal at both poles.²¹ This remarkable pattern of distribution has long been one of the great mysteries of biology.²²

Tropical rainforests host the largest concentration of biodiversity on the planet, accounting for more than half of known species.²³ Tropical coral reefs contain a disproportionate amount of marine diversity.²⁴ Consequently, the most biodiverse areas in the world tend to be clustered within the borders of poor, tropical, developing countries. For example, more than two thirds of the twenty-five most biodiverse terrestrial areas on earth—areas called “biodiversity hotspots”—because they are both highly diverse and severely threatened—occur within the borders of these countries.²⁵

¹⁵ WILSON, *DIVERSITY OF LIFE*, *supra* note 6, at 393.

¹⁶ *See generally* SPECIES CONCEPTS AND PHYLOGENETIC THEORY: A DEBATE (Quentin D. Wheeler & Rudolf Meier eds., Columbia Univ. Press 2000) (debating various concepts of species that are prevalent in contemporary biological literature).

¹⁷ *E.g.*, Jody Hey, *On the Failure of Modern Species Concepts*, 21 TRENDS IN ECOLOGY & EVOLUTION 447, 449 (2006); Robert J. O'Hara, *Systematic Generalization, Historical Fate, and the Species Problem*, 42 SYSTEMATIC BIOLOGY 231, 242 (1993).

¹⁸ DARWIN, *supra* note 3, at 45.

¹⁹ SUSTAINING LIFE: HOW HUMAN HEALTH DEPENDS ON BIODIVERSITY 3 (Eric Chivian & Aaron Bernstein eds., Oxford Univ. Press 2008).

²⁰ *Id.*

²¹ *See* Kevin J. Gaston, *Global Patterns in Biodiversity*, 405 NATURE 220, 220–22 (2000).

²² *See, e.g.*, Stuart L. Pimm & James H. Brown, *Domains of Diversity*, 304 SCI. 831, 831 (2004).

²³ *See* T.C. WHITMORE, AN INTRODUCTION TO TROPICAL RAIN FORESTS 31, 58, 65 (2d ed. 1998).

²⁴ SUSTAINING LIFE, *supra* note 19, at 35.

²⁵ *See* Norman Myers et al., *Biodiversity Hotspots for Conservation Priorities*, 403 NATURE 853, 855 (2000).

In addition to geographic unevenness, different groups of organisms have produced wildly different numbers of species. To date, more than 270,000 species of plants have been described by taxonomists.²⁶ By contrast, only 6,000 species of eubacteria and archaea have received formal names.²⁷ Similar disparities exist among the animals. Vertebrates—the taxonomic group that includes humans—comprise only about 45,000 species,²⁸ whereas arthropods—including insects, spiders, crabs, and lobster—can claim a membership of about 855,000.²⁹ In fact, so diverse is the insect order Coleoptera that J.B.S. Haldane, a famous biologist, concluded that God must have “an inordinate fondness for beetles.”³⁰

C. Importance of Biodiversity

Biodiversity is vital to the survival and prosperity of humanity. Far from being separated from and independent of nature,

The human species evolved as a natural element of diversity in the living world, and it is a simple ecological imperative that humans depend on other species and communities to supply the basic requirements of existence and to maintain biosphere function.³¹

Biodiversity provides a variety of vital amenities to humanity. These include not only conspicuous amenities, such as food, clothing, shelter, tools, labor, protection, pleasure, and natural biochemicals useful as medicines, industrial and agricultural biochemicals, and raw material for producing genetically modified organisms, but also inconspicuous amenities, such as clean air, clean water, well-functioning biogeochemical cycles (e.g., nitrogen, carbon, oxygen), flood mitigation, erosion control, control of toxins in soil and water, pest and disease control, pollination and seed dispersal, and many other irreplaceable ecosystem services.³²

One of the most prominent amenities biodiversity provides to humanity is genes and biochemicals, many of which are useful in human medicine.³³ As a result of natural selective pressures acting on organisms’ genetic potentials and environmental challenges, the prodigious variety of life on earth has given rise to myriad genes and other natural biochemicals.³⁴ The practice of surveying biodiversity for useful biochemicals has become commonly known as “bioprospecting.”³⁵ In economic terms, bioprospecting is the “exploration of

²⁶ SUSTAINING LIFE, *supra* note 19, at 16.

²⁷ *Id.* at 10.

²⁸ *Id.* at 16.

²⁹ *Id.*

³⁰ *Id.* at 3.

³¹ GROOMBRIDGE & JENKINS, *supra* note 5, at 33.

³² See generally NATURE’S SERVICES: SOCIETAL DEPENDENCE ON NATURAL ECOSYSTEMS (Gretchen C. Daily ed., Island Press 1997) (identifying how the quantity and quality of amenities impact human life).

³³ *E.g.*, SUSTAINING LIFE, *supra* note 19, at 119, 121.

³⁴ *E.g.*, *id.*

³⁵ Walter V. Reid et al., *A New Lease on Life*, in BIODIVERSITY PROSPECTING 1, 1 (World Res. Inst. 1993).

biodiversity for commercially valuable genetic and biochemical resources.”³⁶ From nucleic acids (including genes), polypeptides, lipids, and carbohydrates, to chimaeric combinations of these basic categories, such as lipoproteins, peptidoglycans, and glycoproteins, to a limitless array of derivative biochemicals, such as “small molecules,” biodiversity provides abundant opportunities for bioprospecting.³⁷

Biodiversity represents a vast storehouse of natural biochemicals whose economic value is enormous. For example, in 1993, roughly sixty percent of the best selling prescription drugs in the United States were derived from biodiversity.³⁸ A decade ago, Kerry ten Kate and Sarah Laird estimated that the annual value of products derived from genetic resources alone ranges from between \$500 billion and \$800 billion.³⁹ From medicinal drugs and botanical medicines to agricultural crops, crop protectants, and ornamental plants, to cosmetics and non-medical industrial products and processes, biodiversity provides the raw material for countless economically-valuable inventions. The Rosy Periwinkle (*Catharanthus roseus*), a flowering plant endemic to the island of Madagascar, is perhaps the most famous example of the benefits of bioprospecting.⁴⁰ Edward O. Wilson has described the Rosy Periwinkle and its importance:

An inconspicuous plant with a pink five-petaled flower, it produces two alkaloids, vinblastine and vincristine, that cure most victims of two of the deadliest of cancers, Hodgkin’s disease, mostly afflicting young adults, and acute lymphocytic leukemia, which used to be a virtual death sentence for children.⁴¹

In addition, the two therapeutic biochemicals produced by the Rosy Periwinkle, vinblastine and vincristine, have proved efficacious in treating Wilms’ tumor, primary brain tumors, and testicular, cervical, and breast cancers.⁴² The pharmaceutical firm, Eli Lilly and Company, has earned considerable revenue—roughly \$180 million per annum—since it began selling vinblastine and vincristine in the 1960s.⁴³ As an example of how valuable biochemicals derived from biodiversity can be, vincristine sulphate had a retail price of \$11,900,000 per kilogram in 1999.⁴⁴

Despite the great benefits biodiversity provides to humanity, it is currently being destroyed at a rapid, and accelerating, rate.⁴⁵

³⁶ *Id.*

³⁷ See generally The Biology Project: Biochemistry, <http://www.biology.arizona.edu/biochemistry/biochemistry.html> (last visited Mar. 18, 2010) (providing tutorials on the chemical structures and mechanisms associated with biological processes).

³⁸ See FRANCESCA GRIFO ET AL., *The Origins of Prescription Drugs in Biodiversity and Human Health*, in BIODIVERSITY AND HUMAN HEALTH 131, 135–36 (Francesca Grifo & Joshua Rosenthal, eds., Island Press 1997).

³⁹ See KERRY TEN KATE & SARAH A. LAIRD, *THE COMMERCIAL USE OF BIODIVERSITY: ACCESS TO GENETIC RESOURCES AND BENEFIT-SHARING* 2 tbl.1.1 (1999).

⁴⁰ See WILSON, *DIVERSITY OF LIFE*, *supra* note 6, at 283.

⁴¹ *Id.*

⁴² *Id.* at 381.

⁴³ See *id.* at 283.

⁴⁴ KATE & LAIRD, *supra* note 39, at 2 tbl.1.2.

⁴⁵ RAVEN ET AL., *supra* note 2, at 844.

D. Threats to Biodiversity

Humans have increasingly come to dominate the earth's ecosystems.⁴⁶ However, humans are not atypical for altering nature to suit their preferences. As Peter Vitousek et al. have observed, "All organisms modify their environment, and humans are no exception."⁴⁷ Instead, what sets humans apart from most, if not all, other organisms is their tremendous success in achieving modification of the earth's surface. Vast portions of the earth's landmass have been transformed from natural ecosystems into areas managed intensively for human purposes (e.g., ten to fifteen percent as agricultural, urban, or industrial land, six to eight percent as pasture for livestock).⁴⁸ In total, thirty-nine to fifty percent of land on earth has been significantly degraded from its natural state, and about forty percent of the primary production of plants is appropriated for human activities.⁴⁹ Even the oceans are not immune from human domination. More than fifty percent of mangrove ecosystems have already been destroyed, sixty-six percent of fisheries are either overexploited or maximally exploited, and humans appropriate about eight percent of the total primary production of ocean organisms.⁵⁰

As a direct or indirect consequence of human activities, biodiversity is currently being liquidated:

Although species have gone extinct since life began, what distinguishes present-day extinctions from those that have occurred in the past is a distinctive human fingerprint.⁵¹

The human activities most responsible for causing the current acceleration in the extinction rate may be described by the mnemonic device "HIPPO."⁵² Habitat destruction leads very quickly—and sometimes immediately—to the extinction of organisms dependent on that habitat destroyed.⁵³ Invasive species often displace native species and alter native ecosystems.⁵⁴ Pollution, such as the nitrates, sulphates, and phosphates, poison, weaken, and sometimes kill native biodiversity.⁵⁵ Human population competes with other forms of life for both space and natural resources.⁵⁶ Overexploitation of trees, mammals, and fish have led to collapses in their populations.⁵⁷ Although each of the HIPPO factors alone threatens

⁴⁶ Peter M. Vitousek et al., *Human Domination of Earth's Ecosystems*, 277 SCI. 494, 494 (1997) [hereinafter Vitousek et al., *Human Domination*].

⁴⁷ *Id.*

⁴⁸ *Id.* at 494–95.

⁴⁹ *Id.* at 495; Peter M. Vitousek et al., *Human Appropriation of the Products of Photosynthesis*, 36 BIOSCIENCE 368, 368 (1986).

⁵⁰ Vitousek et al., *Human Domination*, *supra* note 46, at 495.

⁵¹ SUSTAINING LIFE, *supra* note 19, at 29.

⁵² WILSON, FUTURE OF LIFE, *supra* note 14, at 50.

⁵³ *Id.*

⁵⁴ *Id.*

⁵⁵ *Id.*

⁵⁶ *Id.*

⁵⁷ *Id.*

biodiversity, the toxic stew of all HIPPO factors that currently prevails poses a clear and present danger to the extinction of countless species.⁵⁸

Although seldom associated as a contributor to conservation, the patent system can help to staunch the loss of biodiversity in a number of significant ways.

II. PATENT LAW

A. *The Patent Bargain*

Society generally disfavors monopolies, in part because monopolies tend to inflict a deadweight loss on society due to inefficiently low production and monopoly pricing of goods or services.⁵⁹ No less an inventor than Benjamin Franklin wrote that “*as we enjoy great Advantages from the Inventions of others, we should be glad of an Opportunity to serve others by any Invention of ours, and this we should do freely and generously.*”⁶⁰ Nevertheless, a patent affords its owner a monopoly right to exclude others and to sell patent goods and services for monopoly prices.⁶¹ Patents are allowed as an exception to the general rule against monopolies in order to create economic incentives for innovation by rewarding inventors for their efforts.⁶² In return, the inventor is required to add to society’s “storehouse” of knowledge.⁶³ Society is free to use this new knowledge, but is prohibited from making, using, selling, offering to sell, or importing a claimed invention during the patent term.⁶⁴ If scientists make progress by “standing on the shoulders of Giants,”⁶⁵ the patent system is intended to incentivize the creation of additional shoulders.

Because many inventions are the results of attempts to solve specific technical problems, patented inventions tend to be practical and useful.⁶⁶ Though not a panacea, the patent system can be useful in spurring the creation of solutions to the some of the challenges facing biodiversity.

B. *Patentable Subject Matter*

Patentable subject matter encompasses myriad categories of inventions. In response to a patent application filed by Ananda Chakrabarty, a professor of biology at the University of Illinois, in which he claimed a genetically engineered a

⁵⁸ *Id.*

⁵⁹ GREGORY MANKIW, PRINCIPLES OF ECONOMICS 326–34 (3d ed. 2004).

⁶⁰ BENJAMIN FRANKLIN, THE AUTOBIOGRAPHY OF BENJAMIN FRANKLIN 192 (Leonard W. Labaree et al. eds., 2d ed. 2003) (1791).

⁶¹ U.S. CONST. art. 1, § 8, cl. 8; 35 U.S.C. § 154(a)(1)–(2) (2006).

⁶² U.S. CONST. art. 1, § 8, cl. 8; *Precision Instrument Mfg. v. Auto. Maint. Mach. Co.*, 324 U.S. 806, 816 (1945).

⁶³ *In re Argoudelis*, 434 F.2d 1390, 1394 (C.C.P.A. 1970) (Baldwin, J., concurring).

⁶⁴ 35 U.S.C. § 154(a)(1)–(2) (describing content and term of patents).

⁶⁵ JAMES GLEICK, ISAAC NEWTON 98 (2004).

⁶⁶ *See* 35 U.S.C. § 101.

Pseudomonas bacterium capable of metabolizing hydrocarbons,⁶⁷ the United States Supreme Court (“Supreme Court”) declared that patentable subject matter could include “anything under the sun that is made by man.”⁶⁸ Subsequently, judicial and administrative decisions expanded the categories of patentability to include multicellular organisms,⁶⁹ plants,⁷⁰ mammals,⁷¹ computer software,⁷² and even methods of doing business.⁷³

C. Requirements of Patentability

The Patent Act imposes a number of statutory requirements that patent applications must meet before they can mature into valid patents.⁷⁴ An invention must satisfy the legal requirements of novelty,⁷⁵ nonobviousness,⁷⁶ utility,⁷⁷ and disclosure.⁷⁸ In addition, a patent application must include at least one “claim,”⁷⁹ a precise description of the metes and bounds of whatever aspects of the invention the inventor seeks to exclude others from practicing.⁸⁰

D. Patents in Practice

Patenting is a relatively expensive undertaking, costing an average of more than \$11,000 simply to file a patent application,⁸¹ and considerably more to have a patent

⁶⁷ *Diamond v. Chakrabarty*, 447 U.S. 303, 305 (1980); see *Microorganisms Having Multiple Compatible Degradative Energy-Generating Plasmids & Preparation Thereof*, U.S. Patent No. 4,259,444, at [75], col. 16 ll. 21–26 (filed June 7, 1972) (issued Mar. 31, 1981).

⁶⁸ *Chakrabarty*, 447 U.S. at 309.

⁶⁹ *Ex Parte Allen*, 2 U.S.P.Q.2d (BNA) 1425, 1426–27 (B.P.A.I. 1987).

⁷⁰ *J.E.M. Ag. Supply, Inc. v. Pioneer Hi-Bred Int'l, Inc.*, 534 U.S. 124, 145 (2001).

⁷¹ *E.g.*, *Transgenic Non-Human Mammals*, U.S. Patent No. 4,736,866 (filed June 22, 1984) (issued Apr. 12, 1988).

⁷² See *Diamond v. Diehr*, 450 U.S. 175, 196 (1981) (Stevens, J., dissenting).

⁷³ *State St. Bank & Trust Co. v. Signature Fin. Group, Inc.*, 149 F.3d 1368, 1375 (Fed. Cir. 1998), *abrogated by In re Bilski*, 545 F.3d 943 (Fed. Cir. 2008), *cert. granted sub nom. Bilski v. Doll*, 129 S. Ct. 2735 (2009).

⁷⁴ See 35 U.S.C. §§ 101–03, 112 (2006).

⁷⁵ *Id.* § 102.

⁷⁶ *Id.* § 103.

⁷⁷ *Id.* § 101.

⁷⁸ *Id.* § 112.

⁷⁹ *Id.*

⁸⁰ *Id.*; *Kara Tech. Inc. v. Stamps.com Inc.*, 582 F.3d 1341, 1347 (Fed. Cir. 2009) (“It is the claims that define the metes and bounds of the patentee’s invention.” (citing *Corning Glass Works v. Sumitomo Elec. U.S.A., Inc.*, 868 F.2d 1251, 1257 (Fed.Cir.1989))).

⁸¹ Thomas C. Fiala & Jon E. Wright, *Preparing and Prosecuting a Patent that Holds up in Litigation*, in *PATENT LITIGATION 2006*, at 515, 521–22 (PLI Patents, Copyrights, Trademark, & Literary Prop. Course, Handbook Series No. 875, 2006), *available at* WL, 875 PLI/PAT 515 (“For example, based on the AIPLA Report of the Economic Survey 2005, the average expected charge in 2004 for preparing and filing a utility patent application was \$11,218 for a relatively complex electrical or computer application and \$12,373 for a relatively complex biotechnology/chemical application.”).

granted by the United States Patent and Trademark Office (“USPTO”).⁸² Patent prosecution (the process through which a patent application must pass prior to issuance as a patent) can be a very slow process, generally lasting between two and a half and five years.⁸³ Once a patent has been issued by the USPTO, its effective term of enforceability only lasts about fifteen to seventeen and a half years.⁸⁴ And, the average cost of patent litigation to enforce one’s patent rights can readily rise above \$5 million, depending on the amount of damages at issue.⁸⁵

E. Purposes of the Patent System

Legal authority for the patent system is situated in Article 1, Section 8, Clause 8 of the United States Constitution, which states that “The Congress shall have Power . . . To promote the Progress of Science and useful Arts, by securing for limited Times to Authors and Inventors the exclusive Right to their respective Writings and Discoveries.”⁸⁶ Congress has exercised its Constitutional authority to offer patent protection to inventors since the first Patent Act of 1790.⁸⁷ In theory, the availability of patent protection should “promote the Progress of . . . useful Arts” by providing a monetary incentive (that is, monopoly pricing) to inventors to invest their valuable time, talent, and efforts in technological innovation.⁸⁸ Instead of providing direct support for invention through the public purse, the patent system allows Congress to

⁸² Interview with Craig Smith, Partner, Fish & Richardson P.C. (Mar. 5, 2007).

⁸³ *Id.* The USPTO Performance Report for fiscal year 2006 reports an average patent pendency time (defined as time from filing until patent issued or application abandoned by applicant) of 31.1 months and shows that this figure has been increasing over the past few years. U.S. PAT. & TRADEMARK OFFICE, U.S. DEP’T OF COMMERCE, PERFORMANCE AND ACCOUNTABILITY REPORT: FISCAL YEAR 2006 22 (2006) [hereinafter PERFORMANCE AND ACCOUNTABILITY REPORT], available at <http://www.uspto.gov/about/stratplan/ar/2006/2006annualreport.pdf>. However, the average pendency times estimated by the USPTO are likely underestimates. Kristen Osenga, *Entrance Ramps, Tolls, and Express Lanes—Proposals for Decreasing Traffic Congestion in the Patent Office*, 33 FLA. ST. U. L. REV. 119, 129–30 (2005).

[T]he average prosecution (or pendency) time for an ultimately successful patent is 3.6 years, with a median of 2.7 years. Anecdotally, the time period from filing to issuance varies by technology and ranges from twenty-four to thirty-six months for chemical and mechanical arts and thirty-six to sixty months for electrical and software arts.

Osenga, *supra*.

⁸⁴ *See id.*; see also 35 U.S.C. § 154(a)(2) (2006) (“[A patent] term begin[s] on the date on which the patent issues and end[s] 20 years from the date on which the application for the patent was filed . . .”).

⁸⁵ Fiala & Wright, *supra* note 81, at 522.

In comparison, the average estimated costs associated with litigating a patent in 2005 as reported by the [AIPLA Report of the Economic Survey 2005] were: \$769,562 for a patent infringement suit in which less than \$1 million was at risk; \$2,637,179 for a suit in which between \$1 and \$25 million was at risk; and \$5,175,753 for a suit in which more than \$25 million was at risk.

Id.

⁸⁶ U.S. CONST. art. I, § 8, cl. 8.

⁸⁷ Patent Act of 1790, ch. 7, 1 Stat. 109 (repealed 1793) (current version tit. 35 (2006)).

⁸⁸ *Kewanee Oil Co. v. Bicron Corp.*, 416 U.S. 470, 480 (1974).

rely on the prospect of private monopoly profits to incentivize inventive activity.⁸⁹ Furthermore, monopoly pricing inflicts only a limited deadweight loss on society because the patent term is limited in time to roughly 20 years.⁹⁰ Society receives information benefits from a patent as soon as it is published,⁹¹ and then, after a patent expires, its owner can no longer exclude others from practicing its technologies.⁹²

By incentivizing the creation of new technologies, and by providing various means by which those technologies may be disseminated and practiced, the patent system can augment the goal of biodiversity conservation in a number of important ways.

III. PATENT LAW AND BIODIVERSITY

Humanity is currently causing an extinction event of a magnitude that life on earth has not suffered for millions of years.⁹³ The many anthropogenic factors threatening biodiversity can be organized into five major categories conveniently called the HIPPO factors.⁹⁴ In order of severity, these causes of extinction are: (1) habitat loss, (2) invasives, (3) pollution, (4) population, and (5) overexploitation.⁹⁵ Patent law can provide many useful tools to combat each of the major causes of biodiversity extinction. To illustrate the usefulness of patent law in combating biodiversity loss, one patent conservation tool is highlighted for each of the HIPPO factors.

A. Patents Against Habitat Loss⁹⁶

In the realm of biotechnology, satisfying patent law's enablement requirement is sometimes accomplished by depositing the gene, biochemical, or organism of interest in a biological depository.⁹⁷ Biological deposits "of living material may enable a claimed invention whose manufacture or use depends thereupon."⁹⁸ Although this

⁸⁹ *See id.*

⁹⁰ *See* 35 U.S.C. § 154(a)(2) (2006); MANKIW, *supra* note 59, at 328–29 (discussing the effects of monopoly pricing on society).

⁹¹ *See* 35 U.S.C. § 122(b)(1)(A) (discussing how publication of a patent application generally occurs approximately eighteen months after the filing date of the patent application).

⁹² *Id.* § 154(a)(1)–(2).

⁹³ *See* RAVEN ET AL., *supra* note 2, at 844 ("Spanning the 3.5 billion year history of life on Earth, there have only been 5 great extinction events, each apparently cause by environmental cataclysms . . . [t]he beginning of the sixth extinction event has been brought about through human activity.").

⁹⁴ WILSON, *FUTURE OF LIFE*, *supra* note 14, at 50.

⁹⁵ *Id.*

⁹⁶ A more detailed discussion of the "extinction bar to patentability" appears in Andrew W. Torrance, *An Extinction Bar to Patentability*, 20 GEO. INT'L ENVTL. L. REV. 237 (2008), of which this section is a distillation.

⁹⁷ 35 U.S.C. §§ 112, 114; U.S. PAT. & TRADEMARK OFFICE, U.S. DEP'T OF COMMERCE, MANUAL OF PATENT EXAMINING PROCEDURE § 2402 (8th ed., 7th rev. 2008) [hereinafter MPEP]; *In re* Lundak, 773 F.2d 1216, 1220–21 (Fed. Cir. 1985).

⁹⁸ *Johns Hopkins Univ. v. Cellpro, Inc.*, 152 F.3d 1342, 1359 n.25 (Fed. Cir. 1998).

approach may be feasible in the case of small biological materials, such as biochemicals, cells, or microorganisms, it is infeasible for biological depositories to store and propagate larger, multicellular organisms, such as animals, plants, or fungi.⁹⁹ This physical size limitation on the capacity of biological depositories represents a challenge for many biotechnological inventions because macroorganisms, such as plants, insects, and fish, are far more diverse than microorganisms,¹⁰⁰ and so represent a larger potential pool of biochemicals and other biological materials useful as raw materials for inventors. For inventions based on macroorganisms, an alternative to existing *ex situ* depositories would be useful.

In 1980, Dr. Kenneth L. Rinehart, Jr. filed a patent application claiming, among other inventions, a process for preparing a natural biochemical named didemnin.¹⁰¹ Dr. Rinehart was a distinguished professor of chemistry at the University of Illinois, and a pioneering researcher in the field of natural biochemicals chemistry, in general, and marine natural biochemicals, in particular.¹⁰² One form of didemnin, didemnin B, was “the first marine-derived compound to undergo phase I clinical trials as an anticancer agent and was also the first to reach phase II testing for efficacy.”¹⁰³ Didemnin and similar biochemicals tend to exhibit a variety of therapeutic properties, including strong antiviral, antitumor, and immunosuppressive activity.¹⁰⁴ Dr. Rinehart derived didemnin B from colonial marine tunicates, small urochordate animals commonly called “sea squirts” that are usually found on tropical coral reefs.¹⁰⁵

⁹⁹ One method might be to house the organism in a zoo or farm-like setting. However, for the vast majority of taxa, whose survival requirements are either unknown, poorly understood, or maddeningly complex, this solution would be both infeasible and risky, especially if a population of the organism representing its genetic or biochemical variability is required to enable more than narrow claims. Furthermore, biological depositories that comply with the requirements of the Budapest Treaty on the International Regulation of the Deposit of Microorganisms for the Purposes of Patent Procedure do not accept whole-organism “deposits” of such organisms. See Budapest Treaty on the International Recognition of the Deposit of Microorganisms for the Purposes of Patent Procedure art. 2(ii), April 28, 1977, 32 U.S.T. 1241, 1861 U.N.T.S. 361 (*amended* on Sept. 26, 1980), available at http://www.wipo.int/treaties/en/registration/budapest/trtdocs_wo002.html#P19_196 (“[D]eposit of a microorganism’ means . . . the transmittal of a microorganism to an international depositary authority, which receives and accepts it, or the storage of such a microorganism by the international depositary authority, or both the said transmittal and the said storage.”).

¹⁰⁰ In fact, multicellular plants, fungi, and coral animals may be the most fruitful sources of novel natural biochemicals in nature. See RAVEN ET AL., *supra* note 2, at 843, 846 (suggesting plants are an important source of new drugs, agricultural improvements and other technologies).

¹⁰¹ U.S. Patent App. No. 06/186,932 (filed Sept. 12, 1980) (abandoned); see U.S. Patent No. 4,950,649 (filed Dec. 23, 1987) (issued Aug. 21, 1990).

¹⁰² Guy T. Carter et al., Editorial, *Special Issue in Honor of Professor Kenneth L. Rinehart*, 70 J. NAT. PRODUCTS 329, 329–30 (2007).

¹⁰³ *Id.* at 330; see Craig M. Crews et al., *Didemnin Binds to the Protein Palmitoyl Thioesterase Responsible for Infantile Neuronal Ceroid Lipofuscinosis*, 93 PROC. NAT'L ACAD. SCI. 4316, 4316 (1996).

¹⁰⁴ See Kenneth L. Rinehart et al., *Biologically Active Natural Products*, 62 PURE & APPLIED CHEMISTRY 1277, 1277–79 (1990); see also Kenneth L. Rinehart, Jr. et al., *Didemnins: Antiviral and Antitumor Depsipeptides from a Caribbean Tunicate*, 212 SCI. 933, 933–34 (1981) (“[C]ompounds in the tunicate extract offered promise both as antiviral agents and potentially, as antitumor agents as well.”).

¹⁰⁵ See Rinehart et al., *supra* note 104, at 1277.

After a long and difficult prosecution of his patent application in the USPTO, resulting in the final enablement rejection of several key claims “for lack of deposit of the marine tunicate,” Dr. Rinehart appealed the rejections to the Patent Board of Appeals and Interferences (“BPAI”).¹⁰⁶ Agreeing with Dr. Rinehart, the BPAI reversed the rejection, and held that the disclosure provided in the patent application satisfied the enablement requirement despite the lack of a biological deposit of the marine tunicate.¹⁰⁷ The BPAI decided that Dr. Rinehart had provided sufficient detailed information about the source taxon to enable the claims at issue.¹⁰⁸ As the BPAI explained:

With respect to the lack of deposit of the marine tunicate, we find that the source of the marine organisms necessary for practice of the invention is described in detail in the specification by reference to specific locations in the sea.

The marine tunicates are a well known class of marine microorganisms having definitive characteristics. Appellant has described the phylum, subphylum, class, order and suborder as well as where the organisms are located and how they can be obtained. The marine microorganisms are neither new nor unique but are commonly known and generally available to the public without any undue experimentation. In this area of technology, the written description sufficiently discloses how to obtain the tunicata from various specified locations in the sea. Accordingly, we see no necessity for a deposit of the organism.¹⁰⁹

Ex parte Rinehart recognized an alternative form of biological deposit. A biological sample placed into the care of a conventional biological depository may be described as an “*ex situ* biological deposit” because the source taxon has been removed from (*ex*) its location in nature (*situ*) and transported to a biological depository in another location. By contrast, the BPAI, in *Ex parte Rinehart*, implicitly recognized a second category of biological “deposit” that may be referred to as an “*in situ* biological deposit” because the source taxon, rather than being removed and transported elsewhere, remains “deposited” in (*in*) its natural location (*situ*).¹¹⁰ Under *Ex parte Rinehart*, both *ex situ* and *in situ* biological deposits may satisfy the enablement requirement, as long as the biological deposit remains “available to the public without any undue experimentation.”¹¹¹

Ex situ biological deposits are particularly useful “[w]here biological material cannot be taxonomically described,”¹¹² whereas *in situ* biological deposits may be available when *ex situ* biological deposits are unavailable because the “[*ex situ* biological] deposit requirement applies only to biological materials that are not

¹⁰⁶ *Ex parte Rinehart*, 10 U.S.P.Q.2d (BNA) 1719, 1720 (B.P.A.I. 1989).

¹⁰⁷ *See id.*

¹⁰⁸ *See id.*

¹⁰⁹ *Id.* (footnote omitted).

¹¹⁰ *See id.*

¹¹¹ *Id.*

¹¹² *Evans Med. Ltd. v. Am. Cyanamid Co.*, 11 F. Supp. 2d 338, 344 n.7 (S.D.N.Y. 1998).

readily reproducible from their written description [and diagrams].¹¹³ According to the principles applied in *Ex parte Rinehart*, an *in situ* biological deposit is particularly useful when an *ex situ* biological deposit is infeasible and the inventor is able to disclose the specific: (1) *in situ* location and (2) taxonomic description of the source taxon upon which enablement depends.¹¹⁴ *In situ* biological deposits can accomplish for physically large taxa what *ex situ* biological deposits accomplish for physically smaller organisms, cells, and biochemicals: sufficient evidence of enablement when words and diagrams alone would be insufficient. Since most natural biochemicals are derived from physically larger taxa, recognition of *in situ* biological deposits provides significant advantages to inventors of biotechnologies.

For an *in situ* biological deposit to satisfy the enablement requirement it must ensure that the source taxon upon which the claimed invention depends be “available to the public without any undue experimentation.”¹¹⁵ In accordance with *Ex parte Rinehart*, a patent application must provide at least two fundamental categories of information about the source taxon. First, the disclosure must provide a taxonomic description of the source taxon of sufficient detail and accuracy to allow a person having ordinary skill in the art to distinguish the source taxon from other, similar, taxa.¹¹⁶ Modern taxonomic methods are well elaborated, and can be used to develop accurate methods for diagnosing any taxon of interest.¹¹⁷ These methods often rely on knowledge of genetics and evolutionary relatedness to ensure successful diagnosis of a source organism,¹¹⁸ and increasingly use mathematical phylogenetic analysis of DNA sequences to infer the evolutionary family tree, or “phylogeny,” that links one taxon to related taxa.¹¹⁹ Clearly, satisfying this requirement of *Ex parte Rinehart* is easier for well-described taxa than for taxa new to science.

Second, in addition to taxonomic disclosure, *Ex parte Rinehart* requires that a patent application also provide information, such as geographical range and habitat, sufficient to allow a person having ordinary skill in the art to locate a source taxon.¹²⁰ Disclosing the geographical range could involve a detailed written description, set of geographical coordinates, or map. Since all taxa have specific ecological limitations on which habitats they can and cannot inhabit,¹²¹ the patent application might additionally have to provide sufficient ecological information to enable a person having ordinary skill in the art to locate a source organism within whatever complex matrix of habitats that occurs within every geographical range. Without detailed taxonomic and geographic information, one having ordinary skill might have to employ extraordinary efforts, or “undue experimentation,” to locate a source taxon,

¹¹³ *In re Lundak*, 773 F.2d 1216, 1217 (Fed. Cir. 1985).

¹¹⁴ *See Ex parte Rinehart*, 10 U.S.P.Q.2d at 1720.

¹¹⁵ *Id.*

¹¹⁶ *Id.*

¹¹⁷ A variety of traits are available for taxonomic diagnosis. These include morphological traits, such as physical size, shape, and color of different parts of an organism, as behavioral, physiological, and genetic traits. *See, e.g.*, David L. Swofford et al., *Phylogenetic Inference, in MOLECULAR SYSTEMATICS* 407, 409 (David M. Hillis et al. eds., 2d ed. 1996).

¹¹⁸ *See* Tree of Life: What is Phylogeny, <http://tolweb.org/tree/learn/concepts/whatisphylogeny.html> (last visited Mar. 19, 2010) (discussing evolutionary relatedness).

¹¹⁹ *See, e.g.*, Swofford, *supra* note 117, at 407–514.

¹²⁰ *Ex parte Rinehart*, 10 U.S.P.Q.2d at 1720.

¹²¹ *See, e.g.*, PAUL COLINVAUX, *ECOLOGY* 31 (John Wiley & Sons, Inc. 1986).

resulting in patent claims not enabled by the disclosure of a corresponding patent application.¹²²

In addition to disclosure of taxonomic and geographic information, one can imagine that a patent applicant might also prefer to possess information regarding the conservation status of any source taxon upon whose ability to be located any patent claims rely for their enablement. After all, any source taxon that cannot be located without undue experimentation—for reasons of rareness or extinction, perhaps—may render patent claims invalid for lack of enablement.¹²³ Therefore, a logical corollary of employing biological deposits, whether *ex situ* or *in situ*, to enable claims is an “extinction bar” to patentability.

This extinction bar to patentability has an analogy in another patent case, entitled *In re Metcalfe*, in which the Court of Customs and Patent Appeals (“CCPA”) ruled that a reference to a trademark in a patent application could be sufficient to enable a claimed invention initially.¹²⁴ However, the CCPA then warned that “there is always the possibility that sometime after the issuance of a patent, the disclosure which was initially enabling may become ‘unenabling.’”¹²⁵ As the CCPA echoed in *In re Argoudelis* there exists “the possibility that at some future date one skilled in the art might no longer be enabled to practice the invention [should the *ex situ* biological deposit supporting enablement become unavailable].”¹²⁶ Similarly, the Court of Appeals for the Federal Circuit (“Federal Circuit”), in *In re Lundak*, warned that “the applicant or his assigns [must provide] assurance of *permanent availability* of the culture to the public through a[n *ex situ* biological] depository [in compliance with other USPTO rules].”¹²⁷ The USPTO Manual of Patent Examination Practice also considers secondary loss of enablement through loss of *in situ* biological deposits:

If the biological material and its natural location can be adequately described so that one skilled in the art could obtain it using ordinary skill in the art, the disclosure would appear to be sufficient to meet the enablement requirement of 35 U.S.C. [§] 112 without a[n *ex situ* biological] deposit so long as its degree of availability is reasonable under the circumstances.

By showing that a biological material is known and readily available or by making a[n *ex situ* biological] deposit in accordance with these rules, applicant does not guarantee that such biological material will be available forever. *Public access during the term of the patent may affect the enforceability of the patent. . . .*

. . . .

. . . *Those applicants that rely on evidence of accessibility other than a[n *ex situ*] deposit take the risk that the patent may no longer be enforceable if*

¹²² See *In re Wands*, 858 F.2d 731, 736–37 (Fed. Cir. 1988).

¹²³ See *id.*

¹²⁴ See *In re Metcalfe*, 410 F.2d 1378, 1382 (C.C.P.A. 1969).

¹²⁵ *Id.*

¹²⁶ *In re Argoudelis*, 434 F.2d 1390, 1394 (C.C.P.A. 1970).

¹²⁷ *In re Lundak*, 773 F.2d 1216, 1219 (Fed. Cir. 1985) (emphasis added).

*the biological material necessary to satisfy the requirements of 35 U.S.C. [§] 112 ceases to be available.*¹²⁸

The quid pro quo of the patent bargain involves an inventor receiving a monopoly right to exclude others from the claimed invention in return for providing society with an enabling disclosure of that invention.¹²⁹ Thus, when disclosure becomes secondarily nonenabling, it is both logical and equitable that the inventor secondarily lose monopoly exclusion rights. An extinction bar to patentability ensures that the patent bargain remains balanced throughout the entire term of a patent.

Recognition of the extinction bar to patentability creates new opportunities for private international law to help solve the biodiversity crisis around the world.¹³⁰ The extinction bar to patentability creates an incentive for the owner of any patent whose enablement depends on an *in situ* deposit to ensure survival of the source taxon. A rational patent owner will protect the source taxon in order to protect any corresponding patent rights because extinction of the source taxon can lead to loss of corresponding patent rights.¹³¹ The more valuable the patent rights are, the more efforts a patent owner will make to ensure survival of the source taxon. In the extreme case of a patent owner whose patent claims cover a blockbuster drug, one would expect heroic efforts expended to ensure survival of the corresponding source taxon.

Most biodiversity is concentrated within the borders of tropical, developing nations.¹³² Although these countries have few resources to devote to conservation of their rich stores of biodiversity, they are disproportionately targeted by bioprospectors hoping to discover new and valuable natural biochemicals to patent and commercialize.¹³³ Recognition of an extinction bar to patentability can create not only incentives to conserve biodiversity, but can also help to align the interests of bioprospectors and host countries. To ensure survival of a source taxon, a patent owner might pursue conservation efforts such as purchasing, leasing, or acquiring conservation easements to the land on which the source taxon were found, hiring guards and paying local residents to protect the source taxon and its habitat from harm, and negotiating with local, regional, or national governments and agencies to gain cooperation to ensure that the source taxon survives. A rational patent owner would protect the value of the patent by employing whatever safeguards were warranted to ensure survival of a source taxon.

¹²⁸ MPEP, *supra* note 97, § 2404.01 (emphasis added).

¹²⁹ See U.S. CONST. art. 1 § 8, cl. 8; 35 U.S.C. §§ 112, 154(a) (2006); *Enzo Biochem, Inc. v. Gen-Probe, Inc.*, 323 F.3d 956, 977 (Fed. Cir. 2002) (Rader, J., dissenting).

¹³⁰ Other efforts have been made to use private international law to conserve biodiversity. Simple payments for conservation efforts have met with some success. See, e.g., Paul J. Ferraro & Agnes Kiss, *Direct Payments to Conserve Biodiversity*, 298 SCI. 1718, 1718–19 (2002). More complicated strategies, such as debt for nature swaps between conservation organizations and heavily indebted tropical, developing countries, have also been used. See generally, e.g., Amanda Lewis, *The Evolving Process of Swapping Debt for Nature*, 10 COLO. J. OF INT'L ENVTL. L. & POL'Y 431 (1999) (analyzing debt-for-nature swaps as a practical tool to expand international conservation activities).

¹³¹ See *In re Metcalfe*, 410 F.2d 1378, 1382 (C.C.P.A. 1969).

¹³² See Gaston, *supra* note 21, at 220–21.

¹³³ See Chen, *supra* note 13, at 1–6.

All organisms are dependent on a web of ecological interactions for survival, and, consequently, they survive best when they remain integrated within their native ecosystems.¹³⁴ Thus, although the patent system is agnostic regarding how to ensure the survival of source taxa, patent owners would often decide that habitat conservation represented the most effective approach. For this reason, the most effective strategy for conserving a source taxon will often be to ensure that its native ecosystem is preserved. By ensuring the preservation of its ecosystem, a source taxon would thus act as a “conservation umbrella” protecting other organisms with which it shares its ecosystem. Such a positive conservation externality would benefit both society and biodiversity. Given a substantial number of patents claiming inventions based on natural biochemicals, recognition of the extinction bar to patentability could spur the creation of a significant network of privately-funded “patent parks” around the world, but especially in the developing, tropical countries richest in biodiversity. Countries might even decide to preserve areas rich in biodiversity for their potential to yield patentable natural biochemicals in the future, particularly if they assessed the opportunity cost of liquidating their biodiversity as unacceptably high. The magnitude of the conservation incentive created by the extinction bar to patentability may be difficult to calculate, but, at the very least, the incentives it provides to conserve biodiversity will decrease the destruction of land rich in biodiversity at the margins of land use decisions.

B. Patents Against Invasives

Over the past several thousand years, the ability of humans to travel long distances has increased significantly. Beginning in the Renaissance, long-range sailing vessels facilitated intercontinental travel.¹³⁵ Since then, millions of humans have moved from country to country and continent to continent. Today, long distance travel is routine for millions of people around the world.¹³⁶ As human travel has increased, so has the long-distance movement of other organisms:

In the past couple of thousand years, isolation has been diminished for many species. The worldwide movement of people, especially with the rise of maritime shipping in the past few hundred years, has created a new agent for moving biota around the globe¹³⁷

With respect to biodiversity, “the rate at which biological communities are reshuffled as species move in and out of them through geographic range shifts has been greatly accelerated by human activities.”¹³⁸

¹³⁴ See COLINVAUX, *supra* note 121, at 21.

¹³⁵ See MICHAEL W. MARSHALL, OCEAN TRADERS: FROM THE PORTUGUESE DISCOVERIES TO THE PRESENT DAY 24 (1990).

¹³⁶ See Data Elements, Bureau of Transportation Statistics, Research and Innovative Technology Administrations, http://www.transtats.bts.gov/Data_Elements.aspx?Data=1 (last visited Mar. 20, 2010).

¹³⁷ MALCOLM L. HUNTER, JR. & JAMES GIBBS, FUNDAMENTALS OF CONSERVATION BIOLOGY 205 (3d ed. 2007).

¹³⁸ *Id.*

Organisms that live outside their native geographic ranges are termed “exotics.”¹³⁹ Some exotics do not thrive when translocated to new areas.¹⁴⁰ However, other, “invasive,” exotics thrive, often with devastating consequences for native biodiversity.¹⁴¹ Invasives are “exotic species that have successfully invaded (or are likely to invade) an ecosystem, causing significant ecological, economic, or human health problems.”¹⁴² For example, invasives have been identified as the most serious threats to the survival of 305 of 877 species listed as endangered in the United States.¹⁴³ And, invasives have been found responsible for US \$314 billion in damage to the economies and environments of Australia, Brazil, India, South Africa, the United Kingdom, and the United States.¹⁴⁴ In short, invasives are very serious threats to biodiversity.

Exotic Asian carp illustrate the great threat to native biodiversity posed by invasives. These carp were introduced through a variety of human actions:

Introductions of Asian carps into waters of the United States are the result of combinations of direct stockings by or authorized by various agencies, unauthorized stockings by private individuals, and unintentional escapes from university research facilities, federal and state agency facilities, and private aquaculture operations.¹⁴⁵

By various means, Asian carp have spread widely through the Mississippi watershed since their introduction into the United States. Unfortunately,

Based on experiences with other nuisance species, natural resources management agencies, fishery and aquaculture scientists, and associated industries are concerned about the potential ecological and economic effects posed by feral populations of Asian carps.¹⁴⁶

In 2009, concerns that Asian carp might reach the Great Lakes via the Chicago River reached a crescendo.¹⁴⁷

Although the Chicago River used to empty into Lake Michigan, in 1900 a massive engineering project reversed its flow into the Mississippi River.¹⁴⁸ This has

¹³⁹ *Id.* at 206.

¹⁴⁰ *See id.*

¹⁴¹ *Id.*

¹⁴² *Id.*

¹⁴³ Brian Czech et al., *Economic Associations Among Causes of Species Endangerment in the United States*, 50 *BIOSCIENCE* 593, 594 (2000).

¹⁴⁴ *BIOLOGICAL INVASIONS: ECONOMIC AND ENVIRONMENTAL COSTS OF ALIEN PLANT, ANIMAL, AND MICROBE SPECIES* 7 (David Pimental ed., CRC Press 2002).

¹⁴⁵ G. CONOVER ET AL., *ASIAN CARP WORKING GROUP, AQUATIC NUISANCE SPECIES TASK FORCE, MANAGEMENT AND CONTROL PLAN FOR BIGHEAD, BLACK, GRASS, AND SILVER CARPS IN THE UNITED STATES 2* (2007), available at http://www.anstaskforce.gov/Documents/Carps_Management_Plan.pdf.

¹⁴⁶ *Id.* at 4.

¹⁴⁷ *See generally* Renewed Mot. for Prelim. Inj., *State of Mich. v. State of Ill.*, No. 2, Original (Feb. 4, 2010) (requesting that the U.S. Supreme Court grant a preliminary injunction against Illinois to close a lock on the Calumet River to prevent the spread of Asian Carp to Lake Michigan).

allowed the mixing of biodiversity between the Great Lakes and the Mississippi River watersheds ever since. As the Asian carp has spread throughout the Mississippi River watershed, it has reached the Chicago River.¹⁴⁹ If the Asian carp were to reach Lake Michigan through the Chicago River, many fear an ecological catastrophe:

The carp, a non-native species that some fear could destroy the ecosystem of Lake Michigan by consuming what the lake's native fish eat, have long been making their way up the Mississippi River, and since at least 2002 have been the focus of an enormous effort to prevent them from reaching the lake here.¹⁵⁰

The threat posed by Asian carp is so great that Michigan (supported by Minnesota, Ohio and Wisconsin) sued Illinois in the Supreme Court, seeking an injunction to force the closure of locks connecting the Chicago River to Lake Michigan.¹⁵¹ In the meantime, hopes have been resting on an elaborate "barrier system, which acts like a powerful electric fence," placed across the Chicago River to prevent the Asian carp's further spread.¹⁵² Nevertheless, on January 19, 2010, DNA from Asian carp was detected inside Lake Michigan, as well as in a nearby river.¹⁵³

Patents can play a strong role in combating invasives. Inventors have patented many inventions intended to eradicate, detect, or predict the spread of invasives. For example, United States Patent Application Number 11/213,710 claims

A non-destructive method for the detection of infestation of a living conifer tree by a[n invasive] wood boring insect having a specific established fungal associate, comprising

- (a) identifying an infested tree by the visual presence of insect exit holes of a characteristic shape, size and orientation in the bark and by a characteristic pattern of visible resin flow not originating from the insect exit holes
- (b) providing an elongated sterile probe having a diameter and length to accommodate the range of diameters of insect exit holes and length of connected insect exit tunnels, and having a fungal spore collecting tip,
- (c) inserting the probe into an exit hole to collect viable fungal spores or mycelium,

¹⁴⁸ See LIBBY HILL, *THE CHICAGO RIVER: A NATURAL AND UNNATURAL HISTORY* 69–75 (2000) (discussing the reconstruction of Chicago's harbor before the Chicago River was reversed).

¹⁴⁹ See Monica Davey, *Voracious Invader May Be Nearing Lake Michigan*, N.Y. TIMES, Nov. 21, 2009, at A13.

¹⁵⁰ *Id.*

¹⁵¹ *Michigan v. Illinois*, 130 S. Ct. 1166 (2010) ("Motion of Michigan for preliminary injunction denied."); see Renewed Mot. for Prelim. Inj., *supra* note 147.

¹⁵² Emma Graves Fitzsimmons, *Illinois Tries United Front Against Fish and Lawsuit*, N.Y. TIMES, Jan. 13, 2010, at A21.

¹⁵³ Renewed Mot. for Prelim. Inj., *supra* note 147, at 2; Susan Saulny, *Carp DNA is Found in Lake Michigan*, N.Y. TIMES, Jan. 20, 2010, at A13.

(d) withdrawing the probe from the exit hole, and

(e) matching the fungus with a wood boring insect species known to have a specific established fungal associate.¹⁵⁴

United States Patent Number 7,536,979 includes

[Claim] 1. A method of controlling noxious plant species, the method comprising:

identifying a target area in a foraging area, wherein the target area includes a noxious plant specie;

selecting a treatment period, wherein ungulates will interact with the noxious plant specie in the target area; and

providing a highly-palatable, portable, self-limiting, animal feed supplement at a first deployment location in the target area wherein the supplement attracts the ungulates to the target area and increases a length of stay of the ungulates in the target area.¹⁵⁵

And, United States Patent Number 7,308,392, which includes

[Claim] 1. A computer-implemented method of predicting species invasions, the method comprising:

receiving native species occurrence information; receiving native environmental information;

formulating at least one ecological niche model based on the native species occurrence information and the native environmental information;

receiving target environmental information corresponding to an alternative geography; and

projecting the ecological niche model onto the alternative geography to predict characteristics of an invasion of the species.¹⁵⁶

United States Patent Number 6,125,778, which involves a “treatment [that] provides an effective, safe; and economical method to render ballast water free of

¹⁵⁴ U.S. Patent App. No. 11/213,710, at 13 (filed Aug. 30, 2005).

¹⁵⁵ U.S. Patent No. 7,536,979 col. 20 ll. 59–67, col. 21 ll. 1–2 (filed Dec. 14, 2005) (issued May 26, 2009).

¹⁵⁶ U.S. Patent No. 7,308,392 col. 15 ll. 4–15 (filed Jan. 12, 2002) (issued Dec. 11, 2007).

contaminating organisms,” even cites the National Invasive Species Act as one of the motivations behind the invention.¹⁵⁷

Invasives, such as the Asian carp, can present a clear and present danger to new ecosystems they colonize. For example, having reached the Great Lakes, Asian carp now threaten “a \$7 billion fishing industry and [lakes that] contain 20 percent of the world’s freshwater.”¹⁵⁸ Michigan and other states bordering the Great Lakes must now act immediately to prevent the Asian carp from establishing itself in this new ecosystem.¹⁵⁹ Delay in these efforts could result in permanent ecological catastrophe.¹⁶⁰ Patent law provides several powerful options that allow the federal and state governments rapid, or immediate, access to patented technologies useful in preventing or combating spread of invasives: sovereign immunity.

If the federal government need not act immediately against an invasive, “patent breaking” is an option. Patent breaking refers to total abrogation or revocation of the rights conferred by a patent. The Paris Convention forbids immediate patent breaking, warning that “[f]orfeiture of the patent shall not be provided for except in cases where the grant of compulsory licenses would not have been sufficient to prevent the said abuses.”¹⁶¹ As a prerequisite to breaking a patent, the government must institute a compulsory licensing scheme because “[n]o proceedings for the forfeiture or revocation of a patent may be instituted before the expiration of two years from the grant of the first compulsory license.”¹⁶² According to the terms of both the North American Free Trade Agreement (“NAFTA”) and the World Trade Organization Trade-Related Aspects of Intellectual Property (“TRIPS”) side-agreement, patent breaking involves an additional requirement that “the scope and duration of [government sanctioned] use shall be limited to the purpose for which it was authorized.”¹⁶³

Cipro® provides an instructive illustration. On September 18, 2001, exactly a week after the 9/11 terrorist attacks, anthrax-laced letters entered the United States postal system, killing several people.¹⁶⁴ Bayer AG, a large German pharmaceutical company, owned a patent covering Cipro®, or ciprofloxacin, an antibiotic effective in treating anthrax infections.¹⁶⁵ Demand for Cipro® rose so quickly after the anthrax attacks began that Bayer could not manufacture enough of the drug to satisfy the

¹⁵⁷ U.S. Patent No. 6,125,778 col. 2 ll. 5–31 (filed Mar. 15, 1999) (issued Oct. 3, 2000).

¹⁵⁸ Saulny, *supra* note 153.

¹⁵⁹ Renewed Mot. for Prelim. Inj., *supra* note 147; see Monica Davey, *Be Careful What You Fish For*, N.Y. TIMES, Dec. 13, 2009, at WK3.

¹⁶⁰ Davey, *supra* note 159.

¹⁶¹ Paris Convention for the Protection of Industrial Property art. 5(A)(3), Mar. 20, 1883, 21 U.S.T. 1583, 828 U.N.T.S. 305 (*revised at* Stockholm on July 14, 1967) [hereinafter Paris Convention], available at http://www.wipo.int/export/sites/www/treaties/en/ip/paris/pdf/trtdocs_wo020.pdf.

¹⁶² *Id.*

¹⁶³ North American Free Trade Agreement art. 1709, §10(c), U.S.-Can.-Mex., Dec. 17, 1992, 32 I.L.M. 289 (1993) [hereinafter NAFTA], available at [http://www.wto.int/english/docs_e/legal_e/27-TRIPS.pdf](http://www.nafta-sec-alena.org/en/view.aspx?x=343&mtpiID=ALL; Agreement on Trade-Related Aspects of Intellectual Property Rights art. 31(c), Apr. 15, 1994, Marrakesh Agreement Establishing the World Trade Organization, Annex 1C, Legal Instruments—Results of the Uruguay Round, 33 I.L.M. 1125, 1869 U.N.T.S. 299 [hereinafter TRIPS Agreement], available at <a href=).

¹⁶⁴ Federal Bureau of Investigation – Amerithrax <http://www.fbi.gov/anthrax/amerithrax/links.htm> (last visited Mar. 20, 2010).

¹⁶⁵ U.S. Patent No. 4,670,444 (filed May 29, 1984) (issued June 2, 1987).

demand.¹⁶⁶ United States Senator Charles Shumer of New York tried to persuade the federal government to authorize generic drug manufacturers to produce a generic version of Cipro® that could satisfy demand while costing less than the patented, branded version.¹⁶⁷ If Senator Shumer's plan for combating anthrax had been successful, the federal government would have broken Bayer's Cipro® patent.¹⁶⁸ However, he was unsuccessful, and Bayer's patent rights survived.¹⁶⁹ By contrast, the Canadian government did precisely what Senator Shumer had suggested, and allowed the production of generic Cipro® in violation of Bayer's Canadian patent.¹⁷⁰

At first, Tommy Thompson, Secretary of Health and Human Services, doubted that the government had the legal right to override Bayer's patent rights.¹⁷¹ But when the Canadian government decided to allow production of Cipro®, Secretary Thompson began to use the specter of patent-breaking as a negotiating tactic with Bayer:

Thursday morning, October 18, Thompson quickly forgot about legal technicalities when Canada jumped into the Cipro fray. The Canadian minister of health signed a contract with a generic manufacturer to make extra ciprofloxacin, expressing concerns about the sufficiency of Canada's stockpile. The next morning, Thompson started publicly bullying Bayer on price, threatening to get the law changed so he could ignore the company's patent.¹⁷²

Rather than risk loss of their patent, Bayer agreed to manufacture more Cipro®, and to sell it at a lower its price.¹⁷³ Several years later, spurred by worries about the global bird flu epidemic, the administration of George W. Bush threatened to break Roche's U.S. patent covering Tamiflu®, but never actually followed through on its threat.¹⁷⁴ Patent breaking is a very rare occurrence, and has yet to be used by the federal government of the United States in modern times.

Sovereign immunity provides an alternative way for the federal and state governments to use patented inventions without permission from their inventors. The doctrine of sovereign immunity confers to the U.S. federal government the constitutional authority to infringe U.S. patents without penalty,¹⁷⁵ as well to

¹⁶⁶ Anthony York, *Is it Time to Bust the Cipro Patent?*, SALON, Oct. 18, 2001, http://archive.salon.com/tech/feature/2001/10/18/cipro_patent/index.html.

¹⁶⁷ *Id.*

¹⁶⁸ *Id.*

¹⁶⁹ See Keith Bradsher, *A Nation Challenged: The Treatment: Bayer Halves Price for Cipro, but Rivals Offer Drugs Free*, N.Y. TIMES, Oct. 26, 2001, at A1 (discussing Bayer's agreement with the U.S. Government to reduce the cost of Cipro).

¹⁷⁰ York, *supra* note 166.

¹⁷¹ *Id.*

¹⁷² Matt Fleischer-Black, *The Cipro Dilemma: In the Anthrax Crisis, Tommy Thompson Distorted Patent Law to Save Public Health. Good Move?*, AM. LAW., Jan. 2002, at 54, available at <http://www.cptech.org/ip/health/cl/cipro/americanlawyer012002.html>.

¹⁷³ *Id.*

¹⁷⁴ Sebastian Mallaby, *A Double Dose of Failure*, WASHINGTON POST, Nov. 7, 2005, at A21, available at <http://www.washingtonpost.com/wp-dyn/content/article/2005/11/06/AR2005110601013.html>.

¹⁷⁵ *W.L. Gore & Assocs., Inc. v. Garlock, Inc.*, 842 F.2d 1275, 1283 (Fed. Cir. 1988).

authorize others to infringe.¹⁷⁶ Nevertheless, were the federal government to appropriate a patent, patent owners are entitled to compensation by federal statute.¹⁷⁷ According to 28 U.S.C. §1498(a)

Whenever an invention described in and covered by a patent of the United States is used or manufactured by or for the United States without license of the owner thereof or lawful right to use or manufacture the same, the owner's remedy shall be by action against the United States in the United States Court of Federal Claims for the recovery of his reasonable and entire compensation for such use and manufacture. . . .

For the purposes of this section, the use or manufacture of an invention described in and covered by a patent of the United States by a contractor, a subcontractor, or any person, firm, or corporation for the Government and with the authorization or consent of the Government, shall be construed as use or manufacture for the United States.¹⁷⁸

Thus, the United States has very broad discretion about when and how to manufacture or use, or authorize to manufacture or use, patented inventions.

The federal government, federal agencies, and nongovernmental actors authorized by the federal government can practice any patented invention.¹⁷⁹ In response, patent owners can sue in the United States Court of Federal Claims under 28 U.S.C. § 1498 to recover “reasonable and entire compensation for such use and manufacture,” but are not entitled to injunctive relief, willful damages, or attorney fees.¹⁸⁰ As the Federal Circuit has observed, “The government has graciously consented, in [28 U.S.C. § 1498], to be sued in the Claims Court for reasonable and entire compensation, for what would be infringement if by a private person.”¹⁸¹

States also possess sovereign immunity capable of overriding patent rights.¹⁸² However, patent owners have little recourse if a state chooses to override a patent. In an attempt to remove from states their sovereign immunity from patent infringement suits, Congress amended the Patent Act to add 35 U.S.C. §271(h).¹⁸³ This amendment would have stipulated that “Any State, and any . . . instrumentality, officer, or employee [of the State], shall be subject to the provisions of [the Patent Act] in the same manner and to the same extent as any nongovernmental entity.”¹⁸⁴ The Federal Circuit upheld the constitutionality of 35 U.S.C. § 271(h) in authorizing a patent owner to bring suit against a state for

¹⁷⁶ *Id.*

¹⁷⁷ 28 U.S.C. § 1498(a) (2006).

¹⁷⁸ *Id.*

¹⁷⁹ *Id.*

¹⁸⁰ *See id.*

¹⁸¹ *W.L. Gore*, 842 F.2d at 1283.

¹⁸² U.S. CONST. amend. XI; Fla. Prepaid Postsecondary Ed. Expense Bd. v. College Savings Bank, 527 U.S. 627, 647–48 (1999).

¹⁸³ Patent and Plant Variety Protection Remedy Clarification Act, Pub. L. No. 102-560, 106 Stat 4230 (1992) (codified as amended at 35 U.S.C. § 271(h) (2006)).

¹⁸⁴ *Id.*

infringing a patented invention,¹⁸⁵ but the Supreme Court overturned the Federal Circuit's decision, instead holding that 35 U.S.C. § 271(h) violated the Eleventh Amendment.¹⁸⁶

Thus, under the Eleventh Amendment, states do retain sovereign immunity against patent infringement suits.¹⁸⁷ A state is permitted to engage in activities that, but for their sovereign immunity, might constitute patent infringement.¹⁸⁸ State governments can practice any patented invention, and their sovereign immunity protection extends to their instrumentalities and employees.¹⁸⁹

According to the doctrine of sovereign immunity, the federal or state governments could practice any patent relevant to invasives without waiting for permission or a license from the patent's owner.¹⁹⁰ This holds true for any patents claiming devices or methods for combating invasives.¹⁹¹ For example, if states around the Great Lakes so chose, they could use whatever patented anti-invasive Asian carp technologies they wished, without fear of consequences more serious than compensating the relevant patent owners. And, unlike the case of patent breaking and compulsory licenses, the federal and state governments could do so as soon as needed to combat the spread of invasives.¹⁹²

C. Patents and Pollution

As a result of industrialization and a growing population, humans raised the concentrations of many chemicals in the environment well above their pre-industrial levels.¹⁹³ Toxic heavy metals, such as lead, mercury, cadmium, and arsenic, now circulate through the environment at levels dangerous to many kinds of biodiversity.¹⁹⁴ Combustion of fossil fuels has produced prodigious amounts of sulphuric, nitric, and carbonic acids leading to acidification of precipitation (e.g., acid rain), soils, and water, leading to measurable damage to biodiversity.¹⁹⁵ In fact, so much carbonic acid has accumulated in the oceans that it has already lowered their acidity by a measurable amount, and may soon make the oceans more acidic than they have been for at least 20 million years.¹⁹⁶ In addition, advances in chemical

¹⁸⁵ *College Savings Bank v. Fla. Prepaid Postsecondary Ed. Expense Bd.*, 148 F.3d 1343, 1355 (Fed. Cir. 1998), *rev'd*, 527 U.S. 627 (1999).

¹⁸⁶ *Florida Prepaid*, 527 U.S. at 647–48 (1999); *see also* U.S. CONST. amend. XI (“The Judicial power of the United States shall not be construed to extend to any suit in law or equity, commenced or prosecuted against one of the United States by Citizens of another State, or by Citizens or Subjects of any Foreign State.”).

¹⁸⁷ U.S. CONST. amend. XI; *Florida Prepaid*, 527 U.S. at 647–48.

¹⁸⁸ U.S. CONST. amend. XI; *Florida Prepaid*, 527 U.S. at 647–48.

¹⁸⁹ U.S. CONST. amend. XI; 35 U.S.C. § 271(h) (2006) (“[T]he term ‘whoever’ includes any State, any instrumentality of a State, and any officer or employee of a State or instrumentality of a State acting in his official capacity.”); *Florida Prepaid*, 527 U.S. at 647–48 (holding 35 U.S.C. § 271(h) unconstitutional).

¹⁹⁰ *See* U.S. CONST. amend. XI; *Florida Prepaid*, 527 U.S. at 647–48.

¹⁹¹ *See* U.S. CONST. amend. XI; *Florida Prepaid*, 527 U.S. at 647–48.

¹⁹² *See* U.S. CONST. amend. XI; *Florida Prepaid*, 527 U.S. at 647–48.

¹⁹³ *See* SUSTAINING LIFE, *supra* note 19, at 69.

¹⁹⁴ *Id.* at 58.

¹⁹⁵ *Id.* at 57.

¹⁹⁶ *Id.* at 69.

technology have exposed ecosystems to many synthetic chemicals not previously known in nature. These include persistent organic pollutants (or “POPs”), such as PCB,¹⁹⁷ toxic herbicides and pesticides,¹⁹⁸ biologically-active pharmaceuticals,¹⁹⁹ and myriad forms of durable plastic.²⁰⁰ Finally, the accumulation of carbon dioxide in the atmosphere, and the global climate change this accumulation is causing, currently poses one of the most serious dangers to biodiversity, as temperatures, weather patterns, and sea levels all shift in response.²⁰¹ Pollution from human sources has many adverse effects on biodiversity worldwide.

In addition to legal prohibitions, taxation to discourage usage, and environmental cleanups, the patent system offers a powerful approach to the threat of pollution: technological innovation. New technologies can replace existing toxins with more benign substitutes, remediate the effects of toxins already in the environment by offering methods to detoxify or remove them, and offer new, cleaner, more efficient processes in the place of older, dirtier, less efficient ones. In fact, one of the most famous patents claimed an invention useful in cleaning up crude oil spills.²⁰² Ananda Chakrabarty, a professor of biology at the University of Illinois, genetically engineered a *Pseudomonas* bacterium to enable it to metabolize hydrocarbons,²⁰³ and intended his new bacterium to be introduced into crude oil spills, where, having an abundant hydrocarbon food source, the modified *Pseudomonas* could reproduce exponentially, consume the oil, and then die of starvation, thereby minimizing the toxic effects of spilled oil on the environment.²⁰⁴

Increasingly, public attitudes have turned against pollution as an acceptable byproduct of economic activity.²⁰⁵ This has led to abundant environmental litigation, as well as specific statutory mandates to reduce pollution, such as in the Clean Air Act,²⁰⁶ the Clean Water Act,²⁰⁷ the Comprehensive Environmental Response, Compensation, and Liability Act,²⁰⁸ Toxic Substances Control Act,²⁰⁹ and even the Endangered Species Act.²¹⁰ The Clean Air Act, in particular, has employed the patent system to achieve its goals of reducing airborne pollution.²¹¹ It has done so through a system of compulsory licensing.²¹² The owner of a patent can exclude

¹⁹⁷ *Id.* at 54.

¹⁹⁸ *Id.* at 59.

¹⁹⁹ *Id.* at 55.

²⁰⁰ *Id.* at 59.

²⁰¹ *Id.* at 63–73.

²⁰² See U.S. Patent No. 4,259,444 col. 16 ll. 23–26 (filed June 7, 1972) (issued Mar. 31, 1981).

²⁰³ *Diamond v. Chakrabarty*, 447 U.S. 303, 305 (1980).

²⁰⁴ *Id.*

²⁰⁵ RAVEN ET AL., *supra* note 2, at 845.

²⁰⁶ Clean Air Act, Pub. L. No. 84-159, 69 Stat. 322 (1955) (codified as amended at 42 U.S.C. §§ 7401–7626 (2006)).

²⁰⁷ Clean Water Act, Pub. L. No. 92-500, 86 Stat. 816 (1972) (codified as amended at 33 U.S.C. §§ 1251–1387 (2006)).

²⁰⁸ Comprehensive Environmental Response, Compensation, and Liability Act of 1980, Pub. L. 96-510, 94 Stat. 2767 (codified as amended at 42 U.S.C. §§ 9601–75).

²⁰⁹ Toxic Substances Control Act, Pub. L. No. 94-469, 90 Stat. 2003 (1976) (codified as amended at 15 U.S.C. §§ 2601–92 (2006)).

²¹⁰ Endangered Species Act of 1973, Pub. L. No. 93-205, 87 Stat. 884 (codified as amended at 16 U.S.C. §§ 1531–44 (2006)).

²¹¹ 42 U.S.C. §§ 7404(b)(4), 7608.

²¹² *Id.* § 7608.

others from making, using, selling, offering to sell, or importing into the United States any patented invention.²¹³ A patent owner may choose to license others to practice a patented invention, or she may choose not grant licenses at all.²¹⁴ As the Supreme Court has noted, “[c]ompulsory licensing is a rarity in our patent system.”²¹⁵

If the federal government imposes a compulsory license on a patent owner, others are allowed to practice the patented invention even without permission from the patent owner.²¹⁶ The government acts in the stead of the patent owner, granting a compulsory license to itself or to third parties it authorizes.²¹⁷ The patent owner does receive some compensation for the compulsory license, usually an amount deemed by the government or courts to constitute a reasonable royalty.²¹⁸ The Paris Convention, NAFTA, and TRIPS provide for compulsory licensing, though the practice is much more common in other countries than in the United States.²¹⁹

Although there were some efforts to include a broader system of compulsory licenses in the 1952 amendments to the Patent Act, none were successfully incorporated.²²⁰ Congress has revisited the issue of including compulsory licenses in the Patent Act since then, but has yet to act.²²¹ However, both of the compulsory licensing schemes Congress has enshrined in statute are relevant to controlling pollution: air pollution control technology (42 U.S.C. § 7608) and nuclear technology (42 U.S.C. § 2183(c)).²²²

Congress passed the Clean Air Amendments of 1970 to the Clean Air Act (“CAA”)²²³ in large part “to protect and enhance the quality of the Nation’s air resources so as to promote the public health and welfare and the productive capacity of its population.”²²⁴ Under the CAA, the primary responsibility for reducing air pollution rests with states and local governments, who are legally obligated to reduce the concentrations of specified pollutants below maximum allowable limits.²²⁵ However, Congress realized that meeting these limits would be challenging, and might require access to expensive new pollution abatement technologies.²²⁶ Thus, Congress included in the amendments a provision to allow states to take compulsory

²¹³ 35 U.S.C. § 271(a) (2006).

²¹⁴ *Id.* § 271(d)(4).

²¹⁵ *Dawson Chem. Co. v. Rohm & Haas Co.*, 448 U.S. 176, 215 (1980).

²¹⁶ *See* 28 U.S.C. § 1498(a); 42 U.S.C. §§ 2183, 7608.

²¹⁷ *See* 28 U.S.C. § 1498(a); 42 U.S.C. §§ 2183, 7608.

²¹⁸ 28 U.S.C. § 1498(a); 42 U.S.C. §§ 2183(g), 7608(g).

²¹⁹ Paris Convention, *supra* note 161, art. 5(a); NAFTA, *supra* note 163, art. 1709, § 10; TRIPS Agreement, *supra* note 163, art. 31; *see Dawson Chem. Co.*, 448 U.S. at 215.

²²⁰ *See* H. COMM. ON THE JUDICIARY, 81ST CONG., PROPOSED REVISION AND AMENDMENT OF THE PATENT LAWS: PRELIMINARY DRAFT 91–92 (Comm. Print 1950).

²²¹ *See, e.g.*, SUBCOMM. ON PATENTS, TRADEMARKS, AND COPYRIGHTS OF THE S. COMM. ON THE JUDICIARY, 85TH CONG., COMPULSORY LICENSING OF PATENTS UNDER SOME NON-AMERICAN SYSTEMS 1 (Comm. Print 1959).

²²² 42 U.S.C. §§ 2183(c), 7608.

²²³ Clean Air Amendments of 1970, Pub. L. No. 91-604, 84 Stat. 1676 (codified as amended at 42 U.S.C. §§ 7401–7626).

²²⁴ 42 U.S.C. § 7401(b)(1).

²²⁵ *Id.* § 7401(a)(3).

²²⁶ 136 CONG. REC. S16,877–04, 16,888 (daily ed. Oct. 27, 1990) (statement of Sen. Symms).

licenses (what the CAA refers to as “mandatory licenses”) to air pollution abatement technologies necessary to meet the new federal air quality standards.²²⁷

In order to receive a compulsory license to use a patented pollution abatement technology, a state had to satisfy certain conditions. First, the Administrator of the Environmental Protection Agency (“EPA”) must make a formal request to the U.S. Attorney General for a compulsory license to allow governmental or commercial practice (or continued practice), of the patented air pollution abatement technology.²²⁸ Then, the Attorney General must certify that the patented technology is “not otherwise reasonably available,” “is necessary” to meet air quality standards mandated by the CAA,²²⁹ “there are no reasonable alternative methods to accomplish such purpose,”²³⁰ and failure to grant a compulsory license would result in a significantly anticompetitive market for the technology.²³¹ Finally, this certification must be made to a federal district court, “which may issue an order requiring the person who owns such patent to license it on such reasonable terms and conditions as the court, after hearing, may determine.”²³²

Congress also set up a statutory compulsory licensing framework for patented nuclear energy technologies.²³³ Here, the Department of Energy (“DOE”) must first “giv[e] the patent owner an opportunity for a hearing,” and then declare that the patented nuclear technology “is of primary importance in the production or utilization of special nuclear material or atomic energy” and that obtaining a license to the technology “is of primary importance to effectuate the policies and purposes of this [chapter].”²³⁴ If, after these steps, “any patent has been declared affected with the public interest,” the DOE may then obtain a license to practice the patented technology.²³⁵ In addition, the DOE may sometimes be allowed to grant nonexclusive licenses to authorized third parties²³⁶ who have previously tried, but failed, to obtain a license to the technology from the patent owner.²³⁷ Prior to granting any compulsory licenses, the patent owner must be informed of any applications for compulsory licenses,²³⁸ and is entitled to further hearings to consider these applications.²³⁹ If the DOE then finds that the patented technology “is of primary importance in the production or utilization of special nuclear material or atomic energy,”²⁴⁰ compulsory licensing “is of primary importance to the conduct of the activities of the applicant,”²⁴¹ the uses defined in the proposed compulsory licenses “are of primary importance to the furtherance of policies and purposes of [Chapter

²²⁷ Clean Air Amendments of 1970, 84 Stat. at 1708–09 (codified as amended at 42 U.S.C. § 7608).

²²⁸ 42 U.S.C. § 7608(1)(A).

²²⁹ *Id.*

²³⁰ *Id.* § 7608(1)(B).

²³¹ *Id.* § 7608(2).

²³² *Id.* § 7608.

²³³ *See id.* §§ 2183–88.

²³⁴ *Id.* § 2183(a).

²³⁵ *Id.* § 2183(b).

²³⁶ *Id.* § 2183(b)(2).

²³⁷ *Id.* § 2183(c).

²³⁸ *Id.* § 2183(d)(1).

²³⁹ *Id.* § 2183(d).

²⁴⁰ *Id.* § 2183(e)(1).

²⁴¹ *Id.* § 2183(e)(2).

23,”²⁴² and the “applicant cannot otherwise obtain a patent license from the owner of the patent on terms which the [DOE] deems to be reasonable for the intended use of the patent to be made by such applicant,”²⁴³ then the DOE can grant a compulsory license to the technology “on terms deemed equitable by the [DOE] and generally not less fair than those granted by the patentee or by the [DOE] to similar licensees for comparable use.”²⁴⁴ Another ground on which the DOE can grant a compulsory license to patented technology “of primary use in the utilization or production of special nuclear material or atomic energy” is triggered if the patent owner has violated certain provisions of antitrust law.²⁴⁵

As in the CAA, a patent owner whose patented technology is subject to compulsory licensing is entitled to a “reasonable royalty fee from the licensee for any use of [the patented invention].”²⁴⁶ In cases of dispute between the patent owner and any party granted a compulsory license, the DOE may convene a special “Patent Compensation Board” to help set a just level of compensation.²⁴⁷ The DOE must set the reasonable royalty after having considered the advice of the Patent Compensation Board,²⁴⁸ “any defense, general or special, that might be pleaded by a defendant in an action for infringement,”²⁴⁹ the extent of federal funding that contributed to the development of the patented invention,²⁵⁰ and “the degree of utility, novelty, and importance of the [patented] invention” and optionally “the cost to the owner of the patent of developing . . . or acquiring [the patented invention].”²⁵¹ Once the DOE has granted a compulsory license, a patent owner is no longer entitled to injunctive relief with respect to practice of the patented technology authorized by the compulsory license.²⁵² However, a patent owner is entitled to recover unpaid royalty fees.²⁵³

Compulsory licensing schemes could be used to allow the government or third parties access to patented pollution abatement technologies. However, such use of compulsory licensing could have an adverse effect on the incentives the patent system creates to spur new technological innovation.²⁵⁴ If inventors believed that their inventions would be appropriated by the government via compulsory licensing, thus depriving inventors of the monopoly right to exclude others and attendant monopoly profits, the incentives created by the prospect of patent protection would likely be weakened. Weakening patents could lead to lower levels of technological development. In the case of biodiversity, compulsory licensing would be best justified in cases where patented technologies critical to reducing pollution were insufficiently available and the damage from continuing pollution were socially unacceptable. In

²⁴² *Id.* § 2183(e)(3).

²⁴³ *Id.* § 2183(e)(4).

²⁴⁴ *Id.* § 2183(e).

²⁴⁵ *Id.* § 2188.

²⁴⁶ *Id.* § 2183(g).

²⁴⁷ *Id.* § 2187.

²⁴⁸ *Id.* § 2187(c)(1)(A).

²⁴⁹ *Id.* § 2187(c)(1)(B).

²⁵⁰ *Id.* § 2187(c)(1)(C).

²⁵¹ *Id.* § 2187(c)(1)(D).

²⁵² *Id.* § 2184.

²⁵³ *Id.*

²⁵⁴ U.S. CONST. art. I, § 8, cl. 8; *Precision Instrument Mfg. Co. v. Auto. Maint. Mach. Co.*, 324 U.S. 806, 816 (1945).

addition, the prospect of compulsory licensing could help to avoid hold-outs by patent owners, who would be encouraged to license their pollution abatement technologies under reasonable terms rather than risk imposition of a compulsory license.

D. Patents and Population

Human population has increased rapidly over the past two centuries, from 1 billion in 1800 to 1.6 billion in 1900 to the current level of more than 6 billion.²⁵⁵ This rapid growth in human population is predicted to continue, with total population reaching approximately 8.9 billion in 2050.²⁵⁶ Such a rate of increase is remarkable for a large mammal:

The pattern of human population growth in the twentieth century was more bacterial than primate. When *Homo sapiens* passed the six billion mark we had already exceeded by as much as a hundred times the biomass of any large animal species that ever existed on the land. We and the rest of life cannot afford another hundred years like that.²⁵⁷

As human populations have increased, other forms of biodiversity have become increasingly crowded out. When livestock, crops, pets, and other human commensals are considered, human and human-associated populations constitute one of the greatest, and most rapidly increasing, threats to biodiversity.²⁵⁸

Technological innovation has the potential to reduce the impact that human population growth places on biodiversity by increasing the efficiency of human technologies. Consider the equation $I_B = PAT$, where I_B represents impact on biodiversity, P represents human population (that is, number of people), A represents affluence (that is, wealth per person), and T represents technological efficiency (that is, I_B per wealth generated). This “IPAT identity” was first proposed by Paul Ehrlich in the early 1970s as a simple, but comprehensive, method to express the effects that human population, as amplified by affluence and technology, have on the environment.²⁵⁹ Impact (I) can represent impact on the environment, in general, or it can represent impact on a particular aspect of the environment, such as I_B (that is, impact on biodiversity).²⁶⁰

As either human population (P) or affluence (A) increase, so does impact on biodiversity (I_B). Technology (T) has a subtler relationship with I_B , because improvements in technology often lead to more efficient methods of producing wealth. Although early interpretations of the $I = PAT$ equation tended to emphasize the environmental harms that new technologies can cause, technology is increasingly

²⁵⁵ WILSON, FUTURE OF LIFE, *supra* note 14, at 28–29.

²⁵⁶ SUSTAINING LIFE, *supra* note 19, at 325.

²⁵⁷ WILSON, FUTURE OF LIFE, *supra* note 14, at 29.

²⁵⁸ *See id.* at 50 (stating that human population is the “prime mover” of the other HIPPO factors).

²⁵⁹ *See* Marian R. Chertow, *The IPAT Equation and Its Variants: Changing Views of Technology and Environmental Impact*, 4 J. INDUS. ECOLOGY 13, 15 (2001) [hereinafter Chertow, *Changing Views*].

²⁶⁰ *See id.* at 15, 17.

viewed as a means of ameliorating the environmental harms caused by population and affluence. For example,

The World Resources Institute studies of industrial ecology reinterpreted IPAT to suggest that given increases in population and affluence, the T term of the IPAT equation then becomes an essential counterweight to P and A requiring environmentally effective technological choices to reduce environmental impact per unit of economic activity.²⁶¹

As with environmental impact, in general, technological innovation can also act as an essential counterweight to the negative effects that P and A have on biodiversity, or I_B .

More efficient methods of producing wealth lead to lower impact per wealth, thus decreasing the value of T.²⁶² Just as increases in population and affluence drive I_B upwards, technological innovation can drive it downwards. Thus, technological innovation can help to counteract the effects of population (and attendant wealth) on biodiversity.

The patent system is intended to spur technological innovation. As Article I, Section 8, Clause 8 states, Congress shall have power “To promote the Progress of . . . useful Arts, by securing for limited Times to . . . Inventors the exclusive Right to their respective . . . Discoveries.”²⁶³ Patents are highly relevant to the T in the $I_B = PAT$ equation. Progress of useful arts can reduce the value of T, thereby reducing the value of I_B and acting as a counterbalance to upwards pressures exerted by increasing population (P) and affluence (A). In theory, patent protection is intended to spur technological innovation by creating incentives for inventors to devote their valuable money, time, and talents to the invention of new technologies.²⁶⁴ Without patent protection or trade secrecy, innovations can be freely appropriated by others, dissipating the incentive to invent.²⁶⁵ Patent protection prevents such free-riding, and provides inventors with the prospect of compensation for their investment in inventing new technologies.²⁶⁶ Without patent protection, inventive activity would be less than socially optimal, and would result in correspondingly less than socially optimal technological innovation.²⁶⁷ By internalizing the externalities caused by free-riding, a patent system creates an incentive to innovate.²⁶⁸

In the case of I_B , the patent system will tend to incentivize higher rates of technological innovation that drive the value of T downwards, which, in turn will decrease the impact on biodiversity. This outcome is especially beneficial to

²⁶¹ Marian R. Chertow, *IPAT Equation*, ENCYCLOPEDIA OF EARTH (Cutler J. Cleveland & John Felleman eds. 2008), http://www.eoearth.org/article/IPAT_equation (last visited Apr. 6, 2010).

²⁶² That is, if one were to hold impact (I) and population (P) constant, but per capita wealth (A) were to continue to increase, the value of technology (T) would have to decrease (that is, technology would have to become more efficient) in order to compensate for the rise in A.

²⁶³ U.S. CONST. art. I, § 8, cl. 8.

²⁶⁴ *Id.*

²⁶⁵ See, e.g., FED. TRADE COMM’N, TO PROMOTE INNOVATION: THE PROPER BALANCE OF COMPETITION AND PATENT LAW AND POLICY ch. 2, at 4 (2003), available at <http://www.ftc.gov/os/2003/10/innovationrpt.pdf>.

²⁶⁶ *Id.* at ch. 2, at 4–5.

²⁶⁷ *Id.* at ch. 2, at 4.

²⁶⁸ *Id.*

biodiversity conservation as long as the P and A factors in the $I_B = PAT$ equation continue to increase their adverse impact on biodiversity.

E. Patents and Overexploitation

Populations of marine organisms, such as fish and shrimp, are among the most overexploited forms of biodiversity worldwide.²⁶⁹ Over the last several decades, fishery after fishery has been reduced by unsustainable catches.²⁷⁰ Fish occupying higher tropic levels, such as tuna and swordfish, have experienced the worst population declines, and sometimes even population collapses.²⁷¹ Perhaps the best example of a fishery collapse is the Atlantic Cod, which has been driven to the point of commercial extinction by overfishing.²⁷²

Beyond the negative effects on populations of targeted marine organisms, fishing can cause devastation to other marine organisms caught incidentally in fishing nets. Such organisms caught unintentionally are called “bycatch.”²⁷³ The Organization of Economic Cooperation and Development (“OECD”) describes bycatch as “Fish or other fauna (e.g. birds or marine mammals) that are caught during fishing, but which are not sold or kept for personal use.”²⁷⁴ Bycatch can represent a large proportion of what is caught in a fishing net. For example, in shrimp fisheries the ratio of bycatch to intended catch can reach 20:1.²⁷⁵ Fishermen generally consider bycatch undesirable because it creates extra drag for fishing boats, displaces target fish from fishing nets, and can even damage or destroy fishing nets.²⁷⁶ As long ago as 1947, Louis and Charles L. Guthrie filed a patent application in the USPTO claiming an improved “Shrimp Trawling Net” capable of ensuring that “shrimp [are] effectively prevented from escaping” while “escape of small fish of the waste variety is permitted.”²⁷⁷

In addition to non-target fish, bycatch often includes larger organisms, such as whales, dolphins, birds, and sea turtles, which usually drown while trapped inside

²⁶⁹ See ECOLOGICAL ECONOMICS OF THE OCEANS AND COASTS 62–64 (Murray Patterson & Bruce Glavovic eds, 2008) (discussing the changes in marine species populations and the “concern about the ‘collapse’ of fisheries due to overexploitation”).

²⁷⁰ Daniel Pauly & Maria-Lourdes Palomares, *Fishing Down Marine Food Web: It is Far More Pervasive than We Thought*, 76 BULL. OF MARINE SCI. 197, 197 (2005).

²⁷¹ See Christian Mullon, Pierre Freon, & Philippe Cury, *The Dynamics of Collapse in World Fisheries*, 6 FISH & FISHERIES 111, 116 tbl.1 (2005).

²⁷² See CHARLES CLOVER, *THE END OF THE LINE: HOW OVERFISHING IS CHANGING THE WORLD AND WHAT WE EAT* 214–17 (The New Press 2006) (2004).

²⁷³ OECD Glossary of Statistical Terms – By-catch Definition, <http://stats.oecd.org/glossary/detail.asp?ID=252> (last visited March 21, 2010).

²⁷⁴ *Id.*

²⁷⁵ See Ivor Clucas, *A Study of the Options for Utilization of Bycatch and Discards from Marine Capture Fisheries* ch. 9 (Food & Agric. Org. of the United Nations, Fisheries Circular No. 928, Oct. 1997), available at <http://www.fao.org/docrep/w6602e/w6602e00.htm>.

²⁷⁶ See STEVE EAYRS, FOOD & AGRIC. ORG. OF THE UNITED NATIONS, *A GUIDE TO BYCATCH REDUCTION IN TROPICAL SHRIMP-TRAWL FISHERIES* 9 (rev. ed. 2007), available at <ftp://ftp.fao.org/FI/DOCUMENT/rebyc/a1008e.pdf>.

²⁷⁷ U.S. Patent No. 2,511,057 col. 1 ll. 6–8 (filed Feb. 13, 1947) (issued June 13, 1950).

fishing nets.²⁷⁸ Sea turtles, all seven extant species of which are currently listed as endangered or threatened, are especially vulnerable to becoming bycatch in shrimp trawl nets.²⁷⁹ However, the patent system has played a strong role in spurring the creation of an ingenious and relatively effective invention that has helped to prevent many sea turtles from dying as bycatch: the turtle excluder device (“TED”).

On March 19, 1987, Noah J. Saunders filed patent application 27,875 (issued as U.S. Patent Number 4,739,574, “the ’875 patent”), entitled “Turtle Excluder Device,” with the USPTO.²⁸⁰ It claimed

A device for exclusion of sea turtles from a shrimp net during trawling stream flow, adapted for insertion within the trawl body before the cod end of a continuous shrimp trawl net²⁸¹

In the specification of the ’875 patent, Saunders explained how a shrimp trawling net is tapered in shape so that shrimp enter through the open, wide frontal end of the net, and then drift back into the net’s narrower rear, collecting section.²⁸² However, Saunders recognized a problem with this shrimp net design:

The speed of the tow captures in the nets more sea creatures than the desired shrimp; this is exacerbated by the fact that shrimp is also the preferred food of numerous marine species including fish and marine reptiles, especially turtles. The overall trawl speed is such, when trawling for shrimp, that average marine fish can swim against the speed of the flow, and in fact fish can readily enter into the cod [front] end and swim out of the cod end against the force of the flow stream.

Marine reptiles, especially sea turtles, while readily captured in such an arrangement do not have the swimming strength to escape from the cod end. Since a marine reptile, unlike fish, is an air breathing creature the reptile will drown before a given trawl is finished and the nets are raised and dumped. This has provided for a considerable ecological problem where at least one specie [sic] of sea turtles, Kemp’s Ridley turtles, is already an endangered species. Ecologists have noted over three hundred kills, attributed to the effects of shrimp trawling.

²⁷⁸ MICHAEL J. BEAN & MELANIE J. ROWLAND, *THE EVOLUTION OF NATIONAL WILDLIFE LAW* 160–61 (3d ed. 1997).

²⁷⁹ See generally *SHERYAN EPPERLY ET AL., U.S. DEPT. OF COMMERCE, NAT’L OCEANIC & ATMOSPHERIC ADMIN., ANALYSIS OF SEA TURTLE BYCATCH IN THE COMMERCIAL SHRIMP FISHERIES OF SOUTHEAST U.S. WATERS AND THE GULF OF MEXICO (2002)*, available at <http://www.sefsc.noaa.gov/PDFdocs/memo-490.pdf> (discussing the mortality of sea turtles bycatch in the shrimp fishing industry).

²⁸⁰ U.S. Patent No. 4,739,574, at [54] (filed Mar. 19, 1987) (issued Apr. 26, 1988).

²⁸¹ *Id.* col. 6 ll. 1–4.

²⁸² *Id.* col. 1 ll. 17–21.

As a result, it has become a matter of public policy to provide a device or apparatus permitting the escape or exclusion or captured sea turtles.²⁸³

Saunders noted that a TED should be inexpensive enough to be affordable by all shrimp fishermen, and that it must prevent significant loss of shrimp from the net.²⁸⁴ In addition, he cited specific shrimp fishing regulations (that is, “50 C.F.R. §§217, 222, and 227”) that, at the time he filed his patent application, had been proposed by the federal “National Marine Fisheries” agency.²⁸⁵

The '875 patent explicitly acknowledges that the threatened loss of one form of biodiversity—sea turtles—provided motivation for the invention of a new technology to help prevent such biodiversity loss.²⁸⁶ However, the fact that Saunders decided to seek patent protection for his new TED invention may also indicate a desire to benefit financially from his technological solution to the problem of turtle bycatch.²⁸⁷ After all, even with the best of conservation intentions, it is more probable that a rational inventor will choose to invest her valuable time, energy, and talent in inventing new conservation technologies if patent protection provides her with an opportunity to control and profit from her invention.²⁸⁸ In the case of Saunders' TED, the '875 patent afforded the inventor the opportunity to be the sole manufacturer, supplier, or licensor of his new invention.²⁸⁹ Saunders might help save sea turtles drowning while simultaneously profiting from his inventive efforts. This example illustrates that a threat to biodiversity can, at least in part, spur technological innovation that ameliorates such a threat, and that the patent system may facilitate such a beneficial outcome.²⁹⁰

CONCLUSION

Patents and biodiversity might seem strange bedfellows. In fact, some would implicate the patent system, and the new technological innovations it is meant to spur, as a serious threat to biodiversity. However, the patent system possesses a powerful set of tools that can be used to assist in the goal of combating the current biodiversity extinction crisis. For each of the HIPPO factors that describe the major threats to biodiversity, patents can benefit biodiversity. An extinction bar to patentability creates incentives for bioprospectors, companies, and countries that host abundant biodiversity to prevent habitat destruction. Sovereign immunity provides the federal and state governments with the right to immediate access to

²⁸³ *Id.* col. 1 ll. 24–46.

²⁸⁴ *Id.* col. 1 ll. 46–53.

²⁸⁵ *Id.* col. 1 ll. 54–60.

²⁸⁶ *Id.* col. 1 ll. 33–46.

²⁸⁷ See *Festo Corp. v. Shoketsu Kinzoku Kogyo Kabushiki Co.*, 344 F.3d 1359, 1377 (Fed. Cir. 2003) (Newman, J., concurring).

²⁸⁸ See *id.*

²⁸⁹ 35 U.S.C. § 154 (2006).

²⁹⁰ In addition to the '875 patent, U.S. Patent No. 4,739,574 (filed Mar. 19, 1987) (issued Apr. 26, 1988), U.S. Patent No. 5,076,000 (filed Jan. 8, 1990) (issued Dec. 31, 1991), U.S. Patent No. 5,222,318 (filed Apr. 1, 1991) (issued June 29, 1993), U.S. Patent No. 5,325,619 (filed Oct. 26, 1992) (issued July 5, 1994), and U.S. Patent No. 5,575,102 (filed Mar. 16, 1995) (issued Nov. 19, 1996) all pertain to TEDs.

patented inventions useful or necessary in curbing the spread of invasives. Existing federal compulsory licensing schemes provide models for how pollution abatement technologies could, if necessary, be widely disseminated to combat pollution. The incentives created by the patent system can, and do, help to create more efficient new technologies that help to counteract the damage inflicted on biodiversity by human population and its inexorable growth. And, the patent system has already proved itself adept at spurring the creation of ingenious inventions, such as TEDs, capable of alleviating overexploitation of natural populations. In these and many other ways, the patent system can be a valuable ally in the vital struggle to preserve biodiversity.