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Natural Resources, Gadgets and Artificial Life¹

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ABSTRACT: I classify different sorts of natural resources and suggest how these resources may be acquired. I also argue that inventions, whether gadgets or artificial life forms, should not be privately owned. Gadgets and life-forms are not created (although the term 'invention' suggests otherwise); they are discovered, and hence have much in common with more familiar natural resources such as sunlight that ought not to be privately owned. Nonetheless, inventors of gadgets, like discoverers of certain more familiar resources, sometimes should be granted exclusive but temporary control over their inventions as an incentive for making unknown items widely accessible

KEYWORDS: Artificial life, patents, ownership, natural resources, intellectual property, justice

Inventions should belong to no one. It does not matter whether the invention is a genetically engineered life form or a mechanism such as the more familiar radio: it should not be private property. More precisely, *types* of things invented by people (such as *the* radio or *the* dog) as opposed to particular things (such as the radio in my car and the dog in my back yard) should not be private property, with one qualification: at most, people should expect monopolies for brief periods of time on the use of the types of gadgets and creatures they invent, after which such types of things should be freely accessible by all. The monopolies I have in mind bear some resemblance to the monopolies provided by the patent system, but towards the end of the essay I will suggest ways in which that system needs to be rethought, restructured, and extended.

In order to establish that inventions should belong to no one, I will argue that (1) it is impossible to create a process or type of gadget or life form; in fact, (2) the various things people do when they are said to 'invent' a process or type of gadget or life form amount to discovering something that was there all along; (3) there are natural resources, like sunlight and laws of nature, that should be freely useable by all; and (4) processes and types of gadgets and life forms are so much

like these natural resources that they, too, should be freely useable by all. Of course, it is not obvious what a natural resource is, nor is it obvious which natural resources should be private property and which should not be. Oil, virgin forests and sunlight are clear examples of natural resources. But we rarely if ever think of abstract items such as laws of nature, processes, and life forms – let alone types of gadget – when we think of natural resources. Nonetheless, there are good reasons to classify these abstract items alongside natural resources, and good reasons to say that these things are among the natural resources that should be freely accessible by all. These reasons will emerge once I sketch a just policy for handling natural resources.

POLICY FOR NATURAL RESOURCES

I. *The Approach*

Let me begin by explaining the standpoint from which I defend the policy I wish to suggest. Broadly speaking, my approach is libertarian.² I assume that justice requires that each of us participate in a type of scheme I call a *noninterference scheme*. This is a scheme whose adoption by a group of people ensures that each of those people may lead his or her life with minimal interference from others in the group. It maximises individual freedom. Of course, a noninterference scheme will limit people's actions and restrict their freedom in various ways as well. Carving out space for people to live their lives without interference will require placing restrictions on what people may do, since one person has a freedom only if others are not permitted to interfere with that freedom.³ For example, I am free to acquire coal that I dig from the ground only if you are required not to interfere and not to take the coal away from me. A complete noninterference scheme would identify the most generous set of freedoms that can be consistently extended to everyone.⁴ But of course I will not attempt to work out a complete scheme here.

The freedom in which libertarians are interested is negative freedom, characterised by Rawls (1971) as follows: people have the (negative) freedom to do something 'when they are free from certain constraints either to do it or not to do it and when their doing it or not doing it is protected from interference by other persons' (sect. 32). Accordingly, the freedom I mean to discuss is not what Isaiah Berlin (1958) calls 'positive' freedom, not 'freedom' in the sense of having the means to achieve our ends. I might be free to take ten thousand gallons of water from the ocean every day even if my tools for moving water do not include so much as a bucket.

My procedure for working out the details of a noninterference scheme involves John Rawls' (1971, 1993) original position, but of course I do not employ the original position in exactly the way Rawls did. Recall that on Rawls'

description of the original position the parties situated behind the veil of ignorance attempt to choose principles of justice that specify both positive and negative duties.⁵ That is, the parties identify negative duties, which constrain us to refrain from certain behaviour on the grounds that that behaviour will interfere with the lives of others, and the parties also identify positive duties, which enjoin us to perform various acts on the grounds that those acts are beneficial to others. For Rawls' original position device to be useful in working out the details of a noninterference scheme, we must extend Rawls' restrictions on the deliberations of the parties somewhat. We must specify that the parties are interested in the negative duties involved in maximising freedom, and that they do not deliberate about positive duties at all. The concern of each party in the original position is to maximise negative freedom, and this goal they accomplish by working out a maximal set of liberties (or rights) that can be exercised by everyone, as well as the corresponding noninterference duties that secure those liberties.

My procedure endorses many of the policies libertarians defend. For example, since the parties in the original position are interested in protecting people from interference, they will immediately recognise the importance of protecting various basic freedoms such as bodily integrity and the freedom of conscience which can easily be extended to everyone without conflict. The parties will also have a very strong case in favour of letting people decide when and how to labour, and in favour of letting people keep the fruits of their labour. In fact, the parties will recognise that people own themselves and their labour, a doctrine central to much libertarian literature.⁶

However, in endorsing the idea that people own the fruits of their labour, I do not mean to accept the familiar Lockean account of how and when people may acquire things such as natural resources which are not yet owned. The policies I defend are inconsistent with Locke's approach, so to call my view 'libertarian' is something of a stretch. I want to be up front about the difference between my approach and traditional libertarianism. However, I also believe that using the term 'libertarian' in connection with my approach is reasonable, for I am looking to maximise liberty. The problem is that maximising everyone's liberty, as I want to do, entails giving everyone equitable access to the world's natural resources, and Locke's approach to acquisition, adopted by most libertarians, legitimates private ownership of the entirety of those resources by some of our ancestors. I conclude that Locke's account is unacceptable, and so is the more modern version of it developed by Robert Nozick (1974, Chapter 7). If this means that my approach is not 'libertarian', so be it. But at least my version of libertarianism will not be dismissed out of hand by the many people (not all of them Marxists) who object to the fact that private ownership of the world's natural resources enables a fortunate few (who did nothing to bring those resources into existence) to subject everyone else to extreme manipulation since no one can make a life without gaining direct or indirect access to natural resources. My version of libertarianism is not subject to this objection, and yet it upholds the central view

of the libertarian position (as against collectivists of all stripes): we own ourselves and our labour, and we should be as free as possible to live our lives as we prefer.

Let me give a brief explanation of the problem with the Lockean theory of acquisition. Locke said that we may acquire unclaimed resources, such as land, if we meet the sharing clause (the resource is so plentiful that our contemporaries may acquire a share that is 'as good' and that is all they can use), the spoilage clause (we will use all we take), and the labour condition (we mix our labour with the resource) (Locke 1952, Chapter V). As is well known, Nozick subjected the last condition – Locke's labour condition, requiring that we mix in our labour – to a withering critique, but accepted a version of Locke's account of acquisition.⁷ Nozick remarked that 'Locke's proviso that there be "enough and as good left in common for others" ... is meant to ensure that the situation of others is not worsened' (p. 175) by the legitimate acquisition of unheld items. Thereafter, Nozick worked with his own version of Locke's proviso, namely (roughly) that when the acquisition of an unheld item does not worsen the situation of others, except in the sense that the acquisition might eliminate the opportunity for further appropriations, the acquisition is legitimate.

Nozick's proviso is surely unacceptable, and it is worth noting that it would not even have been accepted by Locke. Suppose that there are as many unclaimed natural resources as every living person can use, and if up to half of the world's resources were acquired, the remainder would *still* be as much as everyone alive could use, but if any more were acquired, there would no longer be as much as everyone can use. If I proposed to take that half for myself, would the others have a legitimate objection? Not on Nozick's proviso. My acquisition would not worsen the situation of others except in the sense that they may no longer acquire any resources for their own. Even after I take half, there is still as much as the others can use, so long as no more is taken as private property. Nonetheless, the people in my story certainly would object, and so would Locke, even if he had no spoilage clause. Anyone – with the possible exception of me! – would object to the idea that I get to acquire all the resources that are available as private property while everyone else must share the remainder in the 'commons' (or else purchase some of the resources I own). According to Locke's own proviso, an acquisition is legitimate only if it leaves the other people around (i.e., my contemporaries) free to *take* what they can use. It will not do simply to leave as much as each of my contemporaries can use in common with others.⁸

Locke's own sharing clause is perhaps more acceptable than Nozick's, but in the final analysis Locke's proviso is still unacceptable. To see the problem, consider another hypothetical scenario. Imagine that there are only twelve people alive and one-twelfth of the existing natural resources is all that each person could use. On Locke's proviso, if I am one of those twelve I cannot take half of the resources for myself, but I could take one-twelfth, since that would leave each of the other twelve people free to take the same amount. So on Locke's

NATURAL RESOURCES, GADGETS AND ARTIFICIAL LIFE

account, each of the twelve could take resources such as land until there is no more to go around. This may look unobjectionable, and indeed none of us would have grounds for complaint on our own behalf. But suppose that the twelve people raise twenty-four children. If, as we have said, the twelve parents own the resources, they may do what they wish with them, including passing their property on to only six of their children when those children become adults. But if that is what happens, the other eighteen people will own no resources, and their access to resources like land will be restricted in whatever ways the owners specify. Yet those eighteen people had no less claim to natural resources than did the original twelve parents. Why shouldn't the interests of people in all generations (including future generations) be given equal weight when the issue of access to natural resources is settled? When we considered my first scenario, we objected to one person acquiring half of all the resources because of the impact that acquisition would have on that person's contemporaries: none of them could take resources. Shouldn't we now object to twelve people acquiring all the resources because of the impact that acquisition would have on future generations? No one in future generations could take resources either.

Some will object to my criticism by saying that people in future generations will be better off than they otherwise would be if all natural resources become privately owned by previous generations. This response presupposes, falsely, that natural resources such as land are either privately owned and thus used productively, or else they are left in the 'commons' where they are unproductive and possibly destroyed since no one has a personal stake in them. In this essay I will be offering a policy concerning access to natural resources that is far more complex than either alternative. But for now my response to the objection at hand is a simple one: a 'libertarian' policy of the sort I have in mind would give everyone a package of liberties that is as extensive as possible, and if people are worse off as a result (a dubious proposition indeed), that is simply beside the point: we are maximising liberty, not utility. To give everyone the same package of maximal liberties, we must give future generations as much access to natural resources as we do past generations. This cannot happen if all (or most) resources are the private property of some people before others even exist. Full private ownership of a parcel of land, for example, would allow people to transfer their ownership to some of their successors, and they to theirs, and all landowners would be able to restrict access to their property in whatever ways they wished. Similarly with all other natural resources. No one in the future would be free to take the natural resources that had long since become the private property of others.

Let me make one other criticism of Locke's approach before I move on. I am at least as sceptical as Nozick (or Henry George) is about Locke's idea that we acquire things by adding our labour to them. As far as I can tell, my expending labour on some object does not in itself increase my claim to the object at all. If I steal Mary's ham and bread, I do not own any part of Mary's food, and I cannot

become co-owner of Mary's ham and bread by making a sandwich. Mary may reclaim her food even though my talent, time and energy are invested into her bread and ham, so that in seizing the sandwich she must also seize my human capital. Similarly, if Mary and I (or Mary and I, and the rest of humanity, including future generations) are in a dispute about which natural resources we may appropriate, and I grab some of the disputed items and invest human capital into them, my action in no way settles the question of what share I may acquire. To settle that question, we must work out our answer using considerations other than what people have *done* to the natural resources in dispute. Even if my capital is now irretrievably a part of items I have seized, I cannot legitimately claim to own what I have seized if I have taken more than I am entitled to. On the other hand, if I *am* entitled to such and such items, then they are mine even if I do nothing to them; they are mine even if I leave them in a completely unspoiled state, and turn my labour to other things. Indeed, I might be entitled to something about which I am entirely unaware.

Thus the labour theory of acquisition simply gets the cart before the horse: what we need to know is how we may come to acquire materials upon which to labour in the first place. In the first instance the materials upon which people may labour are natural resources. So how should access to them be handled?

II. *Two Preliminary Principles*

In developing a policy for dealing with access to natural resources, the representatives in the original position would focus on the facts that (1) natural resources are in great demand, so that people, both living and not yet born, both here and in other countries, would like to have free access to natural resources; but (2) the supply of some of those resources is limited. Some resources are limited because they are consumed when used, and therefore no longer available to others. And some resources that are not consumed when used nonetheless are limited because they cannot be used simultaneously by everyone who wants to use them. So (3) there must be restrictions on our access to resources when supply cannot meet demand.

Situated behind the veil of ignorance, the parties in the original position would not know whether they represented someone in one social position rather than another, one geographical location rather than another, or one generation rather than another. Hence, when faced with the need for restrictions, the parties would, I suggest, favour a policy that treated everyone, whether alive or not yet born, equitably. Thus the parties would favour, as a general guideline, the *resource-equity principle*: natural resources are to be handled in a way that is equitable both across the country, across the world, and across the generations.

A second guiding principle takes into account the co-dependence of reproductive policy and policy governing the consumption of natural resources. Notice that from the standpoint of the original position, what we may do with

NATURAL RESOURCES, GADGETS AND ARTIFICIAL LIFE

natural resources depends upon the number of children we decide to produce, and vice versa. For example, if, by the many separate decisions of families, a generation plans to produce a large number of children, the parties would insist on corresponding reductions in the natural resources which that generation consumes, so as to leave the next generation access to an equitable share.

Accordingly, if we suppose that each generation will want to produce children, so many children, in fact, that the next generation's demand for natural resources will be great, then it is reasonable to say that everything possible should be done to use resources only in ways that are sustainable indefinitely, so that each future generation will be able to produce a successor which will have access to those resources. Any natural resource that *can* be put to good use in perpetuity if handled in a certain way *ought* to be handled only in that way. Because the parties consider everyone's interests to be equally important, I suggest that the parties would favour a principle of intergenerational justice which we might call the *sustainable consumption-reproduction principle*: each generation may pollute, consume (or make use of) natural resources, and reproduce at given rates only if it could reasonably expect that each successive generation could do likewise.

The sustainable consumption-reproduction principle, together with the resource equity principle, can serve as guidelines for designing a more detailed policy for natural resources, as we will see after I interject a few words about the notion of a natural resource.

III. 'Natural'

A few words are necessary since the term 'natural' is notoriously vague. What seems most basic in our usage is that any change human beings make in the world is said to unnatural. Perhaps people can replace a resource and still end up with a *natural* resource, say by planting a tree after cutting one down, or by restocking an overfished river, but in some contexts even these changes would count as unnatural. Nonetheless, naturalness is a measure of the degree to which a thing's features are the product of specifically *human* intervention, so that the less people have to do with something's having the features it does, the more natural it is, and the more we are responsible for something's features, the less natural it is. Exactly which criteria determine whether a thing passes over the threshold and becomes unnatural *simpliciter* vary from context to context. We can avoid such contextual relativity by always speaking of degrees of naturalness, but for my purposes here there is no point to such precision. Let us simply say that a resource is natural so long as it (and its features) was not brought into existence by anyone.⁹

So much for the meaning of 'natural' in 'natural resource'. Now let us turn to policy for dealing with several categories of natural resources. I will skip over a few familiar categories.¹⁰ The first of these familiar categories is natural

resources, such as oil, that are *temporary*, that is, that are *not usable in perpetuity*. A second and third category I will pass over are resources such as trees that are *renewable if regenerated*, and resources like water, air and useable space that are *renewable if recycled*. Having passed over these three categories, let me begin by discussing a fourth category of resources, namely, natural resources that are *self-renewing*.

IV. *Self-Renewing Resources*

The main claim I want to make about self-renewing resources is that no one may reduce future generations' access to self-renewing resources.¹¹ Thus, for example, even if I could do so without injuring anyone, it would be unjust for me to launch a device towards the sun that would block sunlight to a large part of the planet 100 years from now. More importantly, it would be unjust to implement a policy that allows people in the present generation to appropriate the sunlight that otherwise would be available to future generations, say by purchasing (rights to) it (at what would no doubt be bargain prices) and giving (those rights to) it to their children. This latter policy would be unjust since it would result in a situation in which sunlight would be less accessible to some members of given future generations (though not the people who are lucky enough to inherit shares of sunlight). Some members of future generations would have access to the sunlight only if they paid whatever fee is charged by others in their generation. From the standpoint of maximising freedom, this result is objectionable, for there is a better alternative: allowing each generation as a group to have free access to the sunlight that is produced during the span of that generation, or, if there is not enough to go around, to share it on an equal basis.

The above remarks concerned intergenerational justice, justice across the generations. Now consider intragenerational justice vis-à-vis self-renewing resources. Note first that when the supply of a generation's share of a self-renewing resource greatly exceeds the demand, our policy need say no more than that people should be allowed to consume the resource freely. When each of us can consume all of the sunlight we wish to consume without interfering with anyone else's freedom to do the same, we should be free to consume what we wish without providing anyone any compensation for the sunlight we consume (so long as we avoid pollution).¹² At the present time, sunlight is plentiful in this way. (I am not saying that all of us have the means to use sunlight as much as we want; I am saying that it is not a shortage of sunlight that is responsible for our not using sunlight more than we do, and all who have the means to use sunlight may use as much as they want without taking comparable shares from others who want them.) Now suppose that the demand for the self-renewing resource at hand substantially exceeds the supply, as the demand for sunlight might do once improved technology allows sunlight to become a significant source of inexpen-

NATURAL RESOURCES, GADGETS AND ARTIFICIAL LIFE

sive energy. At that point intragenerational policy will have to become more complicated. Even here individuals should be allowed freely to consume an amount which everyone else in their generation could consume. But typically only relatively few people will own equipment that allows them to use resources in the most efficient way. If only a few use resources desired by the many and to which the many have equal claim, those few must provide compensation at a level that will prompt people to permit the use of their resource shares. Intragenerational justice will require something like the following sort of arrangement in order to ensure that all of us receive adequate compensation for the use of our share of a resource: the (spatially and temporally limited) rights to search for and collect high-demand, self-renewing resources might be sold on the free market, and the proceeds distributed equally among the people who do not consume their own shares of the resource. Those who purchase the collection rights would then be allowed to do with the resource shares they collect whatever they wish (for example, converting sunlight into energy which they then sell for a profit), so long as they avoid pollution.¹³

What about resources that are discovered by some individual or group? Doesn't it matter that someone has found a resource, whether a self-renewing resource or some other sort of natural resource? If someone finds a resource that would otherwise have gone undetected, perhaps after expending substantial effort and capital, isn't that person entitled to acquire the resource? And if we answer 'no', won't we be creating a situation in which people lack the incentive to find unfamiliar resources?

Distinguish between two cases: First, the type of resource at hand is a familiar one. For example, the resource is oil, which people can identify. Suppose that, in accordance with the arrangement we sketched above, an individual has purchased the temporary rights to search for and collect that type of resource in a particular area. Such an individual already has an incentive to search for the resource, so the above objection does not apply. Second, now suppose that people are not already familiar with the type of resource at hand. For example, it is a type of cosmic ray that has never been identified until now. So when it is discovered, there is not yet a mechanism in place for compensating the discoverer. Shouldn't people who discover a wholly unfamiliar type of natural resource be allowed to claim it for themselves?

No they should not, as I will argue using another example. Suppose that up until Exit Day the entire human race lived underground, in a place from which sunlight was inaccessible. A pair of scientists hypothesise that if they dig upwards from a cave they will break through to an outer world, and they begin a digging project that takes them years to complete but that eventually leads them to discover sunlight. May the scientists appropriate the supply of sunlight (or indeed, the unfamiliar components of the entire outer world?) Of course not; the idea is absurd. The hypothetical researchers discovered the sunlight, but the

details of access to that resource should be settled basically as we have already suggested: assuming that the resource at hand, as in this example, is a self-renewing resource that exists in overabundance, the discoverers may freely use it; assuming that there would not be enough to meet demand if everyone knew about the resource, then the discoverers may consume only an equitable share or else work out a scheme for adequately compensating others when the discoverers use more than an equitable share.

Even though I object to giving the entire supply of a type of resource to the person who discovers it, I do not mean to downplay the fact that researchers might not put forth much effort to discover unfamiliar types of natural resources unless they have substantial incentives for doing so. Not rewarding people for seeking out resources is one thing, and stopping them from seeking out resources is another, but unless researchers receive substantial compensation, they may well make far fewer discoveries. For familiar reasons it is plausible to say that researchers would make significantly fewer discoveries, and I am simply going to assume this is the case.¹⁴ If this assumption is correct, then there are significant resources to which people will lack access unless researchers are properly motivated. Yet it is reasonable to assume that everyone would prefer (1) that researchers make types of resources accessible that otherwise would be completely inaccessible and in return receive an incentive derived from the resource they make available, over (2) that no one receives incentives to seek out unfamiliar types of resources and those resources remain inaccessible to everyone.¹⁵

From the standpoint of maximising access to natural resources, then, we need to adopt an arrangement whereby researchers will receive enough compensation to warrant expending the labour it takes to discover unfamiliar resources, and the rest of us will receive access to resources that otherwise would remain undiscovered.

Although our topic is this section is self-renewing natural resources, the point about incentives applies generally: we need an incentive system that will apply to all types of natural resources that would remain inaccessible if not for the incentives.

In order to provide the proper incentives, I suggest that we employ a version of the patent system. I will discuss the patent system at the end of the essay. Here I will simply note that while this system ought not be used as is, it can be adapted so that a version of it will do what we need done. Several points are especially important.

First, according to traditional patent policy, mere discoveries, as opposed to inventions, cannot be patented. This restriction against discoveries would make the system unusable for our present task, which is precisely to give people an incentive to make 'mere' discoveries. So our version of the system will reward people for discovering types of resources (as opposed to discovering more of familiar types of resource). Since the features of things can be described at

NATURAL RESOURCES, GADGETS AND ARTIFICIAL LIFE

various levels of abstraction and detail, what counts as a 'discovery' will need clarifying. Toward that end let us simply say that discovery is largely a matter of describing a type of resource clearly enough and precisely enough to facilitate commercial uses of the resource that otherwise would have remained unidentified.

Second, the patent system grants people a temporary monopoly on the use of a type of thing, and our adapted version will do something similar: it will grant people a temporary monopoly on the use (by people) of newly discovered types of natural resources. But we have to restrict the scope of this monopoly a bit. To see why, notice that the identification of a type of resource which people have been using all along (without realising what they were doing) could count as a discovery, since clearly identifying the resource might make it possible to put the resource to uses that otherwise would not have occurred to people. For example, until fairly recently the elements had not been identified, and yet people's lives have always depended on assimilating many of the elements. Once the elements were clearly described and differentiated, it became possible to identify all sorts of uses for the elements that had nothing to do with ingesting them. Now, it is unacceptable to grant a monopoly that would interfere with the prior uses of a type of resource. To rule out that possibility, we could simply ban 'patents' on any resource types which have had prior uses, but a better policy would be to restrict the monopoly that is available for such resources so that it only covers new commercial uses of the resource that would not have been noticed but for the discovery of the resource. Such a monopoly is a reasonable incentive to offer to those who want to look for unfamiliar natural resources. (I have nothing especially useful to say about how long the monopoly should last; it should only last long enough to provide an incentive sufficient to motivate people to find types of resources that otherwise would remain unnoticed.) Among other desirable features of the temporary monopoly system is the way in which it automatically adjusts incentives according to the importance of the resource to be discovered: a temporary monopoly on extremely important resources would be highly lucrative, while a temporary monopoly on less important resources would be far less lucrative.

Third, on the adapted version of the patent system we need, patented discoveries would not revert to the public domain. Instead, once a patent expired, the remainder of the resource would fall under our policy for familiar natural resources.

A final word: by providing for temporary monopolies on certain sorts of natural resources, haven't I admitted that there are types of natural resources that can be owned? No; as I will explain in the last part of the essay, temporary monopolies fall far short of full ownership. Full ownership gives us exclusive, permanent control over our property, control we may bequeath to others, and they to still others.

V. Indestructible Resources

Self-renewing natural resources are, we said, usable in perpetuity. Are there perpetually useable natural resources other than self-renewing ones? Perhaps surprisingly, there are. Some natural resources, such as the airwaves, are indestructible. However, while some indestructible resources are nonexclusive in the sense that they could be used by everyone (all contemporaries) simultaneously (for example, laws of nature), others are in fact exclusive in the sense that they cannot be used by everyone simultaneously (for example, the airwaves). I will discuss both, starting with natural resources that are exclusive.

The bands of the electromagnetic spectrum are perhaps not usually considered under the rubric 'natural resource', but natural resources they nonetheless are, for no one brought the spectrum into existence. Moreover, the bands that constitute the electromagnetic spectrum are practically indestructible. However, their indestructibility does not make them plentiful in the way that sunlight is plentiful. The main problem is that their use is exclusive: not everyone can use particular bands of the spectrum simultaneously, and the spectrum is not, for practical purposes, infinitely divisible.

Intergenerational justice requires that we treat exclusive, indestructible resources such as the bands of the electromagnetic spectrum in much the same way we must treat other resources that are usable in perpetuity. Present generations should not be permitted to reduce the availability of these resources to future generations. Thus outright ownership of the airwaves is unjustifiable, and the present policy of the United States government is unacceptable. By the Omnibus Budget Reconciliation Act of 1993, Congress authorised the FCC to auction off bands of frequencies of the electromagnetic spectrum after reserving large swatches of the spectrum for use by the government.

Intergenerational justice rules out the ownership of the bands of the electromagnetic spectrum, but intragenerational justice does not favour a policy of free access to these bands. When the demand for the use of exclusive resources such as the spectrum substantially exceeds the supply (as it does in most parts of the world), we cannot adopt a policy of intragenerational justice that simply allows people free use of the resource, for under such circumstances it is impossible for everyone simultaneously to use the resource at will. Instead, as the resource equity principle suggests, the use of the spectrum ought to be shared equitably, and some sort of arrangement must be implemented that will reflect the fact that people are entitled to such equitable use. For example, one appropriate policy would be to sell temporary rights to the use of particular bands of the spectrum on the open market, and then to distribute the revenues equally to the people who are foregoing the opportunity to use the spectrum. In return, those who purchase the rights to use the spectrum should be allowed to use the spectrum in any ways that do not create pollution (such as noise pollution) and to keep anything they gain as a result of the exercise of their rights.

NATURAL RESOURCES, GADGETS AND ARTIFICIAL LIFE

So much for policy concerning exclusive, indestructible natural resources. Now let us turn to natural resources such as the laws of nature that are indestructible and nonexclusive.

When we discussed sunlight, I argued that if the supply of a resource were inexhaustible, as in effect the supply of a self-renewing resource is, and if that resource were so plentiful that all of us (including people in the future) could have as much of it as we could use, more or less, then justice calls for letting people use it freely. Similar points can be made about any resource that is inexhaustible because it is indestructible, and useable by all people because it is nonexclusive. The laws of nature are good examples of this type of resource. Justice calls for letting people use indestructible, nonexclusive resources freely. And let us add that this free use should be enjoyed by members of future generations as well. Present generations should not be permitted to reduce the availability of these resources to individuals in future generations, say by purchasing them now so as to transfer ownership to their children.

Laws of nature are not the only resources that are indestructible and nonexclusive. I suggest that construction processes are natural resources that are for all practical purposes both indestructible and nonexclusive. Construction processes include processes for constructing gadgets or for constructing new (or old) kinds of animals, plants, and subcomponents thereof (such as genes). Other examples of indestructible, nonexclusive natural resources are techniques for synthesising drugs and other chemicals, techniques for repairing things and techniques for treating human beings, such as medical procedures. For simplicity, I will refer to all of these things as 'processes'.

Are processes really inexhaustible and usable by all simultaneously? Perhaps the point is not obvious, but any doubt is presumably due to a failure to draw the type-token distinction, for while process types are indestructible and while one person's use of a process type (on materials she owns) does not interfere with another person's use (on materials he owns), process tokens are not indestructible. A process, such as a technique for synthesising a drug, can be used by all of us who wish to transform raw materials; my use of a process does not preclude yours. But particular tokens of the process are another story altogether.¹⁶

But are processes, as types, natural resources? Well, they possess the relevant features. For a resource is natural, I said at the outset, so long as it was not brought into existence by anyone, and processes as types are not brought into existence by anyone. Of course, I am not saying that people do not bring process tokens into existence. They do. Rather, I am denying that they create process types. How could they create such things? As far as I can tell, to bring a process type into existence would be to make it the case that a certain set of causes has a certain set of effects. But no one can make it the case that causes have given effects. All we can do is discover that certain causes have given effects. So we can only discover processes. We cannot bring them into existence. So processes can be called natural resources.

Most of this is not true of process tokens, however. For example, while we cannot bring a process type into existence, we can make it the case that a token of a process type occurs or exists. To bring a process token into existence is simply to cause particular effects in accordance with the process. Let us add that process tokens do not always bear the distinguishing marks of natural resources. For something to be natural, its occurrence or existence must not be instigated by anyone. So process tokens are natural only when their occurrence is not instigated by someone.

Applying my notion of 'natural' turns out to have surprising consequences. On my understanding of 'natural', processes are always natural, but their tokens are not always natural, for sometimes these tokens are instigated by people. More: processes are always natural, but the only existing tokens of some processes are not natural, and some processes have no existing tokens. These consequences are odd and surprising because normally people assume that a type of thing is natural if and only if the tokens of that type are natural.

Perhaps it is too great a strain on language to apply 'natural' or 'natural resource' to a process whose tokens occur through human intervention, and I do not want to insist on this terminology. However, I need a way to draw attention to a fact that is of substantial moral significance, namely, that processes, like more familiar natural resources, are found, not brought into existence by anyone. To mark this fact, I will say that processes are virtual natural resources, meaning that they are found and are not brought into existence by anyone.

A final wrinkle in our policy for indestructible (virtual) natural resources is required. As we said when discussing self-renewing resources, we need to provide for the case in which a researcher discovers a type of resource that otherwise would have gone undetected. Such people should receive a temporary monopoly on new commercial uses of the resource that would not have been noticed but for the discovery of the resource.

VI. *Summary*

It might be useful to review the categories of natural resources and to summarise the policies I have defended above.

Unfamiliar Types of Resources

Policy: the discoverer of unfamiliar types of natural resources (including virtual natural resources) should receive a temporary monopoly on their new commercial uses.

Familiar Types of Resources

A. Temporary Resources: e.g., oil, gas (policy not discussed)

B. Resources that are Usable in Perpetuity

1. Renewable (policy not discussed)

NATURAL RESOURCES, GADGETS AND ARTIFICIAL LIFE

- a. Regenerable (renewable if regenerated): e.g., trees
 - b. Recyclable (renewable if recycled): e.g., territory, water, soil
2. Self-Renewing: e.g., solar energy.
- Policy:*
- a. Intergenerational Policy: keep accessible to all generations.
 - b. Intragenerational Policy: keep access free so long as supply meets demand; thereafter, access must be leased and the revenues raised through leasing must be shared.
3. Indestructible
- a. Nonexclusive (usable simultaneously): e.g., processes and other types.
- Policy:*
- i. Intergenerational Policy: keep accessible to all generations.
 - ii. Intragenerational Policy: keep free (no owning or leasing).
- b. Exclusive (not usable simultaneously): e.g., airwaves.
- Policy:*
- i. Intergenerational Policy: keep accessible to all generations.
 - ii. Intragenerational Policy: must be leased and the leasing revenues shared.

OWNING GADGETS AND LIFE FORMS¹⁷

Next I want to argue that it is unjust for people to own types of gadgets like the radio or life forms like types of genetically engineered bacteria. I will pursue two strategies. First I will argue that people do not create types of gadgets and forms of life; on the contrary, such things are indestructible, nonexclusive virtual natural resources, hence discoverable at best. This claim is important because I have already argued that people may not claim the indestructible, nonexclusive virtual natural resources which they discover, and may expect no more than a temporary monopoly on their use. My second strategy will be to examine what people do when they ‘invent’ gadgets and life forms, and to argue that what ‘inventors’ do does not confer the right of ownership.

I. *Creation and Ownership*

In the previous section I argued that people cannot create process types and that processes are indestructible, nonexclusive virtual natural resources which should not be owned. The same points hold for life forms and types of gadgets. Consider, for example, the yo-yo, or the oil-eating bacterium which Chakrabarty engineered. Neither the yo-yo nor the oil eating bacterium was brought into existence by anyone. The yo-yo is a device with certain properties such as having string

wound inside a cylinder that enable it to behave in a way characteristic of yo-yos (and the oil-eating bacterium is a creature with certain properties that enable it to do various things, such as eat oil). To say that the yo-yo exists is to say that devices with certain properties behave in certain ways. To create the yo-yo, it would be neither necessary nor sufficient to (be the first person to) wrap string inside a cylinder. To create the yo-yo would be to make it the case that string wrapped inside a cylinder would do the things that yo-yos do. But no one can make any such thing the case. In fact, of course, it already is the case that devices with yo-yo features would do the things yo-yos do, and it always has been the case. Moreover, if it were not the case – if instead (for example) devices with yo-yo features exploded when moved – then there could not be yo-yos. Perhaps someone might still wrap string inside a cylinder, and do this before anyone else, but the resulting device would not be a yo-yo.

There is an alternative view given which the yo-yo and other types of gadgets are creations after all. It is a story with great initial plausibility. We could say that a necessary and sufficient condition for the F (a type of thing) to exist is that at least one F exist. On this assumption the yo-yo was brought into existence since at one time no yo-yos existed and then someone wrapped a string inside a cylinder and began playing with the new toy. My objection to the assumption here is that law-like relationships between features or events are involved in the nature of some types of thing, so that creating those types of thing is altogether distinct from initiating events that cause a token of them to exist. Perhaps the clearest examples are processes, each of which amounts to a law. Suppose that *C-type events cause E-type events* is a law of nature, and that up until now no C-type events have occurred. I cannot bring this law of nature into existence by causing a C-type event that then results in an E-type event.

To bring a type of process, device, or living thing into existence we would have to make it the case that a certain set of causes has a certain set of effects, or that things with certain properties would also have other properties. We cannot do any such thing, so we cannot add to the world's supply of these types of thing, any more than we can add to the world's supply of natural laws. We can only discover these types. But merely discovering them does not entitle us to claim them. In fact, they are indestructible, nonexclusive virtual natural resources, which are the sorts of thing that, as I argued previously, justice precludes our owning.

II. *Ideas and Ownership*

Nonetheless, a seemingly powerful case for claiming types of gadgets or living things can be made by the person who invents such things. Of course, if inventing means creating, then we have just shown that it is impossible to invent a type of gadget or life form, and the case for ownership fails from the outset. But aren't there other things we might do that count as inventing a type of gadget or living

NATURAL RESOURCES, GADGETS AND ARTIFICIAL LIFE

thing? If so, it still will be tempting to think that we can own types of gadgets and living things, for it is plausible to think that we own what we invent. And, in fact, there are some candidates to consider. Let us start with the view that I invent an F when (before others) I get the idea of an F, and am thereby entitled to the F the idea of which I have conceived.

The science fiction writer Arthur Clark wrote about communications satellites long before there were any such devices, and he may have been the first person ever to do so. Other science fiction writers described engines that would propel spacecraft faster than the speed of light. Yet no one would say that Clark owns the communications satellite, or that some other author owns any faster-than-light engines that might be manufactured in the future.

There is a trivial sense in which people 'have the idea' of a type of thing simply by imaginatively combining a set of features. Such imaginings are what fantasy fiction writers often provide. But we cannot summon things into existence simply by imagining combinations of features, and the fact that a set of features can be combined in the imagination does not help show that those features can actually go together, much less tell us how to get them combined in real devices. The main reason science fiction writers cannot begin to claim the faster-than-light engine is that they haven't a clue what features would enable an engine to propel a craft faster than the speed of light. In fact, in the relevant sense, they do not yet really have the idea of such an engine. To 'have the idea' of this sort of engine would be to know in fairly precise detail what features would enable a device to exceed the speed of light. To 'have the idea', the writers would have to have discovered that devices with certain given features perform in given ways. They would have to have discovered that a certain type of gadget exists, so that tokens of the type might also exist. Unfortunately, the faster-than-light engine probably just does not exist, so no one can have the idea of it.

If this is a correct account of having the idea of a type of gadget, should we say that those who have the idea (before others) are entitled to claim that type of gadget? No; for we have said that having the idea of a type of gadget consists in discovering that certain properties of things are associated in a law-like way with certain other properties. In other words, it consists in discovering the existence of a virtual natural resource, a resource that we have classified as indestructible and nonexclusive. Discovering such virtual resources, as we have already seen, does not entitle us to claim them.

III. *Construction Processes and Ownership*

There is another point about Clark and his colleagues that helps explain why he could not claim the communications satellite and why no one can claim the faster-than-light engine: neither Clark nor anyone else could have built a communications satellite when Clark wrote about them, and even now no one knows how to make an engine capable of propelling a craft faster than the speed

of light. If our having the idea of the faster-than-light engine is going to help us to claim the faster-than-light engine, our idea must have enough specificity that, given available technology, that type of engine can be built.

The same goes for designs for things. Designs, like ideas, vary in degrees of specificity: to help warrant a claim to something, our design must have enough specificity to allow that type of thing to be constructed, given available technology.

Such considerations lead us to another account of how invention might warrant ownership: I am entitled to the F when I invent the F in the sense of discovering a way to produce particular Fs (before others). A design or blueprint might figure large in the construction process I discover, as when I invent a mechanical device. Or the process might not involve designs, as, for instance, when I genetically engineer a life form. In any case, discovering how to bring things of a given type into existence is, as far as I can tell, the only viable remaining way people can plausibly position themselves to claim that type of thing.

Of course, if we want to be a bit more precise we would have to qualify the claim that people acquire a given type of thing by discovering how to produce things of that type. At best, this sort of invention of some type of thing only gives us ownership of some of the tokens of that type: at best, we can claim only the tokens of that type that are produced using the process P which we have identified (or using a version of P which others identify after unauthorised study of P), and not tokens that in no way owe their existence to process P. To see that this qualification is necessary, imagine that after I discover how to produce widgets through process P, something unexpected occurs: by a cosmic accident or through natural processes or even through the independent research of another, widgets are produced in a way that is wholly unlike my process P. Obviously I cannot claim these other widgets; at best, I own only widgets produced through process P. More generally: inventing a type T entitles me to T's only to the extent that discovering a process for constructing T's entitles me to the T's made through that process.

But if people cannot create a type of gadget or creature, and if having the idea of that gadget or creature does not warrant ownership, then a legitimate claim to a type of creature or thing seems to depend on our having identified a construction process, even if this kind of claim must be qualified. For notice what happens when such knowledge is absent. Suppose that I find a replicating device left behind by aliens, and neither I nor anyone else can figure out how to manufacture other such devices. If I know so little about my device, it would be odd to say that I own *the* replicating machine (as opposed to the particular machine that I found). Or suppose that I accidentally do something in a laboratory that results in a replicating device, and later I cannot figure out how to make more of them (nor can anyone I hire). Again it would be odd to say I own the replicating machine.

NATURAL RESOURCES, GADGETS AND ARTIFICIAL LIFE

For I will be unable to make more of them, unable to hire anyone to make more, unable to enable others to make more, etc.

Presumably it is uncommon to manufacture a mechanical device without knowing how to do so in fairly precise detail (especially since we can often resort to reverse engineering). But the people who 'invent' types of living things are ignorant in precisely this way, and the question arises as to whether the invention of types of living things poses a problem for my view that (once we put aside creating the F and 'having the idea' of the F) our claim to a type of thing hinges on our discovering a way to make things of that type. I do not think so. In fact, extending the claim of ownership to life forms is especially dubious.

People who introduce a new type of animal using RDNA technology or through the relatively old-fashioned techniques of breeding cannot specify the events through which the new animal comes to be. Partly this is because much is unknown about the processes they apply and the living things to which they apply those processes, and partly it is because a great deal of luck is involved in the successful production of engineered animals, types whose tokens have not been around before. Let us also note that living things do most of the work of reproducing themselves, even if we do not know the details about how the reproduction occurs. If the knowledge gap that is involved in inventing life forms (or components of living things) left researchers with (components of) individual creatures and absolutely no means to produce more, the question of ownership of the life forms probably would not arise. But of course a living thing typically does the job largely on its own. (As an analogy, consider the replicating device again, and suppose that I find that if I aim the device back on itself I can make more replicating devices, but I still have no idea what enables the machine to do what it does, and no idea how to manufacture more of them from scratch. Surely I cannot claim the replicating machine, and if others do figure out how to build replicating machines I cannot claim the devices those people construct.)

So when it comes to 'inventing' life forms, the case for ownership is especially tenuous. Here researchers do not 'have the idea' of the life form, and they have very little knowledge about the details of the processes they are using to introduce new tokens of the life form they are investigating. The best that researchers can do is to describe the biotechnological processes they have discovered in sufficient detail that others may, if they persist, also bring forth tokens of the life form.

To pick up the thread once more: we have said that our inventing the F confers ownership of Fs only to the extent that discovering (before others) a process for constructing Fs entitles us to the Fs made through that process. But now notice that discovering (before others) a process for constructing Fs entitles us to the Fs that are made through that process only if discovering a construction process entitles us to that process itself. If discovering a process does not entitle us to that process, then discovering that it can be used to make things does not entitle us

to those things. This claim is probably obviously true, but let me pause to argue for it.

How could discovering a construction process entitle us to the items which it is used to produce? Well, if we own the construction process (or a salient part of it), then we can legitimately control its use. We can even insist that no one else use it at all, or that everyone who uses it must turn over to us anything its use produces. Probably we will simply insist on receiving a fee, but in any case it is apparent that full ownership of the process would help position us to claim ownership of the things the process produces. So the assumption that we own those construction processes that we discover is an explanation for our owning the items that are produced using the process.

Moreover, as far as I can tell, this assumption is the only explanation for our owning the items that are produced using a construction process which we have identified. Consider what happens if we attempt to evade reliance on the assumption that we own construction processes we discover. That is, suppose we say that discovering a construction process does not entitle us to that process. Then even though we discover a particular construction process, others may use it without our permission. And if others may use it without our (or anyone else's) permission, then they may use it to construct objects and creatures using materials they own. But if they do use the process to construct objects using materials they own and may do so without our permission, then they would own the objects they construct. So they would be able to own objects they construct using the process we discovered. And this means that we do not own the objects that are constructed using the process that we have discovered after all.

I conclude that if we are not entitled to a process we discover, then we are not entitled to the things which people use it to make. This conclusion is important because while many people believe that they are entitled to construction processes which they discover, their belief is false. Discovering a construction process never entitles us to that process. For, as we have already argued, processes should never be owned, and that includes construction processes. Construction processes are virtual resources that are indestructible and usable by all simultaneously, so they should not be owned even by their discoverers. Discoverers may claim no more than a temporary monopoly on the uses of the unfamiliar virtual resource that they identify. Thereafter, all those who own the requisite raw materials should be free to apply familiar construction processes, and free to keep whatever results (so long as they recycle, avoid pollution, etc.)

And now we have completed our arguments for the claim that people ought not own types of gadgets or creatures. The first argument consisted in showing that these things are indestructible, nonexclusive virtual natural resources which people may discover but not create and hence may not own. The second argument was that if we understand 'inventing a type of gadget or living thing T' to mean 'getting the idea of the T', the latter reduces to 'discovering certain

NATURAL RESOURCES, GADGETS AND ARTIFICIAL LIFE

law-like facts in which the T's existence consists', and such discovery does not warrant ownership. The third argument was as follows:

- (1) Discovering a process through which things of a given type can be constructed entitles me to ownership of the things constructed using that process only if discovering a construction process entitles me to that process itself.
- (2) But discovering a construction process does not entitle me to that process. For construction processes are virtual resources that are inexhaustible and usable by all simultaneously, and as such should be freely useable by everyone.
- (3) So discovering a process through which things of a given type can be constructed does not entitle me to ownership of the things constructed using that process.¹⁸

PATENTS

Under current U.S. law, it is possible to patent not just microorganisms, but even complex plants and animals that are introduced using genetic engineering. Several life forms have been patented in this country.¹⁹ The first was Chakrabarty's oil eating bacterium, patented in 1980. In 1988, the first animal was patented: a transgenic mouse altered by researchers at Harvard University to be predisposed to develop cancer (in fact, the patent is on any animal engineered through the cancer inducing process used by the Harvard researchers). Human beings cannot be patented (in deference to the Thirteenth Amendment banning slavery), although human materials can be (bone marrow stem cells have been patented²⁰). With some hesitation, some European nations have followed the lead of the U.S. Even though the 1973 European Patent Convention says that 'essentially biological processes cannot be patented', in 1991, the European Patent Office granted a patent for the so-called oncomouse pioneered by the Harvard researchers.

I have concluded that individuals are not entitled to own types of devices or types of living things (or the processes by which things of these types can be manufactured), and that, at most, people who discover unfamiliar (virtual) resources such as types of processes, gadgets and living things may claim a temporary monopoly on their use. In this, the final part of the essay, I want to underscore the differences between traditional patenting and ownership, and to discuss some ways in which the institution of patenting should be rethought and redesigned. I will start with ownership.

One useful clarification of the notion of ownership was offered by A.M. Honoré (1977), who lists eleven things that 'are not individually necessary, though they may be together sufficient, conditions for the person of inheritance to

be designated “owner” of a particular thing in a given system’: ‘the right to possess, the right to use, the right to manage, the right to the income of the thing, the right to the capital, the right to security, the rights or incidents of transmissibility and absence of term, the prohibition of harmful use, liability to execution, and the incident of residuary’. It is plausible to say that each of these (with the possible exceptions of the last two) plays a role in the notion of full ownership. However, for my purposes it suffices to focus on the seventh and eighth items on Honoré’s list, and to claim that if I own something in the full sense of ‘ownership’, then I may keep it as long as I like, and I may also transmit it to others who, in turn, may transmit it to still others, and so on. This claim is all I need to show that full ownership is not granted by or protected by the institution of patenting.

Patenting (in the United States) is an arrangement whereby an inventor publicly discloses salient facts about a ‘process, machine, manufacture, or composition of matter ... or improvement thereof’²¹ that is novel,²² nonobvious²³ and useful;²⁴ in return, the inventor’s control of the invention is legally protected for seventeen years.²⁵ The patent application must meet the enablement requirement: the application must describe the invention and ‘the manner and process of making and using it, in such full, clear, concise and exact terms as to enable any person skilled in the art to which it pertains ... to make and use the same’.²⁶ The control that is protected by a patent is the right to exclude others from making, using or selling the patented item. After seventeen years the item falls into the public domain, so that there is a fixed term of protection and no protection of (indefinite) transmissibility. Thus patents protect only some of the rights that owners of things have.

Of course, it is difficult to imagine how applicants who wish to patent life forms could meet the traditional enablement requirement, and apparently the legal enablement standard for life forms is in flux. Instead of (per impossibile) describing how to make living things from scratch, some applicants have been permitted to deposit samples of such items as microorganisms or DNA in repositories (See Beier 1985, pp. 22-26). But there are no repositories for live animals. Nationally and internationally, there is still a great deal of disagreement about the sort of disclosure it takes to patent inventions that result from the manipulation of living material whose constituent elements cannot be described in detail (See Brent 1987, p.2).

We have said enough to show that a patent does not confer ownership. Now let us ask whether our defence of a system of monopolies as incentives can be used to support the traditional patent system. The point I want to make is that the traditional system is not a pure incentive system, unlike the system we have advocated for discoveries. Instead, the traditional system has a mixture of goals. It is supposed to be an incentive system as well as a system that protects property rights.²⁷ But the result of combining these two goals is a confused policy. Because of the latter goal, an attempt is made to ensure that the only things that

NATURAL RESOURCES, GADGETS AND ARTIFICIAL LIFE

can be patented are things that really ought to be thought of as private property, and because of the former goal, an attempt is made to cover all types of things that are difficult to discover and whose discovery would be useful to people. Again, because the system is only supposed to protect property, it includes a restriction against patents on mere discoveries, for obviously no one can come to own an entire type of thing such as the elm tree simply by discovering (before others) that that type of thing exists. It is a commonplace²⁸ that mere discoveries cannot be patented, and mere discoveries are said to include such things as 'a law of nature or natural phenomenon, a property of a substance, a mathematical relationship or the like' (Bent 1987, p. 106). (Unfortunately it is also a commonplace that what it takes to move beyond a mere discovery to subject matter that can be patented is unclear.²⁹) Moreover, because the system is supposed to protect only property, it is greatly stretched when it grants patents for life forms. But because the system is supposed to provide an incentive for inventing (finding? discovering?) types of things that would be useful to people, it does allow some mere discoveries to be patented (for example, types of things that exist in the natural state, but not in a 'pure form'). And of course it is because the system is supposed to cover useful discoveries that it has been stretched to cover life forms.

Once we give up on the idea that gadgets and other types of thing are property, we can repair the patent system. We can drop the goal of protecting property, and instead construe the patent system simply as a means to providing incentives for people to discover (virtual) natural resources that would otherwise remain unfamiliar.³⁰ For even if we agree that a type of thing ought not be private property, it can still make perfect sense to grant people who discover it a temporary monopoly on it as an incentive for discovery.³¹ As for life forms, and components of human beings, we can say that the system should cover them without implying that they are property.

NOTES

¹ This essay was presented in October 1997 at a conference held by the University of Melbourne on the topic, 'Environmental Justice: Global Ethics for the 21st Century'. For useful comments on an earlier version of this essay, I thank an anonymous reviewer selected by Environmental Values. I also want to offer special thanks to Ned Hettinger, who reviewed an earlier draft and gave me an extremely generous set of suggestions and sharp criticism. His comments allowed me to improve this essay tremendously.

² I make no claim here that parts of the non-human world (in particular, living things other than people) have moral standing. But in making no such claim, I do not wish to be construed as denying all such claims. I simply think that assumptions about the moral standing of living things other than human beings are highly controversial, and I want to argue on the basis of a set of assumptions that are as lean and uncontroversial as possible. The thrust of my libertarian approach is that we owe it to other people, including future

people, to interfere with their lives as little as possible, and that means we owe it to them to share access to natural resources and to share access to other things that are like natural resources in the sense that they are not the product of anyone's labour. After saying this, one might go on to make the further claim that we owe it to certain other creatures (in particular ones capable of desires and suffering) to interfere with their lives as little as possible. Almost everyone now will agree that we owe it to sentient creatures not to cause them unnecessary suffering. Presumably the next step would be our ceasing to consider those creatures themselves as natural resources, and our defining natural resources so as to include no creatures with moral standing, and only those things which are not brought into existence by creatures with moral standing. Then we might consider the far more problematic policy of sharing access to natural resources (so construed) with them.

³ For an opposing view, see McCloskey (1965), who argues that liberty is curtailed only if someone's rights are violated. From my point of view, this conception of liberty would involve circularity. I mean to use the idea of liberty to clarify our obligations and rights, and do not presuppose a prior notion of rights.

⁴ For simplicity, I ignore the fact that more than one noninterference scheme is possible.

⁵ Unlike Rawls (1971), I will use the terms 'duty' and 'obligation' interchangeably.

⁶ Jeremy Waldron (1988) defines self-ownership as follows:

To say that I own myself is to say that nobody but me has the right to dispose of me or to direct my action. I have rights to do these things (though...I must not exercise my self-ownership in a way which violates theirs), and those rights are exclusive of anyone else's privilege in this regard, for they are correlative to others' duties to refrain from interfering with what, in this sense, I own (p. 398).

⁷ As against Nozick, Eric Mack (1990) complains that the Lockean doctrine 'surely can be freed from any reliance upon the model of literal physical mixing of one stuff with another by formulating it in terms of a person's investment of his talents, time and energy, his human capital, in the now transformed object' (p. 528). Mack is correct. But the reformulation does not help. It still leaves us with the problem of determining how we may come to own materials upon which to labour in the first place.

⁸ On my interpretation of Locke, I must leave enough that others may take what they can use, and not merely enough that what remains is all that they can use (in common). This interpretation is suggested by Locke's own discussion of his theory of acquisition:

[the] appropriation of any parcel of land by improving it [is not] any prejudice to any other man, since there was still enough and as good left, *and more than the yet unprovided could use*. So that, in effect, *there was never ... less left for others* because of his enclosure for himself; for he that leaves as much as another can make use of does as good as take nothing at all (Sect.33; my italics.)

As for my claim that on Locke's proviso we need only leave contemporaries (and not members of future generations) free to take what they can use: I have no special textual evidence for this interpretation of Locke, but it is consistent with the text and it explains why Locke was not concerned about the zip-back problem Nozick discusses on p. 176.

⁹ Let me acknowledge two necessary qualifications: first, a replacement resource that is for all practical purposes just like the resource it replaces is also natural, we might say. For example, if I remove a tree and plant a sapling of the same variety in its place, the resulting tree is a natural resource. (Similarly, if I could destroy a particular chunk of iron and create a duplicate chunk in its place, the new chunk would be a natural resource.)

Second, we might argue that, in some sense, people themselves (and their components) were not brought into existence by anyone, and yet they are not natural resources.

NATURAL RESOURCES, GADGETS AND ARTIFICIAL LIFE

That people are possible exceptions to the definition of *natural resource* is an unsurprising consequence of the anthropocentric nature of the term.

¹⁰ I discussed these in 1992 and 1995.

¹¹ Here and elsewhere certain sorts of exception would be allowable and are defensible from the standpoint of the original position as I have described it. For example, as Ned Hettinger pointed out to me, we might conceive of circumstances in which the only way to prevent the complete annihilation of a resource is to reduce its supply to future generations.

¹² Thus Grunebaum's (1990) Humean point that 'it is only because [or better: when] goods of the world are scarce that ownership rules are necessary (p. 551)' is close to the truth. The element of truth is that when the supply of a self-renewing or indestructible natural resource vastly exceeds a generation's demand, (1) the resource should be freely available to people in that generation, and (2) the supply available to future generations should not be limited by (or owned by) people in earlier generations. But these are, of course, rules of ownership. Hume's remarks about scarcity occur at Hume (1964), p. 494.

¹³ The reasons for limiting the collection rights temporally and spatially are (1) members of no generation should own the self-renewing resources that come into existence after they die, and (2) the leasing prices should reflect the fact that market prices vary over time and space.

¹⁴ It helps only a little to note that if researchers find an unfamiliar natural resource, they need not provide it to others or even tell others about it; they do not own the resource, but they certainly do own the records they make concerning that resource, and they may choose to tell no one about the resource, or to tell others only for a fee, which can serve as an incentive. However, such arrangements depend on secrecy, and it is difficult to imagine that secret arrangements can be made secure enough and routine enough to motivate people to search for resources that have not yet been discovered.

¹⁵ Similarly for resources that would eventually be discovered in the absence of incentives but only after a long period of time.

¹⁶ The recommended policy of allowing people free use of construction processes does not entail letting people have free access to the raw materials they require in order to employ construction processes.

¹⁷ Ned Hettinger (1989, 1995) has contrasted 'intellectual property, such as biopatents in oncomammals', with 'tangible property, such as wrist watches', on the grounds that only the use of the former is nonexclusive: 'Researchers throughout the world could use Du Pont's oncomammals. Whereas with tangible property, one person's use excludes others from using the property.' For this reason Hettinger argues that 'it is prima facie irrational for society to grant monopoly rights to something that all could use at once', and assembles a formidable case against what he calls 'intellectual property'. I agree with Hettinger's claim that granting monopoly rights to nonexclusive items is objectionable (although I do so on libertarian grounds rather than on the utilitarian grounds offered by Hettinger), except for the brief periods of time necessary to create incentives.

¹⁸ Although I will not go into the matter here, my claims concerning the ownership of types of gadgets, creatures, and processes can be extended to copyrighted items as well. To say that this article (as a type) exists is to say that words can be combined in such and such a way. So articles as types cannot be created, and to own an article I would have to own the fact that words can be combined in such and such a way, or (to mention a highly implausible option) I would have to own the (purported) facts that I discovered and described in my article, neither of which would be acceptable. Similarly with songs as

types (which consist in the fact that notes can be combined in such and such a way). Novels and stories also reduce to the fact that words can be combined in such and such a way, but instead of reporting (purported) facts they describe (purported) possible worlds.

Still, owning something is one thing, and having a copyright on it is another. The institution of copyrighting might be justifiable on grounds that are analogous to the grounds I offer for the (altered and extended) institution of patenting, for copyrighting provides various sorts of incentives to people to reveal things that would otherwise go unnoticed, etc.

¹⁹ For a synopsis of patent law and the background to the controversy concerning the patenting of life forms see Adler (1988) or the more exhaustive review in Bent (1987). Adler attacks several assumptions made by opponents of animal patenting.

²⁰ See Brownlee (1991).

²¹ 35 U.S.C. Sect. 101 (1982).

²² 35 U.S.C. Sect. 101 (1982).

²³ 35 U.S.C. Sect. 103 (1982). Section 103 of the U.S. Patent Code replaced the requirement of 'invention' with 'nonobviousness'. It states that patents will not be granted 'if the differences between the subject sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains'. For an exhaustive discussion of this vague requirement, see Witherspoon (1980).

²⁴ 35 U.S.C. Sect. 102 (1982).

²⁵ Apparently the institution of patenting began in Great Britain with the passing of the British Statute of Monopolies in 1623/1624. It was introduced to the United States in 1790 (See Machlup (1958)).

²⁶ 35 U.S.C. Sect. 112, par. 1 (1982).

²⁷ According to the Organization for Economic Cooperation and Development (Beier (1985), p. 17), modern patent legislation is based on four 'classic objectives justifying patent protection' (formulated by Fritz Machlup), the first of which is to recognise the fact that inventors own their inventions: 'To recognize the intellectual property of the inventor; To reward the inventor for his useful services as "teacher of the nation"; To encourage inventors and industry to invent, invest and innovate; and finally; To further the early disclosure and wide dissemination of technical knowledge.'

The Constitutional basis for patenting is this:

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. (U.S. Const. art. I, Sect. 8, cl. 8)

²⁸ Since the decision *T.G. Morton v. The New York Eye Infirmary*, 17 F. Cas. 879 (S.D.N.Y. 1862).

²⁹ Consider just one example of why the legal distinction between a discovery and an invention is confusing and arbitrary: it is possible to patent a (pure) chemical found in nature so long as the chemical does not naturally exist in a pure form. By extension, the first researchers to isolate a protein or a gene that encodes a protein can patent it. (See Barton 1991, p. 42).

³⁰ In particular, I suggest that only issues of practicality stand in the way of saying that even highly abstract laws of nature (and perhaps certain contributions to mathematics) should potentially be the subject matter for patents, as when those laws are so startlingly helpful that they translate directly into commercial innovations.

NATURAL RESOURCES, GADGETS AND ARTIFICIAL LIFE

³¹ There are other strategies for defending patent protection. Against the utilitarian defence, Hettinger (1989, 1995) offers an able utilitarian rebuttal. Cf. Kass (1981). One might also defend patent protection on the basis of contracts and the right to keep secrets (although legally this kind of protection is less extensive than the protection offered by the patent system since there are substantial international treaties concerning patents and trademarks and copyrights but no substantial treaties dealing with the protection of trade secrets (see Bent 1987, p. 352.) It is not clear that this kind of defence will work but let me discuss it briefly (see Nozick 1974, pp. 141, 182).

If I construct a creature of an unfamiliar type, I can own the individual creature even if I do not own that type of creature, and I can prevent others from having access to my construction. Therefore, if I wish I can restrict other's access to my creature. I can allow access (and sell creatures which only I know how to construct) under conditions I specify (including conditions about keeping the nature of the creature secret and passing my conditions on to anyone to whom the buyer resells the creature).

Moreover, if I discover how to construct creatures of an unfamiliar type, I can refuse to tell others how to do it, even though I do not own the actual process itself. Therefore, I can sell documentation about how to construct the new creature only under conditions I specify. Others will be willing to buy my documentation until the facts I document become common knowledge.

These contractual rights mimic patent protection only up to a point. Suppose that Jones discovers that T-type things can be made through process P, and attempts to control T's. Later, Smith *independently* discovers that T-type things can be made through process P, and begins using P to make T's for sale. The contractual rights do not block Smith's actions. Nor do the contractual rights prevent someone who finds a lost item from applying reverse engineering to it and making copies of it.

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