1 Introduction

1.1 Why an ethic of species?

Humanity's relationship to other species has reached critical junctures. We are causing species to go extinct at an unprecedented rate in comparison with any other time in the last 65 million years.[1] The background or normal historical rate of extinctions is approximately one species per one million per year.[2] There is no precise data, and estimates vary, but many leading experts on biodiversity believe there are around ten million eukaryotic (or plant and animal) species.[3] Therefore, in normal times, there would be around ten species extinctions per year. However, as a result of human activity – for example, pollution, extraction, and habitat destruction – species extinctions already exceed one thousand species per million per year.[4] Moreover, the rate of extinction is expected to substantially increase due to global climate change, according to several scenarios surpassing 10,000 species extinctions per million per year,[5] over a quarter of species committed to extinction by 2050,[6] and one half of species extinct by 2100.[7] Even on optimistic (and increasingly unlikely) scenarios, in which the increase in the global mean surface air temperature of the planet is limited to around 2°C above pre-industrial temperatures, 20–30 percent of species are expected to be at increased risk of extinction by 2100.[8] The Earth's

[1] Magurran and Dornelas (2010).

[2] Baillie et al. (2004) calculates the historical rate of extinction as .1–1 E/MSY.

[3] Vié et al. (2009); Strain (2011).

[4] Baillie et al. (2004); IUCN (2011). For a review of the rates for vertebrates, see Hoffman et al. (2010).

[5] Wilson ([1999] 2010); IUCN (2011). Assuming 10 million species, this is approximately 275 species per day.

[6] Thomas et al. (2004). [7] IPCC (2007a). [8] IPCC (2007a).

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next major extinction event appears to have begun, and this time it is anthropogenic.[9]

In addition to eliminating species, we are engineering them in unprecedented ways. Intentional manipulation of species has been occurring since at least the beginning of agriculture – through selective breeding, hybridization, and grafting – and recombinant DNA techniques have been used for decades to insert genes from one individual into another, including across species. However, advances in genetic engineering have substantially scaled up the precision, intensity, and comprehensiveness of these modifications.

One research group has engineered a yeast (*Saccharomyces cerevisiae*) that produces high concentrations of artemisinic acid – the precursor for artemisinin, an antimalarial drug – by transplanting genes from sweet wormwood (*Artemisia annua*), the traditional source of artemisinin, and several bacteria species, which code for the requisite metabolic pathway, into the yeast.[10] Another research group has chemically synthesized the entire genome of a *Mycoplasma mycoides* bacteria, inserted it into a non-*M. mycoides* host cell, and "booted it to life" – that is, started up the metabolic processes of the *M. mycoides*.[11] Engineering biology has become sufficiently accessible that there is now an annual genetically engineered machine competition in which high school and undergraduate teams use and contribute to "a continuously growing collection of genetic parts that can be mixed and matched to build synthetic biology devices and systems."[12]

While some researchers are intensively reengineering existing biological parts and systems, others are developing life forms that are not derived from prior organisms. One research team has created "self-replicating cells assembled from nonliving organic and inorganic matter."[13] These entities are approximately one million times smaller than bacteria and do not contain any biomolecules found in modern living cells. They are artificial, evolving life forms (or life-like forms) that are unrelated to any existing or prior life forms.

Technologies that are used to modify ourselves, members of the species *Homo sapiens*, are also increasingly powerful. People are eager to incorporate

[9] Barnosky et al. (2011). [10] Ro et al. (2006). [11] Gibson et al. (2010).
[12] Registry of Standard Biological Parts (2010). [13] AAAS (2005).

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technologies into their lives if they believe they will improve their abilities or health. The human growth hormone industry, although largely illegal, is estimated to be worth several billion dollars annually;[14] and 7 percent of college students[15] and 20 percent of research scientists use off-label prescription pharmaceuticals (e.g., methylphenidate [Ritalin] and modafinil [Provigil]) to increase alertness and productivity.[16] This is not a historical aberration. People have been enthusiastically ingesting natural and engineered chemical compounds to improve or repair biological functioning for millennia, and coffee, an effective stimulant, has long been among the most traded commodities in the world. The difference with emerging technological enhancements – such as genetic technologies, brain-machine interfacing, and nootropics ("smart drugs") – is the magnitude of augmentation that they will enable, as well as the extent to which they will do so by modifying or integrating with our biological systems. Already people are controlling computers with their brain states;[17] people have bionic arms that are spontaneously integrating with their nervous system;[18] researchers are successfully combining human and nonhuman genomic material;[19] and pharmaceuticals intended to increase longevity have gone into clinical trials.[20]

It is because we have the power to cause mass extinctions, substantially modify existing species, and create novel species that we require an ethic of species. Central to an ethic of species are an account of the value of species and an account of the ethical significance of species boundaries. The former concerns the sorts of value that species have and the bases for their having it. The latter concerns whether species boundaries carry normative significance, such that mixing species, modifying species, or intentionally creating individuals outside existing species boundaries is intrinsically problematic. These are the core theoretical issues of this book. The core applied issues are what the value of species and normative significance of species boundaries imply for species preservation under

[14] Olshansky and Perls (2008).
[15] McCabe et al. (2005). Others have suggested that the rate could be as high as 35 percent (University of Michigan Health System 2008).
[16] Maher (2008). [17] Hochberg et al. (2006). [18] McGrath (2007).
[19] Ourednick et al. (2001); Almeida-Porada et al. (2005); Jacobs et al. (2007).
[20] Keim (2008).

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conditions of rapid climate change, modification of existing species (including ourselves), and engineering novel species.

In the remainder of this Introduction, I explicate the conception of species that is operative in the book and then provide an overview of the book's organization, central claims, and arguments.

1.2 Species as forms of life

There is no widely agreed upon definition of "species," but rather a host of competing species concepts. Species are sometimes conceived in terms of reproductive isolation: that is, as interbreeding (or potentially interbreeding) populations.[21] They are sometimes conceived phylogentically or evolutionarily: that is, as a lineage of ancestral descendant populations.[22] They are sometimes conceived ecologically: that is, as populations that occupy an ecological niche different from that of any other lineage in its range.[23] They are sometimes conceived genetically: that is, in terms of overall genotypic similarity distinct from that of other organisms.[24] And they are sometimes conceived morphologically: that is, in terms of shared anatomical features different from those of other groups of organisms.[25] That there are so many different conceptions of species has given rise to the issue of whether there is one correct account of species (*species monism*), or whether there is a plurality of legitimate species concepts (*species pluralism*). A related issue is whether species are real categories into which biological organisms are divided based on their features (*species realism*); or whether species are merely conventions (*species conventionalism*), that is, useful ways to organize the living world, but not reflective of the fundamental features of living things.[26] The status of species boundaries tracks that of species. If species are real, then so too are species boundaries; if species are conventions, then species boundaries are as well.

Part of the explanation for why there are myriad conceptions of species is that biologists with different concerns and research projects refer to

[21] Mayr and Ashlock (1991). [22] Wiley (1978). [23] van Valen (1976).
[24] Sokal and Crovello (1970). [25] Cronquist (1978); Kitcher (1984); Stamos (2003).
[26] In addition to the monism/pluralism and real/conventional aspects of "the species problem," there is a metaphysical dimension, i.e., whether species are collections of individuals, abstract forms, or historical individuals distinct from the organisms that comprise them (Crane 2004).

different kinds of groups as "species." For instance, the ecological species concept is more useful for ecologists formulating and studying questions about ecological relationships and functions than is the phylogenetic species concept; whereas the phylogenetic species concept is better suited to the work of evolutionary biologists interested in ancestral relationships than is the ecological species concept. And while reproductive isolation is a useful approach to categorization when trying to distinguish groups of sexually reproducing organisms whose ranges overlap, it is less useful where populations do not overlap geographically, and it is not at all useful when studying populations of asexually reproducing organisms. That there is a multiplicity of species concepts that are used productively to study and explain the biological world provides support for species pluralism. It suggests that each of the various concepts picks out biologically significant features of organisms. The monistic idea that there is a single best way to divide organisms into species seems belied by productive biological practice.

Species pluralism garners additional support from the fact that no one species concept captures an aspect of organisms or the biological world that is more fundamental than all other aspects. For example, all natural (or nonengineered) organisms have ancestor relationships, so it is possible to categorize the natural world, including at the species level, phylogenetically. But all organisms are also inextricably ecologically situated, and this is crucial for understanding why organisms and populations have the characteristics they have and behave as they do. In fact, the ecological situatedness of populations turns out to be important for understanding phylogeny, since environmental changes are crucial in explaining evolutionary history, while phylogenetic information can be useful for understanding the functioning of ecological communities.[27] So it is not the case that either phylogenetic relationships or ecological ones are more explanatorily fundamental. Each captures something important about life in an evolved biological world, which is why they are powerful and influential species concepts.

Organisms have phylogenies, ecological niches, genetic features, and reproductive communities. These are all explanatorily important, and no one of them picks out the fundamental causal structure of the biological world. For these reasons, species pluralism is the more plausible view.

[27] Tan et al. (2011).

However, species pluralism does not imply full-blown relativism. Biological reality places constraints on what counts as a legitimate species concept, otherwise species divisions would be arbitrary and we would have to accept "the suggestions of the inexpert, the inane, and the insane."[28] At a minimum, a legitimate species concept needs to classify organisms into groups, since the point of a species concept is to divide and organize organisms. Moreover, it must do so by features that are biological properties of organisms or groups of organisms. These properties can be either internal (e.g., genetic) or relational (e.g., ancestral). A legitimate species concept must also be explanatorily useful. It must help make sense of the world by organizing it in ways that increase our understanding of it or increase our ability to make predictions regarding it.[29]

The conception of species that is primarily used in this book is that species are groups of biologically related organisms that are distinguished from other groups of organisms by virtue of their shared *form of life*. A species' form of life refers to how individuals of the biological group typically strive to make their way in the world. For example, it concerns what sorts of things they consume and how they acquire it; how they reproduce; how (and when and whether) they move; how they avoid predators; and how they repair themselves when damaged. It is straightforward to distinguish a group of organisms on this basis. The form of life of a cottonmouth snake (*Agkistrodon piscivorus*) is clearly different from that of a silver maple (*Acer saccharinum*), a black swallowtail butterfly (*Papilio polyxenes*), and an Arctic fox (*Alopex lagopus*). It is also quite different from that of eastern garter snakes (*Thamnophis sirtalis sirtalis*) and timber rattlers (*Crotalus horridus*). These species have distinct life cycles, behaviors, habitats, predators, prey, and protections. Of course, they do so largely because of differences in their biological parts and processes: that is, their phenotypes. These, in turn, are largely explained by their genetic differences: that is, their genotypes. It is for genetic reasons that individual grey wolves have a sufficiently common biological form and a sufficiently common set of behaviors (e.g., sociability and diet) under sufficiently common environmental conditions that they constitute a form of life (*Canis lupus*) that is distinct from that of coyotes (*Canis latrans*), zebra mussels (*Dreissena polymorpha*), and green herons (*Butorides virescens*).

[28] Kitcher (1987: 190). [29] Crane and Sandler (2011).

Individual organisms express the form of life that they do because of the life form that they are: that is, their genotype and phenotype. Nevertheless, form of life descriptions track real biological features of organisms – red-winged blackbirds (*Agelaius phoeniceus*) really do migrate south for the winter, whereas ringed-neck pheasants (*Phasianus colchicus*) really do not. Moreover, while the way in which individuals go about the world is largely explained by their genotype and phenotype – for example, by their wing structure – the differences in their genotype and phenotype are also in part explained by how their ancestors went about the world – for example, whether or not they migrated for the winter. Thus, the form of life conception of species classifies organisms by something that is both biologically real and explanatorily useful. It is a legitimate species concept.[30]

In fact, the form of life conception of species is a familiar one. It is operative in zoology and botany when work in those fields involves describing what biologically related individuals do and how they go about doing it. It is the conception around which nature programs about species are organized when they focus on how they migrate, hunt, reproduce, survive the winter, and generally get on in the world. It is almost always the conception of species at work in the practice of professional and amateur naturalists. Moreover, it is the conception of species that picks out what captures many people's imagination about living things and what troubles them most when it comes to the specter of anthropogenic species extinctions: beautiful, amazing, and unique forms of life will cease to be instantiated. It is not the genotype that they primarily want to see preserved, or even the phenotype as it might be in a zoo or farm, but organisms going about the world in their distinctive ways: migrating wildebeest (*Connochaetes taurinus*); soaring condors (e.g., *Gymnogyps californianus*); roaming polar bears (*Ursus maritimus*); spawning salmon (e.g., *Oncorhynchus tshawytscha*); towering torreya (*Torreya taxifolia*); leaf-cutting ants (e.g., *Atta colombica*); dancing honey bees (e.g., *Apis mellifera*); and breaching humpbacks (*Megaptera novaeangliae*).[31]

[30] For further discussion of this species concept, see Crane and Sandler (2011).

[31] A similar conception of species has been suggested by Holmes Rolston III: "It is admittedly difficult to pinpoint precisely what a species is, and there may be no single, quintessential way to define species … All we need for this discussion, however, is that species be objectively there as living processes in the evolutionary ecosystem; the varied criteria for defining them (descent, reproductive isolation, morphology, gene pool) come together at least in providing evidence that species are really there … A

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This conception of species also animates beliefs about the moral significance of species boundaries. The reason why many people are concerned about mixing genetic material across species boundaries is not to do with the sanctity of the genes themselves, but with the sanctity of natural forms of life and the ambiguity of engineered ones. It is thought to be unnatural to insert genes from one individual into the genome of another when the forms of life are not reproductively compatible. Part-human transgenics are thought to be objectionable because the resultant life forms might have some human and some nonhuman characteristics. Robust human enhancement is thought to be a threat to human dignity because it might result in changes to human nature and the human form of life. Creating *de novo* living things is thought to be hubristic and playing at God because it involves bringing novel forms of life into existence. It is crossing, altering, or creating species categories and boundaries, understood in terms of forms of life, not genes or lineages, which many people find unsettling.

The form of life species concept is imperfect. It does not divide every entity in the biological world into neat categories. But in an evolved biological world, there will be ambiguous and marginal cases on any conception of species.[32] There will be organisms that can be biologically grouped in more than one way or that do not fall neatly into a single species category. There also can be reasonable disagreement about whether a group of biologically related organisms have a sufficiently distinct form of life from another group of organisms such that they constitute a distinct species or are instead a variety or subspecies. This sort of ambiguity is also common to all species concepts, since for any species concept it is necessary to determine how much similarity and difference constitutes the species level.

The form of life species concept tracks how biologically related organisms typically strive to make their way in the world, but there is variation among individuals. For example, some Canadian geese (*Branta canadensis*) do not fly south for the winter, while others do. Moreover, many individuals, even if they strive in the ways characteristic of their species, will not

species is a coherent, ongoing form of life expressed in organisms, encoded in gene flow, and shaped by the environment" (1989: 210).

32 The form of life conception of species used throughout this book is naturalistic in the sense that (nonengineered) species are the product of unguided evolutionary processes that have no goal or teleology. They are not established by intentional supernatural or nonnatural agency. This is as true of *Homo sapiens* as it is of any other naturally evolved species.

succeed in realizing their complete form of life. The primary reason for this is that many organisms die early in their life cycle. It is also important to note that the form of life species concept, like many other species concepts, allows for dynamic species. If the ways in which the individuals of a species population go about the world substantially changes, then the form of life of the species can change. (However, if the changes are robust and sudden enough, or if they occur throughout only part of the species population, then it might constitute the emergence of a new species.)

Unless otherwise specified, the conception of species used throughout this book is the form of life conception. Species categories are distinguished by the form of life that individual organisms of the species instantiate or express. Individual organisms are conspecific (or members of the same species) when they are biologically related organisms that share a form of life or express the same form of life. Throughout the book I will also distinguish between the biological grouping criteria for species and the form of life descriptions of species. The biological grouping criteria are the genetic or phylogenetic characteristics shared by members of a species. The form of life descriptions are the propositions that describe how members of the biological group typically go about the world.[33]

The value of species is often thought to be related to the value of biodiversity. This is particularly so in conservation biology, where a prominent justification for preserving species is that it maintains biodiversity. Therefore, an ethic of species, insofar as it concerns the value of species, necessarily involves discussing biodiversity and the value of collections or systems of diverse species.

As with "species," there is no single, universally employed conception of "biodiversity." There is instead a plurality of important varieties of biodiversity, and different conceptions of biological diversity are useful for different purposes. For example, intraspecific genetic diversity is useful when studying the viability of species populations and their capacity to respond to stressors. Generally, the less genetically diverse a population, the less robust and adaptable it is in comparison with a more genetically variable (and comparably sized) population of the species. However, intraspecific genetic diversity does not provide information regarding the importance of organism or population traits to the systems in which they are

[33] Crane and Sandler (2011).

located. For this reason, functional diversity often is more useful when studying the integrity and stability of systems, since it concerns the role of traits of organisms and populations in ecosystem processes. Because it concerns ecosystem processes, functional diversity is also crucial to the capacity of ecosystems to reliably provide ecosystems services. Another type of biological diversity, beta diversity, concerns the diversity between areas or ecosystems. The greater the beta diversity between two or more systems, the more species that are found in one, but not the other, system. Beta diversity is therefore useful for studying why species are distributed as they are, and it is crucial to protection designation decisions and management planning.

Each of these conceptions of biological diversity (and there are many others) is legitimate. They each capture something biologically and ecologically significant. However, because the focus here is on species, "biodiversity" will be used to refer to species-level diversity understood through the form of life conception of species, and not genetic diversity or phylogenetic diversity, for example. More specifically, biodiversity will be understood in terms of species richness – that is, the number of species in a geographic area or system (or what is referred to as alpha diversity) – informed by their relative abundance and uniqueness (or beta diversity). Biodiversity is thus a property of places and systems. One area or system is more biodiverse than another if it has a greater variety of species, less common species, or larger populations of species than the other.[34]

1.3 Overview

The first part of the book focuses on the value of species, particularly as it pertains to species preservation and ecosystem management under conditions of global climate change. In Chapter 2, I consider several different types of value that species have been thought to possess and, for each type, assess whether they do in fact have that value. The typology of value that is used includes a final value/instrumental value distinction and a subjective value/objective value distinction. I argue that species have instrumental value, as well as subjective final value. They are valuable as a means to

[34] For a more extensive discussion of the complexities involved in characterizing "biodiversity," see Sarkar (2005) and Maclaurin and Sterelny (2008).

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sought ends and they are valued for what they are, not merely for what they can do for us. I also argue that species do not have objective final value. They do not have value in and of themselves or independent of people's attitudes with regard to them. In making this argument I reject the widespread commitment in environmental ethics to the objective value of natural historical relationships.[35] The chapter concludes with an argument for the view that, while species lack objective final value, individual organisms possess it. They have a good of their own or interests that we ought to care about for their own sake.

In Chapter 3, I discuss the species conservation dilemma that arises from global climate change. Given the increased rate of extinctions expected to be associated with global climate change, conservation biology – the discipline committed to the preservation of species and biodiversity – seems more important than ever. However, global climate change undermines conservation biology's predominant species conservation strategies, place-based preservation, and ecological restoration. Place-based preservation involves establishing protected areas where local stressors, such as pollution, extraction, and recreational use, on nonhuman species populations and their habitat are eliminated or reduced. However, populations cannot be prevented from going extinct by reducing local stressors if, as is the case with global climate change, the habitats themselves are coming apart and this is what is driving the extinctions. Ecological restoration aims to return a degraded space to what it was, or would have been, absent anthropogenic impacts. However, a distinctive feature of global climate change is an accelerated rate of ecological change. Therefore, past ecological systems and trajectories are, to the extent that global climate change occurs, increasingly poor proxies for ecological integrity in the future, and restoration is undermined as a species conservation strategy. An additional implication of the increased rate of ecological change is that the justification for native species prioritization in ecosystem management is diminished.

In response to the species conservation dilemma, many conservation biologists have begun to advocate for a new conservation strategy called assisted colonization (or assisted migration or managed relocation). Assisted colonization is intentionally moving individuals of a species to a location beyond their historic range, and establishing a viable independent

[35] Rolston (1986); Katz (1992); Preston (2008).

population in that location for the purpose of preventing the species from going extinct. In Chapter 4, I conduct a value analysis and assessment of assisted colonization as a species conservation strategy under conditions of global climate change. I argue that, except in quite rare cases, assisted colonization is not well justified. Only in respect to a small number of species – for example, those that are high in instrumental and subjective final value – is value preserved by a successful assisted colonization. But successful, responsible assisted colonizations are themselves likely to be quite rare, given the challenges and uncertainties associated with global climate change, the features of those species that are most likely to be in need of relocation, and the possibility that there will be significant stakeholders who will be resistant to relocations. Moreover, even in the rare cases of responsible, value-preserving, successful translocations, there are likely to be disvalues: the opportunity costs associated with the assisted colonization and the impacts on the individual organisms involved (both the relocated individuals and those in the recipient system). Therefore, by the conclusion of Chapter 4, I have argued that both traditional species preservation strategies, as well as the emerging alternative strategy, are undermined by global climate change.

In Chapter 5, I defend a positive account of how to respond to the species losses associated with global climate change. Given the ecological challenges posed by global climate change, it is not possible to accomplish traditional conservation goals with traditional conservation strategies. However, it does not follow that new strategies to accomplish traditional goals are always needed. It is also possible to revise the goals. I argue that for less impacted ecological spaces reserve-oriented ecosystem management remains well justified, even under conditions of global climate change. However, the goals for such places must shift away from preservation of particular species and assemblages (i.e., traditional preservationism) to promoting adaptive capacity, allowing for ecosystem reconfigurations, and maintaining ecosystem services. This, in turn, requires changing expectations for what the reserve-oriented approach can accomplish. It also involves revising management strategies. For example, it requires significantly less faithfulness to past systems, as well as refraining from propping up dwindling populations (when they are threatened by global climate change). I also argue that in already highly impacted and manipulated ecological systems, where subjective and instrumental values are predominant, intensive species preservation and ecosystem engineering projects can be well justified. The chapter (and first part of the book) concludes with a discussion of the implications of the value of species for ongoing debates regarding mitigation, adaptation, and geoengineering responses to global climate change. I argue that the value of species strongly favors mitigation over adaptation, but not by means of "hard" geoengineering, such as atmospheric aerosol injection and ocean fertilization.

The second part of the book concerns the ethical significance of species boundaries, particularly with respect to species modification and species creation. Chapter 6 concerns whether nonhuman species boundaries are normatively significant in a way that provides an intrinsic or nonoutcome-oriented reason not to create transgenic organisms. I discuss several arguments for the normative significance of species boundaries. I argue that each one fails, and conclude that there is no objective basis for the ethical significance of species boundaries. However, I also discuss several arguments against the normative significance of species boundaries, and show that each of these fails as well. That arguments both for and against the objective normative significance of species boundaries fail implies that the view that species boundaries are normatively significant can be part of reasonable comprehensive doctrines or worldviews. As a result, it needs to be respected in both political and nonpolitical domains. For example, people need to be informed with regard to whether products they use involve transgenics, so that they can act in accordance with their worldviews. However, respecting people's worldviews does not require refraining from researching, using, or benefiting from transgenic individuals. When there are good reasons for actively opposing or prohibiting particular transgenic research programs or applications, these flow primarily from nonintrinsic concerns – for example, concerns about justice or risks – which vary among research programs and applications. Therefore, differential assessment of the creation and use of nonhuman transgenics is necessary.

In Chapter 7, I consider whether *Homo sapiens* species boundaries are ethically significant in ways that other species boundaries are not. There are two respects in which the category *Homo sapiens* is taken to have special normative significance. The first, is that it defines a moral community for human beings or delineates individuals with a distinctive moral status. The second, is that human nature itself provides justification for or against altering it. Both these views are prominent in the discourse on human

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enhancement. Moreover, the first view, because it concerns the moral status of humans and nonhumans, has wide-ranging implications for issues in environmental ethics and bioethics. I consider several versions of the view that *Homo sapiens* delineates a special moral community or individuals with special moral standing. I argue that each one fails. In the course of doing so, I defend a capacities-based account of moral status on which an individual's moral status is determined by his or her capacities and relationships, and not how he or she is grouped biologically. I also argue that human nature cannot provide justification either for or against human enhancement, since it is not normative in the requisite ways. Therefore, I conclude that there is no special normativity to the species category or boundaries of *Homo sapiens*. As with nonhuman transgenics, there is nothing intrinsically, objectively wrong with creating part-human individuals. Whether to proceed with a particular transgenic or human enhancement research program or application depends primarily on extrinsic considerations – for example, those to do with compassion, prudence, and justice – and, to a lesser extent and only in some cases, on subjective final values.

Some engineered organisms may not fall even partially into preexisting species categories. This might be because they are not created from biological materials or because they are so thoroughly recombined and reengineered that they constitute a novel species. Such organisms would not be interspecific, so they could not be described as mixing species or charged with failure to respect species boundaries. Instead, they would constitute artificially selected, *de novo* species – or artifactual organisms and species. Chapter 8 concerns whether the artifactualness of such organisms and species has any (noninstrumental) value or normative significance. I argue that artifactualness is relevant to some forms of subjective final value, but that this is not a basis for opposing or prohibiting creation and use of them. I also argue that artifactualness is not relevant to the sort of objective final value possessed by individual organisms. The implication of these arguments is that creating novel organisms and species does not raise any unique intrinsic ethical concerns, and, just as was the case with transgenics and human enhancement, evaluation of them and public policy regarding them should focus primarily on extrinsic considerations.

In the Conclusion, I restate the main theoretical conclusions reached in this book regarding the value of species and the ethical significance of species boundaries, as well as their implications for the applied topics addressed throughout the book. I also put these conclusions in context by briefly indicating aspects of the applied topics that are incompletely addressed (or not addressed at all) in the book, such as the ethical dimensions of risk assessment and public engagement in policy making. The topics addressed here are central to an ethic of species, but they are not nearly the whole of it.