In the Anthropocene: Adaptive Law, Ecological Health, and Biotechnologies

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Abstract

Climate change has induced an ecological crisis necessitating reconsideration of how the law should manage human interactions with ecological systems. In most Western domestic and international legal regimes, conservation policy has principally sought to advance historical or natural preservation or sustained yield objectives, while many laws governing biotechnologies focus on minimizing exposure to 'natural' systems. These laws essentially aim to cordon off nature from humanity, whether to exploit, promote nonintervention, or resist change. Meanwhile, Western public processes are largely built on a legal framework that assumes comprehensive rationality at the front end of decision-making. Lastly, prevailing public conservation governance is fragmented, save the limited attempts to consolidate or coordinate decentralized, independent, and/or overlapping authority.

The increasingly convulsive effects of climate change and developments in biotechnology, however, bring to stark relief the limitations of prevailing Western public

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conservation goals, processes, and institutional design. First, promoting biodiversity may require fundamental changes in management to focus on increasing ecological health and other values than consumption, historical fidelity, and nonintervention. Second, integration of adaptive and inclusive processes is imperative for promoting both effective management strategies and learning in the face of unprecedented change. Third, policymakers must appreciate the tradeoffs of allocating authority across the array of institutional structures, and tailor not only the scale of interventions but also the extent of overlap and coordination of authority.

Keywords: Governance, Conservation, Anthropocene, Climate change, Biotechnology

1. Introduction

In 'Law, Innovation and Technology: Fast Forward to 2021,' the editors of this journal identified the fundamental imperative for scholars and policymakers to consider how law, technology, and innovation might offer constructive responses to the daunting challenges levied by the Anthropocene.[1] The present article takes up the editors call, arguing that conventional conservation governance as it has emerged over the past century has been disrupted in significant part by technological developments. It argues that the advancement of ecological health, promotion of adaptive and participatory decision-making, and better integration of empiricism and experimentalism into institutional design will be key to effective governance in the Anthropocene.

As is well-known, global climate change, in concert with other anthropogenic forces such as pollution, development, overconsumption, and population growth, has induced an ecological

[1] Roger Brownsword & Han Somsen (2021) Law, innovation and technology: fast forward to 2021, Law, Innovation and Technology, 13:1, 1-28, DOI:10.1080/17579961.2021.1898298.

crisis that likely necessitates a reconsideration of, among other things, how the law manages human interactions with ecological systems.[2] Though Western domestic and international conservation legal regimes[3] have remained fundamentally unchanged from their twentieth century foundations, they have become characterized by at least three fundamental disruptions at the dawn of the Anthropocene. First, the nature/human and native/nonnative dualisms that have pervaded Western conservation management since its incipience are no longer as productive or perhaps even tenable.[4] Second, ecological and technological change continue to accelerate, often in unforeseen ways, with stability (and linear change) no longer the default.[5] Third, a

[2] Barbara Cosens and others, 'Governing Complexity: Integrating Science, Governance, and Law to Manage Accelerating Change in the Globalized Commons' (2021) 118(36) Proc Natl Acad Sci e2102798118.

[3] This essay critiques the legal adaptive capacity of prevailing Western conservation law and policy, in particular the codified law and institutions in the United States, Europe, and Commonwealth jurisdictions, as well as public international law. Especially in light of its brevity, the essay certainly is not a comprehensive review of conservation law and policy in every jurisdiction. Hopefully it can serve, however, as a template for future scholarship that more comprehensively interrogates the legal adaptive capacities of conservation governance in jurisdictions at various scales, in the Global North and South, including under Indigenous law and management regimes.

[4] Alejandro E Camacho, 'Going the Way of the Dodo: De-extinction, Dualisms, and Reframing Conservation' (2015) 92 Wash U L Rev 849, 852, 855 ('Going the Way of the Dodo').

[5] Cosens and others (n 2).

local/global division in governance has become less salient in view of the complexity of earth's systems, as the desirability to manage ecological resources through fragmented governance becomes increasingly problematic—and the opportunities for tailoring overlapping and/or coordinated governance become more apparent.[6]

These features, increasingly accelerated by global climate change and burgeoning efforts in biotechnology, raise fundamental questions concerning how, or even if, existing legal (1) goals, (2) processes, and (3) institutions can effectively serve to protect and cultivate ecosystems and ecological resources.[7] First, the essential meaning of 'conservation,' and how this characterization is ethically operationalized as a ***goal*** in the law, is called into question. At virtually every scale of governance,[8] Western conservation policies have principally sought to advance either what might be dubbed 'historical preservation' (keeping or restoring nature to a historical baseline), 'natural preservation' (keeping humans out of nature or at most allowing

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[6] Alejandro E Camacho, 'Adapting Governance to Climate Change: Managing Uncertainty Through a Learning Infrastructure' (2009) 59 Emory L J 1 ('Adapting Governance to Climate Change').

[7] Will Steffen and others, 'The Trajectory of the Anthropocene: The Great Acceleration' (2015) 2 Anthropocene Rev 81.

[8] E.g., Convention on the Conservation of European Wildlife and Natural Habitats [1982] OJ L38/3; Art. 191, European Union, Treaty on the Functioning of the European Union; U.S. Wilderness Act of 1964, 16 U.S.C. § 1131 et seq.; New Zealand Hazardous Substances and New Organisms Act 1996, §§ 34, 38; Ill. Admin. Code tit. 17, § 870.10(a)-(b) (2020).

only passive management), and/or 'sustained yield' (maximizing long-term resource production).[9] In a conception of the environment as relatively stable and undisturbed, each of these interpretations of 'conservation' might be plausibly understood as rough surrogates for what I argue is the more imperative, though nonetheless elusive, goal—the promotion of ecological health, whether tethered more to some manifestation of biodiversity and/or some notion of ecological productivity.[10]

As such, Western public lands, endangered species, and invasive species laws have codified historical preservation, natural preservation, and/or sustained yield objectives.[11] Perhaps unintentionally, rules and policies that manage human-dominated areas (e.g., urban or agriculture lands) also have served to reinforce some of these goals by treating such areas as entirely different and apart from 'natural' ones.[12] Similarly, emerging conservation laws governing biotechnologies[13] often have focused on minimizing exposure of such technologies on 'natural'

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[9] Alejandro E Camacho, 'De- and Re-constructing Public Governance for Biodiversity Conservation,' (2020) 73 Vand L Rev 1585, 1601-05.

[10] Ibid 1601, 1603.

[11] Ibid 1596-1607.

[12] Alejandro E Camacho, 'Transforming the Means and Ends of Natural Resource Management' (2011) 89 NC L Rev 1405, 1441-43.

[13] Though the development and use of biotechnologies undoubtedly implicate other legal regimes such as patent, property, and food and drug law, this essay focuses on the implications for their use for public conservation.

systems.[14] In short, these legal frameworks aim to cordon off nature—whether simply for exploitation, to promote nonintervention, or to resist change.

Second, a substantial adaptive management and governance literature has detailed how Western public ***processes*** have been designed primarily based on a public administrative law framework emphasizing expert decision making that generally assumes the capacity for comprehensive rationality[15] at the 'front end' of regulatory and management processes, with limited attention to adapting decisions over time.[16] Third, public institutions established to manage disparate ecological resources are for the most part characterized by fragmented governance authority.[17] In designing such ***structural*** governance, policymakers have conventionally focused largely on setting the appropriate scale of government for each resource

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[14] E.g., Coordinated Framework for the Regulation of Biotechnology in the United States, 51 Fed. Reg. 23,302 (1986); Cartagena Protocol on Biosafety to the Convention on Biological Diversity, 2000.

[15] JB Ruhl & Robin Craig, 'Designing Administrative Law for Adaptive Management' (2014) 67 Vand L Rev 1, 4-5.

[16] Robert L Glicksman & Sidney A Shapiro, *Risk Regulation at Risk: Restoring A Pragmatic Approach* (Stanford University Press 2003).

[17] Robin Kundis Craig, '"Stationarity Is Dead"–Long Live Transformation: Five Principles for Climate Change Adaptation Law,' 34 Harv Envtl L Rev 9 (2010); Erica Lyman, 'Rethinking International Environmental Linkages: A Functional Cohesion Agenda for Species Conservation in a Time of Climate Change' (2015) 27 Fordham Envtl L Rev 1, 10.

problem, with a few more recent but still modest attempts at consolidating or coordinating decentralized, independent, and/or overlapping authority.[18]

The increasingly convulsive effects of global anthropogenic climate change and recent developments in biotechnology, however, bring to stark relief the limitations of these prevailing public conservation goals, processes, and institutional design. Determining the relative value and priority of potentially inconsistent ecological resources and services for a particular area will be even more fundamental; the roles of expertise and public participation will need to evolve; institutions and governance itself will need to be more adaptive.

First, climate change pits historical preservation laws focused on promoting historical fidelity and natural preservation laws emphasizing nonintervention against one another.[19] It also makes historical conservation, natural preservation, and sustained yield goals increasingly costly; difficult, if not unattainable; and misguided, if one cares about advancing some notion of long-term biodiversity or ecological function.[20] Though any operationalization of ecological health in the context of widespread human manipulation of non-human systems is undoubtedly contestable, it is also clear that any version of it would be in tension with the historical conservation, natural preservation, and sustained yield goals embedded in extant conservation

[18] Alejandro E Camacho & Robert L Glicksman, 'Designing Regulation Across Organizations: Assessing the Functions and Dimensions of Governance' (2021) 15 Reg & Governance S102, S105.

[19] Camacho, 'Transforming the Means and Ends of Natural Resource Management' (n 12) 1435-36.

[20] Ibid 1431-35.

laws across the globe. Any desire to promote ecological health may require fundamental changes in legal and management strategies, including movement away from conventional, preservation-based, single-species, and passive approaches to conservation.[21]

Emerging biotechnologies begin to suggest a range of human interventions in ecosystems that may increase ecological function or fitness—but may raise notable risks as well. *Gene editing* technologies provide the potential for altering DNA.[22] Recent breakthroughs substantially simplify gene editing[23] and may make possible a range of active conservation strategies that make biota more adaptable, fill vacated ecological niches, clean up degraded lands,[24] or increase the resilience of rare or endangered species.[25] *Gene drives* use self-replicated genetic elements to control 'natural' populations. Such mutations would propagate through biota at a more rapid

[21] Jan McDonald and others, 'Adaptation Pathways for Conservation Law and Policy' (2018) 10 WIRES Climate Change 1, 4-7.

[22] Genetics Home Reference, NIH, 'What are genome editing and CRISPR-Cas9?' (Aug 17, 2020) <https://ghr.nlm.nih.gov/primer/genomicresearch/genomeediting> accessed 10 September 2022.

[23] Arthur L Caplan and others, 'No Time to Waste – The Ethical Challenge Created by CRISPR' (2015) 16 EMBO Reports 1421.

[24] R Alta Charo & Henry T Greely, 'CRISPR Critters and CRISPR Cracks' (2015) 15 American J of Bioethics 11.

[25] International Union for Conservation of Nature (IUCN), *Genetic Frontiers for Conservation* 79 (eds Kent H Redford, Thomas M Brooks, Nicholas BW Macfarlane, Jonathan S Adams, 2019).

pace than conventional inheritance because of molecular-level snipping tools that help to ensure inheritance.[26] Gene drives have been proposed to abate disease vectors such as mosquitoes and could potentially be used to curb the effects of harmful invasive alien species.[27] Some even suggest that *robotics* may be used to replace key species within ecosystems, such as using drone-type robots as pollinators as biotic populations decline.[28] These and other emerging technologies might provide opportunities to arrest if not reverse ecological damage, but they also might serve to exacerbate such harms. Yet many conservation laws, particularly those focused on historical preservation and natural preservation, do not link the permissibility of such interventions to when the risks are minimized and benefits maximized.

Beyond the substantive goals and strategies of conservation, both ecological change and biotechnological advances also illustrate the limited efficacy of most Western public institutions and processes at managing complex, wicked problems.[29] Integration of adaptive and responsive processes is imperative for promoting institutional learning and regulatory adaptation in the face of unprecedented change.[30] And while scientific expertise will be critical in assessing and reducing uncertainty about ecological conditions, potential strategies, and ecological value, a

[26] The Synthetic Biology Project, *Creating a Research Agenda for the Ecological Implications of Synthetic Biology* 9 (2014).

[27] IUCN (n 25) 68.

[28] Svetlana A Chechetka and others, 'Materially Engineered Artificial Pollinators' (2017) 2 CHEM 224.

[29] Camacho, 'De- and Re-constructing Public Governance for Biodiversity Conservation' (n 9) 1624-26.

core emphasis of conservation governance must be the integration of robust and meaningful participation on what are ultimately normative tradeoffs.[31]

Finally, greater recognition of the advantages and disadvantages of allocating institutional authority across the vast array of different institutional structures is vital for managing potential human interventions for coping with ecological change. Indeed, structural conservation governance includes (but is more than) a choice along the spectrum of local to global; it also involves choices about the extent of overlap in authority, as well as the extent and type of coordination. Policymakers and scholars must consider the tradeoffs of these different dimensions of authority and integrate assessment of and experimentation with different structural configurations into the governance process itself. Yet to date, Western conservation law has remained largely unchanged in its substantive, procedural, and structural dimensions.

This essay explores dysfunctionalities in Western conservation law and governance architectures starkly illuminated by rapid ecological and technological change. It then briefly offers a new vision for promoting conservation in the Anthropocene that is cognizant of human capacities to both harm and improve our environment. In Part II, this paper canvasses the prevailing preservationist objectives and strategies, fragmented structures, and static processes

[30] Cosens and others (n 2); Holly Doremus and others, 'Making Good Use of Adaptive Management' (2011) Center for Progressive Reform White Paper No. 1104 < https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1808106> accessed 13 September 2022.

[31] Donald Waller, *Getting Back to the Right Nature: A Reply to Cronon's "The Trouble with Wilderness," in* THE GREAT NEW WILDERNESS DEBATE 540, 563 (J. Baird Callicott & Michael P. Nelson eds., 1998).

adopted for promoting conservation or use of ecological resources. Part III then explores how climate change and emerging biotechnologies destabilize prevailing conservation governance, with Part IV detailing the effects of such stressors on substantive, structural, and procedural legal adaptive capacity. Part V then briefly offers several considerations needed for policymakers to begin to shift, if not transform, the goals, processes, and structures of conservation law to better manage increasingly dynamic ecosystems and their relationship with a progressively influential humanity.

2. Existing Laws Governing Ecological Conservation and Biotechnology

As detailed in this Part, a broad range of strategies, institutions, and processes developed in the twentieth century to regulate and promote resource conservation at various local, provincial, national, and international governance scales. Western laws governing ecological conservation and biotechnology continue to reflect conventional twentieth century approaches to public law and administration. First, conservation policy *goals and strategies* in most Western jurisdictions emphasize barricade pristine nature from humanity, restoring or maintaining historical conditions, and/or maximizing resource production.[32] Second, governance *structures* have conventionally been focused primarily on issues of scale for each pollution or resource problem.[33] Third, Western governance *processes* largely are based on a public administrative law framework that assumes the capacity for comprehensive rationality.[34]

2.1. Substantive Goals and Strategies

[32] Camacho, 'De- and Re-constructing Public Governance for Biodiversity Conservation' (n 9) 1601-05.

[33] Erin Ryan, *Federalism and the Tug of War Within* (Oxford University Press 2011).

Western laws and institutions managing and regulating ecosystems and biodiversity have relied on a suite of regulatory strategies premised on one or more of several baseline assumptions, if not goals. As detailed in the following subsections, they have alternatively or concurrently focused on (1) promoting *historical* preservation—keeping or restoring nature to a historical baseline; (2) advancing *natural preservation*—keeping humans out of nature, and (3) *sustained yield*—maximizing resource production. Even those that have stressed the protection or promotion of biodiversity have relied on one or more of these objectives.

2.1.1. Historical preservation

One of the most common foci for Western conservation laws has been on historical preservation.[35] These types of laws aim to maintain historical fidelity. In this sense, historical preservation resembles restoration ecology, which customarily has sought to restore disturbed ecosystems to a past baseline.[36] Though maintaining or restoring ecological health may be an ancillary benefit of this objective, the central goal is to tether conservation to pre-existing conditions.[37]

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[34] Han Somsen, 'The End of European Union Environmental Law: an environmental program for the Anthropocene', in Louis J Kotzé, *Environmental Law and Governance for the Anthropocene* (Bloomsbury Publishing 2017) 357.

[35] E.g., Camacho, 'Transforming the Means and Ends of Natural Resource Management' (n 12) 1407.

[36] E.g., Richard J Hobbs and others, 'Restoration Ecology: The Challenge of Social Values and Expectations' (2004) 2 Frontiers Ecology & Env't 43, 43.

Reserved lands regimes, for example, frequently rely on historical preservation. Such regimes are still by far the prevailing global conservation strategy,[38] regularly formed at their outset after displacing indigenous communities.[39] Australia's National Reserve System is primarily focused on maintaining pre-existing conditions in fixed protected areas,[40] as is also the case in the European Union (EU).[41] In the United States, the prime example of this is the National Park Service Organic Act, which aims 'to conserve the scenery and the natural and

[37] Somsen (n 34) 353, 357 (explaining how EU environmental law focuses on preserving, protecting, and/or improving the environment to status quo ex ante levels).

[38] CR Margules & RL Pressey, 'Systematic Conservation Planning' (2000) 405 Nature 243, 243; Frank J Rahel, Britta Bierwagen & Yoshinori Taniguchi, 'Managing Aquatic Species of Conservation Concern in the Face of Climate Change and Invasive Species' (2008) 22 Conservation Biology 551, 552.

[39] E.g., Nelson, J. & Hossack, L., Eds. (2003). *From Principles to Practice: Indigenous Peoples and Protected Areas in Africa.*

[40] Jan McDonald and others, 'Adaptation Pathways for Conservation Law and Policy' (2018) 10 *WIRES Climate Change* 1, 2.

[41] Somsen (n 37) 357; Arie Trouwborst, 'The Habitats Directive and Climate Change: Is the Law Climate Proof?' in C. Born and others, eds., *The Habitats Directive in its EU Environmental Law Context: European Nature's Best Hope?* (Routledge 2014) 303 (stating the leading paradigm for the Directive 'has been to maintain or restore the *status quo* rather than facilitating change'). The United Kingdom has unveiled a recent governmental program to restore 300,000 hectares of habitat across England to support climate recovery. Department for Environment, Food & Rural

historic objects and the wild life therein' (emphasis added).[42] This means administrators 'cannot approve an action if it could lead to the impairment of any preexisting resources or values of a national park.'[43] The United States' wildlife reserve land regime[44] also has been construed to emphasize historical preservation, though the authorizing statute could be interpreted to allow a broader notion of ecological integrity.[45] It is notable that though the historical baseline used for such management in the United States is typically pre-European settlement, existing management does not fully integrate ownership or management of such lands by indigenous communities.[46]

Affairs and others, 'Press Release: Government unveils plans to restore 300,000 hectares of habitat across England' (2022) < https://www.gov.uk/government/news/government-unveils-plans-to-restore-300000-hectares-of-habitat-across-england> accessed 12 September 2022.

[42] 16 U.S.C. § 1.

[43] Camacho, 'Going the Way of the Dodo' (n 4) 878 n. 145.

[44] National Wildlife Refuge System Improvement Act, 16 U.S.C. §§ 668dd to 668ee.

[45] Robert L. Fischman, 'The Meanings of Biological Integrity, Diversity, and Environmental Health,' 44 Nat Res J 989, 992, 1025 (2004); Alejandro E Camacho & Robert L. Glicksman, 'Legal Adaptive Capacity: How Program Goals and Processes Shape Federal Land Adaptation to Climate Change' (2016) 87 U Colo L Rev 711, 774-81 ('Legal Adaptive Capacity').

[46] R Keller & M Turek (University of Arizona 1998) *American Indians and National Parks* (detailing more recent increased commitment to cross-cultural integrity and cooperation, after appropriation and decades of neglect of tribal law and needs).

Yet more subtle versions of historical preservation pervade conventional Western conservation laws. Endangered species laws in Europe and Australia are premised on historical preservation.[47] In the same way, the US Endangered Species Act (US ESA) in part emphasizes historical preservation, defining species as endangered and thus subject to protection based largely on the species' historical range.[48] It also largely allows the maintenance or introduction of a species only where the species existed historically.[49]

Wildlife management laws routinely stress maintenance or restoration of preexisting native species and/or the removal or minimization of non-native species. For instance, the EU's Natura 2000 and Habitats Directive in Annex II set forth the protection of species native to member states.[50] The EU's Birds Directive requires member states to ensure that 'any

[47] See McDonald and others (n 40) 2 (stating Australian and European law defines its goals of endangered species recovery by historical baselines).

[48] Camacho, 'Going the Way of the Dodo' (n 4) 878-79.

[49] 50 C.F.R. § 17.81(a) (2013). The US Fish and Wildlife Services promulgated regulations allowing the introduction of 'non-native' populations outside a species' natural range but emphasized that 'non-native introductions should be exceptionally rare.' The agency noted that federal invasive species laws prohibit the introduction of foreign or exotic species into 'natural' ecosystems. Camacho, 'Going the Way of the Dodo' (n 4) 874.

[50] Council Directive on the Conservation of Natural Habitats and Wild Fauna and Flora, 92/43/EEC O.J. (L 206/7), art 4 (21 May 1992).

introduction of species of bird which do not occur naturally in the wild state in the European territory of the Member States does not prejudice the local flora and fauna.'[51]

Similarly, invasive species management laws often institute a restrictive process for importation,[52] sale,[53] and/or release[54] of non-native species.[55] The United Kingdom, for instance, requires a permit to release non-native species (including into enclosures),[56] and Australia's Biosecurity Act controls and regulates the entry and movement of certain non-native species.[57] Many such regimes promulgate 'blacklists' of restricted species or 'whitelists' that restrict any species not listed.[58] The Ontario Invasive Species Act in Canada, for example, classifies listed

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[51] Council Directive on the Conservation of Wild Birds, 79/409/EEC, art. 11, O.J. (L103/1) (2 Apr. 1979).

[52] E.g., Alaska Stat § 16.05.921 (2020).

[53] E.g., Natural Environment and Rural Communities Act 2006, s 50.

[54] E.g., Cal Fish & Game Code § 3515 (2020).

[55] E.g., Ill Admin Code tit 17, § 870.10(a)-(b) (2020).

[56] Natural England, 'Non-native (alien) species licences' (2019) < https://www.gov.uk/government/collections/invasive-non-native-alien-species-licences> accessed 13 September 2022.

[57] Biosecurity Act 2015 (2015) <https://www.legislation.gov.au/Details/C2020C00127> accessed 13 September 2022.

[58] Alejandro E Camacho, 'Assisted Migration: Redefining Nature and Natural Resource Law Under Climate Change' (2010) 27 Yale J on Reg 171, 181-83.

invasive species as either prohibited or restricted.[59] The intent of these laws is often clear: to maintain conditions by (1) strictly limiting (if not barring) species not present before some pre-determined baseline,[60] and (2) protecting or restoring those that were present.[61] A clear commitment to historical preservation is particularly exemplified by those invasive species laws that deem a species to *never* be invasive (and therefore restricted) if it is native, regardless of the economic, ecological, or other harm caused by such a species.[62]

2.1.2. Natural preservation

A less common but nonetheless persistent focus of some Western resources laws and provisions has historically been on natural preservation: the resistance to, if not prohibition of, human intervention in ecological systems.[63] This class of conservation laws focuses on management or regulation that restricts, if not prevents, human intervention, manipulation, or

[59] Invasive Species Act. 2015. S.O. 2015, c. 22 – Bill 37 <https://www.ontario.ca/laws/statute/s15022> accessed 1 October 2022.

[60] Christine Willmore, 'Native good, non-native bad? Defining troublesome species' (2015) 17 Envtl L Rev 117, 123.

[61] E.g., Convention on the Conservation of European Wildlife and Natural Habitats [1982] OJ L38/3 (committing parties to controlling the introduction of non-native species; New Zealand Hazardous Substances and New Organisms Act 1996, §§ 34, 38. See also Willmore (n 60) 119, 126 (describing Scottish invasive species law as prohibiting release of non-native species even without evidence of harm).

[62] E.g., UN Convention on Biological Diversity, UNEP, CDB, COP, 06/20 at 257 (requiring prevention and eradication only of invasive *alien* species).

control of ecological phenomena. Though cordoning off such areas may be understood as having some ecological benefit, the fundamental goal is to protect such lands from human interference.

2.1.2.1. Natural preservation in conservation laws

The paradigmatic example that reinforces this human/nature dualism is wilderness. The International Union for Conservation of Nature classifies wilderness as those 'usually large unmodified or slightly modified areas, retaining their natural character and influence, without permanent or significant human habitation, protected and managed to preserve their natural condition.'[64] The US Wilderness Act of 1967 seeks to keep large swaths of land 'untrammeled, . . . retaining its primeval character and influence, without permanent improvements of human habitation, which is protected and managed so as to preserve its natural condition.'[65] This is despite the fact that many such wilderness areas in the United States overlap lands owned, claimed and previously managed by indigenous peoples.[66] In Australia, some authorities similarly seek to promote the 'natural, primitive, and remote character of wilderness areas.'[67] Likewise, the EU's Natura 2000 network includes a few sites geared toward wilderness

[63] E.g., Camacho, 'De- and Re-constructing Public Governance for Biodiversity Conservation' (n 9) 1603.

[64] Nigel Dudley (ed), *Guidelines for Applying Protected Area Management Categories* (IUCN 2013) 14.

[65] 16 U.S.C. § 1131 et seq.

[66] Keller & Turek (n 46).

[67] Threatened Species Protection Act 1995, § 3 (2019). See also Jan McDonald and others, 'Rethinking legal objectives for climate-adaptive conservation' (2016) 21 Ecology & Society 25,

protection,[68] and a number of EU member states have enacted legislation focusing on naturalness as key for protected areas.[69] 'No take' marine reserves also include as a central objective minimizing human intervention or disturbance, though they may also be focused on restoration.[70]

Though few other laws may make natural preservation as expressly fundamental an objective as for wilderness conservation, many Western legal provisions nonetheless emphasize protection of (or preference for) wild biota, or restrictions on (or aversion toward) either the artificial or human action. For instance, though primarily focused on historical preservation, the US ESA nonetheless also stresses natural preservation in several provisions. Throughout the statute, biota that is managed or manipulated by humans is subject to less protections or conservation measures than those deemed 'wild' or 'natural'.[71] And some observers actually

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4; Martin Hawes, Roger Ling & Grant Dixon 'Assessing Wilderness Values: The Tasmanian Wilderness World Heritage Area, Australia' (2015) 21 International J of Wilderness 3.

[68] European Commission, *Guidelines on Wilderness in Natura 2000: Guidance on the Management of Wilderness and Wild Areas in Natura 2000* (2013) 6-7. See also ibid 10 (defining wilderness as an area governed by 'natural processes').

[69] Ibid 15-16 (describing member state legislation conserving protected areas unaffected by direct human activity (Estonia), untouched or nearly natural (Latvia) or naturally preserved geotopes and habitats where natural processes take place without human influence (Slovenia)).

[70] Enric Sala & Sylvaine Giakoumi, 'No-take marine reserves are the most effective protected areas in the ocean' (2018) 75 J Marine Sci 1166, 1166.

[71] E.g., Camacho, 'Going the Way of the Dodo' (n 4) 871-73.

suggest that the law is not (or should not be) applicable to human-made species.[72] Similarly, the Threatened Species Protection Act in Tasmania promotes protection of natural species in the wild.[73] The UN Convention on Biological Diversity promotes 'the protection of . . . *natural* habitats and . . . viable populations of species in *natural* surroundings.'[74] The EU's Habitats Directive and Birds Directive likewise emphasize protection of species in their 'natural habitats' and 'natural range.'[75]

Countless Western invasive species management laws also underscore this dichotomy between natural and artificial—some instead of, while others in addition to, historical preservation. Though allowing if not promoting the persistence of pre-existing wild species, most invasive species provisions adopt the regulatory strategy of prohibiting or restricting the human introduction of biota in areas, whether intentional or accidental.[76] The UN Convention on Biological Diversity's (CBD) Guiding Principles, for example, define an alien species as 'a species, subspecies or lower taxon, introduced outside its *natural* past or present distribution.'[77]

[72] Norman F Carlin Ilan Wurman & Tamara Zakim, 'How to Permit Your Mammoth: Some Legal Implications of "De-Extinction"' (2013) 33 Stan Envtl LJ 3, 22.

[73] Threatened Species Protection Act 1995, § 3 (2019). See also McDonald and others (n 67) 6.

[74] Convention on Biological Diversity art. 8, June 5, 1992, 1760 U.N.T.S. 79, 143, 148-49.

[75] Council Directive 92/43/EEC O.J. (L 206/7), art 1-4 (21 May 1992).

[76] E.g., National Invasive Species Act of 1996, 16 U.S.C. § 4701.

[77] Conference of the Parties to the Convention on Biological Diversity, Sixth Meeting, The Hague, Neth., April 7-19, 2002, Report of the Sixth Meeting of the Conference of the Parties to the Convention on Biological Diversity, Guiding Principles for the Prevention, Introduction and

Laws such as the Convention on the Conservation of Migratory Species of Wild Animals tend to rely on nonintervention in defining terms like species habitat or range.[78] Key to these provisions is the promotion of, or at least acquiescence to, whatever is deemed natural, as well as distinguishing, restricting, and/or prohibiting human intervention in ecological systems.[79]

2.1.2.2. Natural preservation in laws regulating biotechnology

Some resource laws governing research on and deployment of biotechnologies also reinforce the natural/human distinction of natural preservation, focusing largely on preventing or minimizing exposure of 'natural' ecological systems to such emerging technologies. The US Coordinated Framework, for example, fundamentally seeks to actively promote the proliferation of biotechnology products in the human domain—the built environment, agriculture, medicine, and the market economy.[80] Even though it rejects a distinction between natural and human-engineered products,[81] it nonetheless is designed to focus risk management for engineered products on preventing or minimizing exposure of 'natural' ecological systems to such emerging technologies. The Cartagena Protocol to the CBD similarly is oriented primarily toward

Mitigation of Impacts of Alien Species that Threaten Ecosystems, Habitats or Species, (Sept. 23, 2002) U.N. Doc. UNEP/CBD/COP/6/20, 257.

[78] Sophie Riley, 'A Weed by any Other Name: Would the Rose Smell as Sweet if it Were a Threat to Biodiversity?' (2009) 22 Geo Int'l Envtl L Rev 157, 171.

[79] Willmore (n 60) 123.

[80] Coordinated Framework for the Regulation of Biotechnology in the United States, 51 Fed. Reg. 23,302 (1986).

[81] Camacho, 'Going the Way of the Dodo' (n 4) 901.

minimizing exposure of 'natural' ecosystems to biotechnology.[82] As a result, these various legal frameworks have sought to divide ''natural' from human-created phenomena.

2.1.3. Sustained yield

A third recurring objective of Western resource laws focuses on sustained yield, i.e., maximizing the sustained production of certain favored or desirable species. Akin to similar goals in agricultural production, many fish and wildlife programs throughout the world have adopted sustained yield as a central goal.[83] The EU, under the Common Fisheries Policy, manages fisheries around its borders to sustain maximum yield for long-term economic sustainability.[84] The US Magnuson-Stevens Act similarly has dual purposes of conserving and managing 'fishery resources found off the coasts of the United States,'[85] and promoting

[82] Cartagena Protocol on Biosafety to the Convention on Biological Diversity (2000).

[83] E.g., Julie Lurman Joly, 'National Wildlife Refuges and Intensive Management in Alaska: Another Case for Preemption' (2010) 27 Alaska L Rev 27, 29 ('Alaska's fish and wildlife management program, like most state wildlife programs, is geared toward providing hunting opportunities . . . . The intention of the program is to maintain a "sustained yield," which the statute defines as 'the achievement and maintenance in perpetuity of the ability to support a high level of human harvest of game, subject to preferences among beneficial uses, on an annual or periodic basis."').

[84] Art. 2, sec. 1, European Union, Common Fisheries Policy, No. 1380/2013; European Union, OCEANA, Reasons to Achieve and Move Beyond Maximum Sustained Yield (Apr. 14, 2012).

[85] 16 U.S.C. § 1801 (b)(1).

'domestic commercial and recreational fishing.'[86] Some public lands such as forestlands or game refugia have also similarly been founded with a goal of maximizing yield.[87] Finland's Forest Act, for instance, emphasizes 'a sustainable satisfactory yield while . . . biological diversity is being maintained.'[88]

By design, these laws are principally driven by consumptive uses, such as timber harvesting, grazing, and mineral development, and not long-term ecological health.[89] As such, sustained yield laws usually do not primarily seek promotion of overall biodiversity but rather narrowly concentrate on maximizing the continued economic productivity of one or a few resources or uses.[90]

2.2. Procedural Governance

[86] Ibid §1801 (b)(3).

[87] U.S. Multiple Use and Sustained Yield Act, 16 U.S.C. § 528–31.

[88] Forest Act 1093/1996 ch. 1, § 1.

[89] E.g., *Sierra Club v. Morton*, (1972) 405 U.S. 727, 748 (Douglas, J., dissenting) (stating that the U.S. Forest Service 'has been notorious for its alignment with lumber companies'); Kelly Nolen, 'Residents at Risk: Wildlife and the Bureau of Land Management's Planning Process' (1996) 26 Env't L. 771, 776 (describing why certain agencies have given greater weight to grazing and mining industries).

[90] E.g., Kai T Kokko, 'A Legal Method and Tools for Evaluating the Effectiveness of Regulation: Safeguarding Forest Biodiversity in Finland' (2009) Nordic Envtl L J 57, 60 (arguing that economic factors are the main drivers behind the 'sustainable or unsustainable' use of forests in Finland).

As amply detailed by administrative law scholars, public agencies manage and implement conservation law in most Western legal contexts by applying administrative processes and management primarily focused on front-end planning and regulation. A substantial literature has documented how conventional administrative procedures such as notice-and-comment rulemaking or permitting[91] that emerged over the twentieth century are not especially designed to manage uncertainty or reduce mistakes.[92] For decades, scholars have raised concerns regarding the rigidity of Western conservation management,[93] how inertia limited the capacity of institutions to respond to new or unnoticed variables in a timely manner.[94]

[91] E.g., United States Administrative Procedure Act, 5 U.S.C. §§ 551-559; ibid §§ 551(5), 551(7) 701-706.

[92] E.g., C.R. Allen and others, 'Adaptive Management for a Turbulent Future', (2011) 92 J. Env't Mgmt. 1339, 1343; Eric Biber & J.B. Ruhl, 'The Permit Power Revisited: The Theory and Practice of Regulatory Permits in the Administrative State' (2014) 64 Duke LJ 133, 205. See also, Glen Wright, 'Regulating Marine Renewable Energy Development: A Preliminary Assessment of UK Permitting Processes' (2014) 32 Underwater Technology 39, 42 (highlighting issues in the United Kingdom with large-scale permitting processes leading to 'undesirable level of uncertainty relative to the large level of investment required').

[93] E.g., Int'l Inst. For Applied Sys. Analysis, Adaptive Environmental Assessment and Management (C.S. Holling ed., 1978).

[94] Lance H. Gunderson and others, 'Escaping a Rigidity Trap: Governance and Adaptive Capacity to Climate Change in the Everglades Social Ecological System,' 51 Idaho L. Rev. 127 (2019).

Instead, these processes largely are based on assumptions that regulators and managers can and should focus most of their attention and resources on their initial decision, rarely revisiting them to account for new information or changes in circumstances.[95] Administrative agencies are encouraged, and even designed, to make most decisions based on information submitted by applicants who may not have the same conservation goals in mind as those committed to the agency.[96] Monitoring is often required but under-funded or otherwise neglected.[97]

2.3. Structural Allocation of Authority

The allocation of public authority to advance the goals and processes of conservation law is crucial to governance effectiveness.[98] To date, public authority over ecological resources in

[95] Craig & Ruhl (n 15) 4-5.

[96] Alejandro E. Camacho, 'Can Regulation Evolve? Lessons from a Study in Maladaptive Management' (2007) 55 UCLA L Rev 293, 324-26 ('Can Regulation Evolve?'). For instance, it is common in environmental impact assessment laws for the initial generation and analysis of such effects to be prepared by private project applicants and consultants. Eva Hansen & Graham Wood, 'Understanding EIA scoping in practice: A pragmatist interpretation of effectiveness' (2016) 58 Environmental Impact Assessment Review, 1-11.

[97] E.g., Eric Biber, 'The Problem of Environmental Monitoring' (2011) 83 U Colo L Rev 1, 34–52; Mgmt Sys Int'l, *An Independent Evaluation of the Effectiveness of the U.S. Fish and Wildlife Service's National Wildlife Refuge System* (2008) 20.

[98] Alejandro E Camacho & Robert L Glicksman, *Reorganizing Government: A Functional and Dimensional Framework* (NYU Press 2019).

most Western jurisdictions has primarily been structured to address the effects of conventional stressors like direct human consumption and development through initially decentralized authority. Limited purpose, often overlapping, centralized institutions eventually have been added to address certain inadequacies of decentralized governance. Yet today, as detailed below, existing authority over resources in most Western jurisdictions remains largely decentralized, with some overlap and only limited coordination over a few governmental functions.

2.3.1. Primarily Decentralized

For centuries, policymakers and scholars have largely focused on issues of scale in institutional design—to wit, whether authority should be allocated to decentralized or centralized institutions.[99] This debate typically assumed authority should be allocated to the one institution best matched with addressing the problem.[100] The long-admired concept of subsidiarity, still enshrined as a general principle of EU law,[101] endorses maintaining at least the implementation of conservation measures as primarily decentralized. Such allocations may leverage local

[99] E.g., Lily Hsueh & Aseem Prakash, 'Incentivizing Self-Regulation: Federal vs. State-Level Voluntary Programs in US Climate Change Policies' (2012) 6 Reg & Governance 445, 447 ('[L]egal scholars of regulatory federalism have long debated the merits of environmental regulation at different scales of governance').

[100] E.g., Henry N Butler & Jonathan R Macey, *Using Federalism to Improve Environmental Policy* (AEI Press 1996); Raymond Yu Wang, Tao Liu & Heping Dang, 'Bridging Critical Institutionalism and Fragmented Authoritarianism in China: An Analysis of Centralized Water Policies and Their Local Implementation in Semi-Arid Irrigation Districts' (2018) 12 Reg & Governance 451, 454.

knowledge, and opportunities for customization or regulatory experimentation.[102] Municipal and provincial governments often retain significant authority that affects ecological resources, for example development controls,[103] forest management,[104] invasive species,[105] or animal welfare.[106]

However, limited allocations of centralized authority have proliferated in recognition of the shortcomings of decentralized authority, including collective action problems (such as transboundary cost externalization or 'race-to-the-bottom' risks), lack of uniformity, and the

[101] Consolidated Version of the Treaty on European Union art. 5(3), Feb. 7, 1992, 2010 O.J. (C 83) 13).

[102] Camacho & Glicksman, *Reorganizing Government: A Functional and Dimensional Framework* (n 98) 34.

[103] E.g., Alejandro E Camacho & Nicholas J Marantz, 'Beyond Preemption, Toward Metropolitan Governance' (2020) 39 Stan Envtl LJ 125, 131 (describing provincial and local control over land use in the US).

[104] Marcus B Lane, 'Decentralization or privatization of environmental governance? Forest conflict and bioregional assessment in Australia' (2003) 19 J Rural Studies 283, 287.

[105] E.g., Invasive Species Centre, 'Legislation and Policy: Who Regulates Invasive Species?'(2022), https://www.invasivespeciescentre.ca/learn/legislation-and-policies/#ontario accessed 1 October 2022 (stating '[i]n Canada, invasive species management is jointly regulated by federal and provincial legislation').

[106] Bruce Englefield and others, 'A Review of Australian Animal Welfare Legislation, Regulation, Codes of Practice, and Policy, and Their Influence on Stakeholders Caring for Wildlife and the Animals for Whom They Care' (2019) 9 Animals 335, *3.

absence of economies of scale.[107] Nonetheless, even such centralized authority over ecological resources often remains divided based on the type of land on which the resource is located.[108] In many nations, public reserved lands are managed by one of several national administrative agencies or provincial authorities.[109]

2.3.2. A Mix of Distinct and Overlapping Authority

Conservation governance in many jurisdictions can be characterized as involving at least limited overlapping authority among various public institutions. Though public resource agencies or governments may have some exclusive planning and management authority,[110] their authority often overlaps at least in part with other public institutions. For instance, jurisdiction focused on particular wildlife, such as endangered or invasive species, will overlap with place-based authority.[111] Cascading international regimes governing wildlife similarly involve a mix of

[107] Camacho & Glicksman, *Reorganizing Government: A Functional and Dimensional Framework* (n 98) 35-37.

[108] E.g., George Cameron Coggins & Robert L. Glicksman, 'Public Natural Resources Law' (2022, Volume 3, Parts 16-21), Pt. G Introduction.

[109] For instance, different units of the federal government of the United States manage forests, national parks, wildlife, and other federal lands, while various state agencies and municipalities manage a range of other public lands. See Camacho (n 9) 1619.

[110] E.g., Englefield and others (n 106) *3 (stating in Australia the 'responsibility for the management of wildlife and other animals remains with the states and territories').

[111] E.g., Erika J Techera & Natalie Klein, 'Fragmented Governance: Reconciling Legal Strategies for Shark Conservation and Management' (2011) 35 Marine Pol'y 73, 76 (describing horizontal

overlapping and distinct authority.[112] Regimes like the European Union's Natura 2000 or certain pollution control statutes in the United States that provide for floor preemption or minimum harmonization—in which a centralized authority puts a minimum regulatory level but allows provincial or sub-national authorities to impose more stringent standards—necessarily involve overlapping authority.[113]

2.3.3. Limited Inter-jurisdictional Coordination

In most Western legal contexts, the various decentralized and centralized (and overlapping and distinct) resource institutions largely exercise their authority independently. Of course, a range of formal coordination mechanisms may exist that link the jurisdiction between certain institutions. Indeed, international environmental governance itself can be understood as fundamentally comprised of various disparate coordination networks. Supra-national institutions such as the EU similarly provide increased hierarchical coordination in addition to more centralization.[114]

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fragmentation in Australia due to tension between conservation efforts in environmental laws and the utilization focus of fisheries regulations).

[112] E.g., Techera & Klein (n 111) 74-76 (describing inconsistencies or incoherencies in international laws governing shark conservation).

[113] When a site is designated as both a NATURA 2000 site and a local national park, the provisions of the EU directives apply, unless stricter rules are in place under national law. See Natalya Yakusheva, 'Managing protected areas in Central Eastern Europe: Between path dependence and Europeanisation' (2019) 87 Land Use Policy 1, 1.

Domestically, informal and formal coordination mechanisms may exist between public land and wildlife management agencies. The US ESA, for instance, requires inter-agency consultation when a proposed federal agency's action may jeopardize a listed species or its critical habitat.[115] Some invasive species laws similarly create formal coordination mechanisms among agencies.[116] Moreover, many environmental impact assessment laws around the world require ad hoc coordination over information generation and planning.[117] And some biotechnology regulation may require coordination among agencies with potentially overlapping authority.[118] Furthermore, throughout the globe, a multitude of ad hoc, voluntary, and/or less rigorous inter-agency coordination arrangements have proliferated.[119]

[114] Michael Blauberger & Berthold Rittberger, 'Conceptualizing and Theorizing EU Regulatory Networks' (2015) 9 Reg & Governance 367.

[115] 16 U.S.C. 1536(a)(2).

[116] In the United States, Executive Order No. 13,751, 81 Fed. Reg. 88,609, 88,611 (Dec. 8, 2016) restricts federal agency introductions of invasive species. It established a National Invasive Species Council composed of thirteen federal agencies to help coordinate federal invasive species management and requires federal agencies to coordinate 'to the extent practicable' with other agencies in performing their duties. Ibid 88,610–11, 88,613.

[117] E.g., National Environmental Policy Act, 42 U.S.C. § 4332(2)(C).

[118] The Coordinated Framework for the Regulation of Biotechnology in the United States, 51 Fed. Reg. 23,302, attempts to coordinate the authority of the Food & Drug Administration, Department of Agriculture, and Environmental Protection Agency in regulating the introduction of biotechnology products.

[119] Camacho (n 9) 1622.

Nonetheless, most inter-jurisdictional coordination is limited. Coordination is often only directed at a particular space or resource. It tends to be limited to softer governmental functions, such as information gathering and planning,[120] and for providing opportunities for increased communication rather than more robust forms of harmonization.[121] Accordingly, in most Western legal regimes, most authority over resources still is exercised by a fragmented assortment of resource managers and regulators exercising authority fairly independently.

3. Climate Change, Biotechnology, and the Inescapable Human Footprint on 'Natural' Systems

In concert with the emergence of conservation sciences, over the course of the twentieth century most Western domestic and modern public international law adopted variations of these substantive, procedural, and structural legal regimes. It is noteworthy that this legal infrastructure has certainly had some success in promoting understanding, protection, and appreciation of ecosystems.[122] These management and regulatory strategies, processes, and institutional arrangements undoubtedly have helped address some of the most direct and egregious threats to

[120] JB Ruhl & James Salzman, 'Climate Change, Dead Zones, and Massive Problems in the Administrative State: A Guide for Whittling Away' (2010) 98 Calif L Rev 59 (discussing fora using 'weak ties' to alleviate the effects of fragmentation).

[121] Jody Freeman & Jim Rossi, 'Agency Coordination in Shared Regulatory Space' (2012) 125 Harv L Rev 1131, 1156 (detailing inter-agency informal coordination).

[122] E.g., The Nature Conservancy, *Communicating Ecosystem Services* (2010) (reporting strong public perception about the value of ecosystem services, with 97% responding that clean and filtered water was either extremely or very important).

biodiversity—most notably, direct human development and consumptive uses that largely ignore the costs of resource degradation.[123] The prevailing fragmented structural configuration has been at least capable of addressing more localized conventional stressors, with the emergence of more recent centralization and coordination addenda helping manage broader-scale and cross-jurisdictional problems.[124] Likewise, conventional administrative processes developed over the past century like notice-and-comment rulemaking and standard licensing or permitting may have been reasonably targeted at managing direct human uses causing relatively bounded ecological depletion and destruction.[125]

Similarly, to varying degrees, sustained yield and historical and natural preservation goals have served as reasonably effective limitations on previously unchecked development and consumption.[126] Mandating resources remain untouched or maintained at or restored to historical conditions can provide formidable barriers sensibly directed at obstructing direct and rampant depletion.[127] Moreover, a focus on maximizing the yield of favored renewable resources can

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[123] Camacho, 'De- and Re-constructing Public Governance for Biodiversity Conservation' (n 9) 1609.

[124] Daniel A Farber, 'Climate Adaptation and Federalism: Mapping the Issues' 1 San Diego J Climate & Energy L 259, 266 (2009).

[125] Craig & Ruhl (n 15) 4; Ruhl & Salzman (n 120).

[126] Holly Doremus, 'Adapting to Climate Change Through Law that Bends Without Breaking' (2010) 2 San Diego J Climate & Energy L 45.

[127] Camacho, 'Assisted Migration: Redefining Nature and Natural Resource Law Under Climate Change' (n 58) 245-46.

serve to stabilize consumption and promote long-term sustainability of that resource. Yet global changes in climate and advances in biotechnology increasingly raise fundamental questions about the future efficacy of this legal infrastructure in advancing long-term ecological and social health.

3.1. Climate Change and Ecological Conservation

Anthropogenic climate change is well established as a grave threat to biota globally.[128] Overwhelming scientific evidence establishes that global climate change is already disrupting species behavior, causing species and habitat loss, and will increasingly do so.[129] Many species will need to shift their range rapidly to survive because their existing range is no longer suitable; others will need human assistance to move to locations they can tolerate.[130] This will include consideration of particularly active conservation interventions, such as rewilding, assisted migration—intentional introduction of a species outside its historical range[131]—or other forms of 'environmental enhancement.'[132] On the other hand, active interventions may harm one or more

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[128] E.g., McDonald and others (n 40) 1.

[129] Working Group II Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, Climate Change 2022: Impacts, Adaptation and Vulnerability 2448-49 (Hans-Otto Pörtner and others, eds.).

[130] Ibid 200.

[131] O. Hoegh-Guldberg and others, 'Assisted Colonization and Rapid Climate Change' (2008), 321 Science 345 (advocating assisted migration as an adaptation tool).

[132] Han Somsen, 'From Improvement Towards Enhancement: a regenesis of environmental law at the dawn of the Anthropocene' (2017) Oxford Handbook L & Reg of Tech 379, 380.

components of target locations. Meanwhile, the migration and proliferation of invasive species is already impairing and expected to further degrade biodiversity.[133]

3.2. Emerging Biotechnologies and Ecological Conservation

A less observed stressor on this prevailing legal infrastructure is the potential effects of the embryonic development of more active biotechnological strategies that may reduce and reverse—or alternatively exacerbate—biodiversity loss. Synthetic biology has surfaced as 'a suite of techniques and technologies that enable humans to read, interpret, modify, design and manufacture DNA in order to rapidly influence the forms and functions of cells and organisms, with the potential to reach whole species and ecosystems.' [134] As detailed earlier,[135] though largely still nascent, innovations in gene editing,[136] gene drives[137] and even robotics[138] are emerging with the promise of increasing ecological function or fitness through active human intervention in and manipulation of non-human systems.

Crucially, these various biotechnologies expressly seek to accelerate human intervention into ecological systems. They each provide opportunities for increasingly active human

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[133] E.g., Working Group II Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change (n 129) 45; D.M. Finch and others, 'Effects of Climate Change on Invasive Species,' in Poland, T.M. at al. eds, *Invasive Species in Forests and Rangelands of the United States* (Springer 2021).

[134] IUCN (n 25) 2.

[135] See (n 22 – 28) and accompanying text.

[136] RA Charo & HT Greely (n 24); IUCN (n 25) , at 68.

[137] The Synthetic Biology Project (n 26) 9; IUCN (n 25) 68.

[138] SA Chechetka and others (n 28) 224.

intervention. In addition, depending on how they are employed, they offer the potential to significantly transform—and improve or impair—human and ecological health.

4. Straining Substantive, Structural, and Procedural Legal Adaptive Capacity

These convulsive changes in global climate and biotechnology call into question not only the adaptive capacity of ecological systems to manage change, but also the adaptive capacity of prevailing Western conservation law and governance.[139] Drawing from a substantial ecological and socio-ecological literature on resilience and adaptive governance, legal adaptive capacity refers to the legal mechanisms that allow governance to respond to emerging information and changes in circumstances.[140] There are significant untapped opportunities to increase legal adaptive capacities in both international and domestic legal regimes.[141] However, as detailed in this Part, while policymakers have insufficiently attended to the adaptive capacity of conservation law's administrative processes, policymakers and scholars have especially neglected how the goals and institutional structures of conservation law are inadequately calibrated to manage ecological and technological change.

4.1. Weaknesses in Substantive Legal Adaptive Capacity

[139] Victor B Flatt, 'Unsettled: How Climate Change Challenges a Foundation of Our Legal System, and Adapting the Legal State' (2017) 2016 BYU L Rev 1397.

[140] E.g., JB Ruhl, 'General Design Principles for Resilience and Adaptive Capacity in Legal Systems—with Applications to Climate Change Adaptation' (2011) 89 NC L Rev 1373, 1375 (providing a framework for applying resilience theory to legal systems); Ahjond S Garmestani & Melinda Harm Benson, 'A Framework for Resilience-based Governance of Social-Ecological Systems' (2013) 18 Ecology & Society 1.

First, the core objectives and strategies of conservation management—regulation of private and public development; reserved lands and corridors; invasive species and other wildlife management laws—have at best limited substantive legal adaptive capacity. To be sure, sustained yield regimes provide some adaptive capacity and are not necessarily in conflict with promoting ecological sustainability.[142] Yet to date they often have had at best a tenuous connection to ecological health, primarily focused on maximizing the productivity of a particular resource.[143] Meanwhile, though historical and natural preservation strategies may have initially served as rough proxies for ecological health, neither is geared to manage biotechnological change or evolving biodiversity demands in a world of climate change.[144]

4.1.1. Conventional Conservation Goals under Climate Change

Climate change elevates existing tensions between various conservation goals and may make each of them less congruent with promoting ecological health. With large-scale shifts in climatic conditions, historical and natural preservation conservation strategies will be

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[141] E.g., Ahjond Garmestani and others, 'Untapped Capacity for Resilience in Environmental Law' (2019) 116 PNAS 19899, 19899; Niko Soininen and others, 'Too Important to Fail? Evaluating Legal Adaptive Capacity for Increasing Coastal and Marine Aquaculture Production in EU-Finland' (2019) 110 Marine Policy 103498; Lucy Greenhill, Jasper O Kenter, & Halvor Dannevig, 'Adaptation to Climate Change–Related Ocean Acidification: An Adaptive Governance Approach' (2020) 191 Ocean & Coastal Mgmt 105176.

[142] Camacho & Glicksman, 'Legal Adaptive Capacity' (n 45) 716, 816-17.

[143] See (n 90) and accompanying text.

[144] Camacho, 'De- and Re-constructing Public Governance for Biodiversity Conservation' (n 9) 1589.

increasingly in conflict: it will not be possible to simultaneously leave ecological resources alone and maintain protected areas in their historical conditions. Historical preservation of 'native' will necessarily require active intervention strategies antithetical to natural preservation, and vice versa.

More importantly, each of these existing approaches raises significant barriers to the advancement of long-term ecological function.[145] Public land laws based in historical and natural preservation are designed to inhibit migration or introduction of biota from other jurisdictions. Under global climate change, these reserved lands focused on preserving resources in fixed places may often diminish in ecological value, and substitute reserves have not been secured.[146] Even those more sanguine about the adaptive capacity of Western public land laws to manage climate change acknowledge that more active interventions for overcoming human-induced dispersal barriers (like assisted migration) raise thorny, unanticipated issues.[147] Similarly, many invasive species and wildlife protection legal strategies are expressly designed either to restrict movement or translocation of species across landscapes[148] or to preserve current or past habitat

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[145] Cf. William Cronon (n 31) 483 ('To the extent that biological diversity (indeed, even wilderness itself) is likely to survive in the future only by the most vigilant and self-conscious management of the ecosystems that sustain it, the ideology of wilderness is potentially in direct conflict with the very thing it encourages us to protect.').

[146] E.g., McDonald and others (n 40) 2-3.

[147] Trouwborst (n 41) 16-18.

[148] Camacho, 'De- and Re-constructing Public Governance for Biodiversity Conservation' (n 9) 1606.

rather than protect areas based on likely future conditions.[149] Classifications and restrictions such as native, exotic, or invasive are often ill-defined,[150] or based on geopolitical considerations rather than ecological ones.[151]

'Terms such as 'wild' and 'natural' will be increasingly unhelpful, if not counter-productive in promoting biodiversity or ecological function under anthropogenic climate change.'[152] The UN CBD, for instance, restricts introductions of invasive alien species including 'movement by human agency, indirect or direct, of an alien species outside its natural range,'[153] which could be understood as including *any* species movement indirectly induced by climate change, regardless of its ecological benefits. On the other hand, recent regulatory interpretations that classify climate-induced migrations as 'natural' and acceptable[154] ignore that such changes are indeed anthropogenic and, in some instances, could damage pre-existing biota. Similarly,

[149] McDonald and others (n 67) *5. Even some recent regulatory interpretations emphasize the protection only of historical or current, rather than future, habitat. See e.g., Endangered and Threatened Wildlife and Plants; Regulations for Designating Critical Habitat, 85 Fed. Reg. 82,376 (Dec. 18, 2020) (subsequently rescinded by Endangered and Threatened Wildlife and Plants; Regulations for Designating Critical Habitat, 87 Fed. Reg. 43,433 (July 21, 2022).

[150] For instance, the Convention on Biological Diversity does not define 'natural range' or 'natural distribution.' See Sophie Riley, 'A Weed by any Other Name: Would the Rose Smell as Sweet if it Were a Threat to Biodiversity?' (2009) 22 Geo Int'l Envtl L Rev 157, 171.

[151] Willmore (n 60) 122.

[152] McDonald and others (n 67) *6.

[153] Guiding Principles (n 77) 257.

those laws that treat introductions to overcome climate harms as artificial and thus objectionable similarly may serve to reduce biodiversity.

4.1.2. Biotechnology under Prevailing Conservation Goals

The potential use of emerging biotechnologies to advance conservation further illustrates this lack of substantive adaptive capacity. The treatment of biotechnology in many conservation laws is largely premised on outdated assumptions of nature as static and divisible from human activity.[155] Because conservation laws regularly place biota in dualisms, privileging the 'natural' and/or 'native' over the 'introduced' and 'exotic,'[156] active conservation strategies may be obstructed in locations where they might advance ecological function, but also allowed or even promoted in other cases even if they raise the risk of ecological damage.[157]

Indeed, some assert that the Cartagena Protocol on Biosafety to the CBD does not offer the opportunity to even explore the potential ecological benefits of biotechnologies.[158] The US'

[154] EU Regulation on the Prevention and Management of the Introduction and Spread of Invasive Alien Species 2014 art. 2(2)(a).

[155] Camacho, 'Going the Way of the Dodo' (n 4) 852.

[156] Yeuk-Sze Lo, 'Natural and Artifactual: Restored Nature as Subject' (1999) 21 Envtl Ethics 247, 260–61 (arguing the moral dualism between wild nature and human-restored nature fallaciously assumes there is an ontological dualism between independently natural entities and 'ontologically dependent' entities).

[157] Camacho, 'Going the Way of the Dodo' (n 4) 855.

[158] See Delphine Thizy and others, 'Providing A Policy Framework for Responsible Gene Drive Research: An Analysis of the Existing Governance Landscape and Priority Areas for Further

Coordinated Framework similarly does not allow broad consideration of ecological impacts or ethical choices.[159] Though conservation laws such as the US ESA or EU Habitats Directive might be interpreted as allowing biotechnologies in some contexts,[160] it is far from clear that such contexts track when the risks are lowest and advantages the greatest.[161] More generally, existing conservation laws have not sufficiently dealt with how if at all existing natural/human and native/ nonnative dualisms should inform interventions such as gene editing, gene drives, or robotics.

4.2. Weaknesses in Procedural Legal Adaptive Capacity

Most Western conservation law and management processes currently also lack sufficient legal adaptive capacity to cope with change effectively in the Anthropocene. Paradigmatic public administrative management and regulation remain largely the same as its initial incarnation in the Twentieth Century, poorly designed to manage uncertainty and advance regulator learning.[162] They assume regulators and managers can and should focus most of their attention and resources on initial decisions to ensure compliance with established law, and only rarely revisit them to account for new data or changes in circumstances. These front-end approaches often assume static environments, the sustaining efficacy of formulas based on historical data, and uncritical

Research' (2020) 5 Wellcome Open Research *1, *5.

[159] Jonas J Monast, 'Editing Nature: Reconceptualizing Biotechnology Governance' (2018) 59 BC L Rev 2377, 2402, 2411.

[160] Han Somsen, 'Towards a Law of the Mammoth? Climate Engineering in Contemporary EU Environmental Law' (2017) 11 EU J Risk Reg 109, 113-15.

[161] Camacho, 'Going the Way of the Dodo' (n 4) 855.

[162] Lawrence Susskind and others, 'A Critical Assessment of Collaborative Adaptive Management in Practice' (2011) 49 J. Applied Ecology 47, 47.

assumptions about expected future outcomes, diminishing adaptive capacity and hampering agile legal adaptation.[163] In this sense, they assume fixed models of decision making and of nature.

Even for conventional stressors on ecological systems, these front-end processes are imperfect in coping with uncertainty and change. A significant adaptive management literature has developed globally on the limitations of (and alternatives to) conventional regulatory processes.[164] Scholars have detailed many examples illustrating that rigid, front-end processes embedded in institutions hamper 'the probing, monitoring and learning policy of adaptive management' and increase the probability of system collapse.[165] Some have advocated more broadly for the integration of incremental decision making and experimentation into legal processes.[166]

[163] Barbara A. Cosens and others, 'The role of law in adaptive governance,' *Ecology & Society 22*(1):30 (2017). https://doi.org/10.5751/ES-08731-220130.

[164] Susskind and others (n 162). Adaptive management refers to the systematic monitoring, assessment, and adjustment of resource management decisions. See e.g., Int'l Inst for Applied Sys Analysis (n 93) 1; C.S. Holling and others, 'In Quest of a Theory of Adaptive Change' in Lance H. Gunderson & C.S. Holling (eds), *Panarchy: Understanding Transformations in Human and Natural Systems* (2002) 3, 21–22.

[165] E.g., C.S. Holling & S.M. Sundstrom, 'Adaptive Management, a Personal History' 11, 20 (2015), in C. R. Allen, A. S. Garmestani (eds.), *Adaptive Management of Social-Ecological Systems*, DOI 10.1007/978-94-017-9682-8_2. See also Gunderson & Holling (n 164).

[166] E.g., Jody Freeman, 'Collaborative Governance in the Administrative State' (1997) 45 UCLA L Rev 1, 28–29; Michael C. Dorf & Charles F. Sabel, 'A Constitution of Democratic

Though incredibly popular among scholars and even some governmental officials, few laws actually require the use of adaptive management procedures.[167] Even when land agencies adopt some form of adaptive management, the core procedures (including judicial review) are suspicious and often resistant to effective adaptive management.[168] These processes are also often in tension with substantive conservation doctrines that promote natural or historical preservation that may neglect unknowns and uncertainties.[169]

Emerging biotechnologies and climate change further expose the lack of procedural adaptive capacity. Biotechnologies that seek to introduce novel interactions and possibly

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Experimentalism' (1998) 98 Colum L Rev 267, 328–89; Robert L. Glicksman & Jarryd Page, 'Adaptive Management and NEPA: How to Reconcile Predictive Assessment in the Face of Uncertainty with Natural Resource Management Flexibility and Success,' (2021) 46 Harv Envtl L Rev 121.

[167] R. Gregory, D. Ohlson & J. Arvai, 'Deconstructing Adaptive Management: Criteria for Applications to Environmental Management' (2006) 16 Ecological Applications 2411, 2413; J. Michael Scott and others, National Wildlife Refuges, in Preliminary Review Of Adaptation Options For Climate-Sensitive Ecosystems And Resources 5-1, 5-35 (Susan Herrod Julius & Jordan M. West eds., 2008).

[168] Craig & Ruhl (n 15) 9-10.

[169] Cosens and others, (n 161) 2. In this paper, Cosens and others provide guidelines for more adaptive legal frameworks such as legitimacy, procedural justice, problem-solving, reflection and learning, balancing stability and flexibility, and dispute resolution.

irreversible effects necessitate cautious, adaptive decision making.[170] Climate change in particular injects significantly more uncertainty and risk throughout the regulatory process[171] and reveals the rigidity of administrative procedures.[172] More fundamentally, public governance in many Western jurisdictions is largely not well designed to manage uncertainties at the scale of global climate change because it suffers from the absence of a legal infrastructure for systematically monitoring, assessing, and adjusting public decision-making procedures to promote learning and thus more adaptive governance throughout the regulatory process.[173]

4.3. Weaknesses in Structural Legal Adaptive Capacity

Finally, in most Western jurisdictions, there is insufficient attention placed on structural legal adaptive capacity—how public institutional relationships can help or hinder the management of climate and biotechnological risks emerging in the Anthropocene. One initial problem has been that the longstanding overemphasis on scale in institutional design has obscured or conflated issues regarding the extent of overlap and coordination among public institutions.[174] Scholars and policymakers also ignore how the tradeoffs of the extent of

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[170] National Academies of Sciences, Engineering, and Medicine, *Gene Drives on the Horizon: Advancing Science, Navigating Uncertainty, and Aligning Research with Public Values* (National Academies Press 2016) 8.

[171] E.g., J.B. Ruhl, 'Climate Change and the Endangered Species Act: Building Bridges to the No-Analog Future' (2008) 88 B.U. L. Rev. 1, 22.

[172] Daniel Schramm & Akiva Fishman, 'Legal Frameworks for Adaptive Natural Resource Management in a Changing Climate' (2010) 22 Geo Int'l Env't L Rev 491, 497.

[173] Camacho (n 9) 1617.

centralization, overlap, and coordination will often vary depending on the governmental function being considered.[175]

More fundamentally, prevailing public conservation governance—decentralized, at times overlapping, and relatively independent institutional configurations—is limited in its capacity to promote conservation because it is not designed for managing change. Decentralized frameworks may work well for direct stressors or discrete and localized issues, as they can leverage more localized expertise, tailored strategies, and opportunities for regulatory experimentation.[176] However, a purely decentralized framework is ill-adapted for managing transboundary harms and can lead to conflicting treatment of species movement, e.g., either impeding valuable migrations or failing to stem harmful ones.[177] Likewise, largely independent authority can avoid administrative coordination costs and reduce risks of government inaction.[178] However, a lack of coordination can lead to regulatory inconsistencies, inefficiencies, and

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[174] Camacho & Glicksman, *Reorganizing Government: A Functional and Dimensional Framework* (n 98) 38–39.

[175] Ibid 21-30.

[176] Ibid 34.

[177] Camacho, 'Transforming the Means and Ends of Natural Resource Management' (n 12) 1438–39.

[178] Camacho & Glicksman, *Reorganizing Government: A Functional and Dimensional Framework* (n 98) 46–48.

gaps,[179] particularly in managing indirect, long-term harms such as invasive species, habitat fragmentation, and especially climate change.[180]

This fragmentation of authority impedes the structural adaptive capacity and success of conservation policy.[181] First, it hinders the possible employment of active conservation interventions that extend across the patchwork of jurisdictions. As endangered and invasive species change their range, conflicts are likely to increase between place-based public land laws and species-focused conservation laws.[182] Yet perhaps more importantly, the absence of coordinating mechanisms for collecting, disseminating, and analyzing information on regulatory effectiveness also limits the ability of government institutions and policymakers to experiment and learn from collective experience.[183]

5. Toward a Transformation of Conservation Governance

Policymakers in Western international and domestic legal regimes can and should transform the goals, processes, and structures of conservation law toward a conservation ethic that focuses on managing rapidly changing non-human systems and the capacity of humans to influence the evolution of such systems. Both climate change and biotechnology accentuate and

[179] Noah D. Hall, 'Toward a New Horizontal Federalism: Interstate Water Management in the Great Lakes Region' (2006) 77 U Colo L Rev 405, 453.

[180] Cf. Trouwborst (n 41) 3.

[181] Lyman (n 17) 10.

[182] E.g., Michael L. Casazza and others, 'Endangered Species Management and Ecosystem Restoration: Finding the Common Ground' (2016) 21 Ecology & Soc'y 19.

[183] Ibid 133.

amplify the characteristic volatility, as well as the interconnectedness, of non-human and human systems. Though some commenters suggest that some existing laws might accommodate such convulsive stressors,[184] this section contends that conservation law in the Anthropocene must be re-focused toward a greater reliance on interventions that advance ecological health and restrict those likely to inhibit it. Policymakers must also reformulate legal frameworks to integrate adaptive processes and trans-jurisdictional structures to be less dependent on simplistic dualisms in favor of cautious risk assessment. Yet even the radical adoption of such foundational principles is merely an initial step; this Part thus seeks to sketch a framework for scholars and policymakers to begin to sort through the key questions raised by the dynamism of nature and humanity's inseparability from it.

5.1. Exploring 'Ecological Health'

In the management of both human-dominated landscapes and ecological reserves, law and policy ought to be reframed to focus less on how to leave nature alone, put things the way they were, or maximize agricultural yield. Conservation law in the Anthropocene must prioritize consideration of how management strategies can promote ecological health in light of current and reasonably foreseeable ecological conditions.[185] Laws directed primarily at species and ecological conservation ought to be reoriented to deem ecological health a dominant objective.[186]

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[184] E.g., Trouwborst (n 41) 19-20.

[185] Camacho, 'De- and Re-constructing Public Governance for Biodiversity Conservation' (n 9) 1628-29.

[186] For example, regulations governing management of the U.S. Federal Refuge System could be interpreted to emphasize ecological integrity, diversity, and health in light of foreseeable

Even laws managing public and private lands that do not designate ecological health as the primary management goal nonetheless can make it a more pronounced priority.[187]

Yet the possible manifestations of a goal of ecological health are varied and contestable. Promotion of ecological health might be understood as fostering the productivity of a particular favored resource or set of resources, perhaps operationalized as maximizing aggregate biomass through one of various measures.[188] Advancing biodiversity, commonly measured in biological science by 'richness' (the number of unique life forms), 'evenness' (numerical equivalence among life forms), and 'heterogeneity' (dissimilarity among life forms), certainly might be another common approach.[189] Yet these components of biodiversity overlap, and scientists disagree on how and even whether they should be aggregated.[190] To date, various metrics for

circumstances. See Fischman (n 45) 1025-26.

[187] Protection of ecological health might have extensions that range beyond direct ecological effects. For instance, laws governing fossil fuel production might be adjusted to address not only localized ecological effects from extractive activities but also consideration of more indirect harms to, for example, global climate.

[188] E.g., CP terHorst & P Munguia, 'Measuring Ecosystem Function: Consequences Arising from Variation in Biomass-Productivity Relationships' (2008) 9 Cmty Ecology 39, 39.

[189] Bradley J. Cardinale and others, 'Biodiversity Loss and Its Impact on Humanity,' (2012), 486 *Nature* 59, 60.

[190] DP Faith, 'Biodiversity' (2021) *Stan Encyc Phil*, Edward N. Zalta (ed), <https://plato.stanford.edu/archives/spr2021/entries/biodiversity/> accessed September 13 (exploring the varied, often conflicting scholarly definitions of 'biodiversity'); Andy Purvis &

biodiversity and biodiversity conservation have been advanced,[191] though many others might be developed. Conservation strategies might focus on a particular scale of diversity—genetic, population, species, assemblage, or ecosystem—or some combination thereof,[192] and might vary in different contexts.

Inevitably, how to operationalize 'ecological health' will be contested and value laden. As stated by one scholar, 'the choice among these different biodiversity "models" will depend on what values are important to the decision-maker.'[193] Undoubtedly, Anthropocene conservation governance will need to reconcile and integrate perspectives of local communities, and in particular indigenous communities and traditional knowledge, in conceptions of ecological health.[194] Yet a much more robust scientific and broader social dialogue on the appropriate characterizations and measures for ecological health is crucial as the legal tethers to historical and natural preservation and the narrow focus of sustained yield regimes become more

Andy Hector, 'Getting the Measure of Biodiversity' (2000) 405 Nature 212, 213, 218.

[191] E.g., Faith (n 190); Matt Davis and others, 'Mammal Diversity Will Take Millions of Years to Recover from the Current Biodiversity Crisis' (2016) 115 PNAS 11262, 11262; Tom Leinster & Mark W. Meckes, 'Maximizing Diversity in Biology and Beyond' (2016) 18 Entropy 88.

[192] Michael E. Soulé, 'Conservation: Tactics for a Constant Crisis' (1991) 253 Science 744, 744.

[193] Faith (n 190).

[194] E.g., Marcus Colchester, Conservation policy and Indigenous peoples (2004) 7(3) 145 Environmental Science & Policy; Jonaki Bhattacharyya and Brendon MH Larson, The Need For Indigenous Voices in Discourse About Introduced Species: Insights From Controversy Over Wild Horses (2014) 23 Environ Values 663-84.

problematic. Scientific and social inquiry will need to be directed increasingly at assessments of value—to not rely reflexively on historical conditions or naturalness as unalloyed virtues but acknowledging the potential harm of antiquarianism and nonintervention. There already are growing literatures in ecology, ethics, and economics seeking to assess the value of ecological phenomena.[195] But the central focus for the advancement of knowledge in the Anthropocene should be exploring and contesting the intrinsic and instrumental values of the many components, services, and processes of ecological phenomena.[196]

Though there undoubtedly will continue to be risks of ecological harm due to the use of interventionist strategies, there increasingly will be substantial ecological risks of nonintervention as well. Where ecological harms cannot be thwarted by passive management, more active approaches should be considered. As such, increased prioritization of ecological health allows the possibility (but not inevitability) of more active conventional strategies, such as

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[195] For instance, a fertile ecosystem services literature seeks to identify and measure some of the beneficial services of ecosystems. See, e.g., C. Brown and others, *U.N. Env't Programme World Conservation Monitoring Ctr., Measuring Ecosystem Services: Guidance on Developing Ecosystem Service Indicators* (2014); Millennium Ecosystem Assessment, *Ecosystems and Human Well-Being: Synthesis* (2005) vi, https://www.millenniumassessment.org/documents/document.356.aspx.pdf (accessed 30 March 2023).

[196] Camacho, 'De- and Re-constructing Public Governance for Biodiversity Conservation,' (n 9) 1628-29.

designations of future habitat, rolling easements, assisted migration,[197] or other tactics for increasing the permeability of private and public lands in ways that promote valued species movement but also impede movement likely to harm ecological health.[198] It might even include biotechnological strategies such as de-extinction and gene drives to enhance biodiversity. Indeed, the International Union for Conservation of Nature (IUCN), a membership union of government and civil society organizations, has already offered guidelines for the emerging but nonetheless controversial development and introduction of de-extinct species for conservation purposes.[199]

Of course, in some (and perhaps many) instances, cultural, historical, spiritual, or even economic concerns may still point to engaging in historical preservation—active efforts to retain past conditions—or natural preservation—allowing ecosystems to change without active management.[200] Even as more active strategies are employed in some instances, it may often be worthwhile to limit the extent of active management in many others. For instance, more active intervention to protect ecological health in wilderness areas may nonetheless be relatively passive as compared to strategies employed in other lands (such as wildlife reserves). What is crucial to appreciate, however, is that climate change may make the environmental costs

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[197] Ibid 4-5, 9.

[198] John Kostyack and others, 'Beyond Reserves and Corridors: Policy Solutions to Facilitate the Movement of Plants and Animals in a Changing Climate' (2011) 61 BioScience 713, 714.

[199] IUCN Species Survival Commission, *Guiding Principles on Creating Proxies of Extinct Species for Conservation Benefit* (2016).

[200] Stephen T Jackson & Richard J Hobbs, 'Ecological Restoration in the Light of Ecological History' (2009) 325 Science 567, 568.

increasingly high of failing to reframe the overall portfolio of conservation strategies to focus primarily on promoting ecological health as conditions change.[201]

5.2. Presumptions and Adaptive Processes.

Such a substantive reorientation may be daunting, but it should only be the beginning in advancing legal adaptive capacity. The host of value judgements raised by increased attention to promoting ecological health makes the processes for deciding what strategies may be adopted in any given context, and by whom, even more salient. Facilitating conditions for more adaptive regulation and management through establishing more adaptive legal processes and institutions are the main procedural tasks for conservation law in the Anthropocene.[202]

A fundamental component of this is cultivating robust participatory and adaptive governance to inform not only natural resource managers but also the public at large.[203] Conventional resource management in the twentieth century leaned heavily on professed scientific expertise, particularly to maximize resource production or establish historical

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[201] Cf. Dan Tarlock, 'Slouching Toward Eden: The Eco-Pragmatic Challenges of Eco-Revival' (2003) 87 Minn. L. Rev. 1173; Stephen T Jackson & Richard J Hobbs, 'Ecological Restoration in Light of Ecological History' (2009) 325 Science 567, 567–68; Alyson C. Flournoy, 'Restoration Rx: An Evaluation and Prescription' (2000) 42 Ariz L Rev 187, 195–96.

[202] B. C. Chaffin and others, 'A decade of adaptive governance scholarship: synthesis and future directions' (2014) 19 Ecology & Society 56 (2014).

[203] Camacho, 'Assisted Migration: Redefining Nature and Natural Resource Law Under Climate Change' (n 58) 254-55.

conditions.[204] Without such anchors, scientific knowledge will remain crucial for helping to develop assessments on value and tradeoffs of varying management strategies. Yet the ultimate prioritizations and adopted measures will not be discernible merely by reference to scientific expertise. Nor will technology on its own provide clear answers for what are ultimately public value choices. As such, fostering open decision making and meaningful participation will be even more vital to manage uncertainty and promote legitimate and effective conservation in the Anthropocene. Undoubtedly, effective conservation governance will require active efforts to identify who is not at the table and seek to integrate those communities so regularly marginalized historically in natural resource decision making, namely communities of color and Indigenous communities.[205]

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[204] A. Starker Leopold and others, 'Wildlife Management in the National Parks,' in *Transactions of the Twenty-Eighth North American Wildlife and Natural Resources Conference* 29, 29–44 (James B. Trefethen ed., 1963).

[205] E.g., Kyle A. Artelle and others, 'Supporting Resurgent Indigenous-Led Governance: A Nascent Mechanism for Just and Effective Conservation' (2019) 240 Biological Conservation 108284; Kyle A. Artelle and others, 'Values-Led Management: The Guidance of Place-Based Values in Environmental Relationships of the Past, Present, and Future' (2018) 23(3) Ecology & Society 35; Melanie Zurba & Fikret Berkes 'Caring for country through participatory art: creating a boundary object for communicating Indigenous knowledge and values, Local Environment' (2018) 19:8, 821-836; R. Phelan and others, 'Intended Consequences Statement,' (2020) 3 Conservation Science and Practice e371, https://doi.org/10.1111/csp2.371.

A shift toward promoting ecological fitness also makes vital the rejection of strict human/nature and native/exotic dualities that may restrict useful interventions and/or allow harmful ones. Essentialist classifications that categorically protect movements if an organism pre-existed or is moving without direct human assistance should be disfavored.[206] Similarly, both active introductions and movement of species outside their historical range should not be categorically barred.[207]

Instead, conservation management should integrate more risk-based assessments into decision making in which resource managers make a provisional assessment of the risks and advantages of the range of passive and active strategies. Though categorical rules may be problematic, rebuttable presumptions may make sense in some contexts. For instance, a presumption that the movement of an ecological unit is appropriate in locations where it already exists or existed (as well as presumptions against movement to areas outside a species' historical or current range) will often be relevant to an assessment of the potential risks and benefits of a management strategy.[208] In contrast, presumptions in favor of unaided 'natural' movement over

[206] Camacho, 'Going the Way of the Dodo' (n 4) 902-05.

[207] Ibid at 903.

[208] *See* US Fish and Wildlife Service, Endangered and Threatened Wildlife and Plants; Designation of Experimental Populations, 87 Fed. Reg. 34,625, 34,628 (June 7, 2022) (proposing amending the regulations for reintroduction of listed endangered species under the US ESA to replace the limitation that a reintroduction must generally occur outside the species' current natural range (but within its probable historical range) to a new standard that still requires introductions occur outside current range but with a focus more on the necessity for the

an intentional, planned translocations are less likely to be warranted in many circumstances. As such, risk assessments neither favoring nor disfavoring direct intervention will be more appropriate in such contexts.[209] With or without default presumptions, resource laws will need to shift toward incorporation of particularized assessment of the tradeoffs of potential conservation strategies as compared to alternative conservation measures.[210]

Choices of when and where to adopt more or less active strategies will inevitably be based on limited information, particularly as ecological processes become more dynamic and even convulsive. Policymakers must reconstruct administrative procedural infrastructure to rely more on 'back-end' strategies that allow for provisional decisions based on existing information and incremental policy and decision adjustments as conditions warrant. This may include adaptive management, including periodic monitoring and adjustment of initial decisions to account for new data and changes in conditions.[211] However, increasing procedural adaptive capacity may also involve less demanding forms of adaptive regulation that feature iterative

introduction to support one or more of the species' life history stages).

[209] Ibid.

[210] Cf. New Zealand Biosecurity Act of 1993 (requiring individualized risk assessment prior to introduction of any alien plant species); Philip E Hulme, 'Plant Invasions in New Zealand: Global Lessons in Prevention, Eradication and Control' (2020) 22 Biological Invasions 1539, 1544.

[211] E.g., JB Ruhl & Robert L. Fischman, 'Adaptive Management in the Courts' (2010) 95 Minn L Rev 424, 429. Adaptive management is more comfortable with unknowns and experimental flexibilities than conventional regulatory processes. Holling & Sundstrom (n 165) 20.

planning and periodic adjustment.[212] Again, incorporating active and robust public participation in governance will be vital in shaping questions and answers about ecological health and value.[213]

5.3. Adaptive Learning and Institutional Design.

Lastly, conservation governance in the Anthropocene may require further redirection from the prevailing baseline of decentralized, increasingly overlapping, but weakly coordinated public authority. Though increasing centralization and coordination of some governmental functions may be worthwhile, structural changes may not need to be unrealistically drastic. In fact, strategically tailored reallocations of authority focused on altering certain dimensions of authority for particular governmental functions may not only be more politically achievable but also crucial for maintaining other structural advantages of existing institutional arrangements.[214]

Centralization strategies focused on a limited subset of governmental functions, for instance, are not only more likely to be implemented but also may be more effective. Judicious increases in centralization, at least at the national level, for public funding and even standard setting over conventional and biotechnological introduction and migration strategies may better

[212] E.g., Gregg P. Macey, 'The Architecture of Ignorance' (2013) 2013 Utah L Rev 1627, 1667; Adam Kelsey and others, 'Global Governing Bodies: A Pathway for Gene Drive Governance for Vector Mosquito Control' (2020) 103 Am J Trop Med Hyg 976.

[213] Cf. Jody Freeman, 'Extending Public Law Norms Through Privatization' (2003) 116 Harv L Rev 1285, 1339-40 (discussing the ways in which increased public participation, though potentially more costly up front, can reduce overall costs by minimizing future conflicts among the affected parties).

[214] Camacho & Marantz (n 103) 129.

tackle concerns about transboundary harms, promote harmonization, and leverage economies of scale.[215] However, doing so importantly can also maintain the expertise, diversity, and experimentation advantages of still primarily decentralized authority over other governmental functions.[216]

Likewise, introducing more robust forms of inter-jurisdictional coordination for only some governmental functions—for example, planning, standard setting (particularly in the international context), and information dissemination and generation—can help address concerns regarding lack of harmonization and transboundary harms exacerbated by climate change.[217] Crucially, in contrast with the traditional focus of many Western species conservation and environmental planning laws on curbing or mitigating the effects of direct human action, proactive conservation also necessitates coordination of governmental planning and standards in contexts in which direct human action has *not* been proposed.[218] Because global climate change and the deployment of conventional and biotechnological conservation strategies raise unprecedented uncertainties, the development of more coordinated information infrastructures

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[215] Camacho, 'De- and Re-constructing Public Governance for Biodiversity Conservation' (n 9) 1635.

[216] Jonathan H. Adler, 'Jurisdictional Mismatch in Environmental Federalism' (2005) 14 NYU Env't LJ 130, 137.

[217] Cf. Kelsey and others (n 211) 976.

[218] Cf. Daniel A. Farber, 'Adaptation Planning and Climate Impact Assessments: Learning from NEPA's Flaws' (2009) 39 Env't L Rep News & Analysis 10605, 10607.

that promote the generation and dissemination of data about ecological effects and systematic assessments of the efficacy of conventional and biotechnological conservation alternatives will be vital for coping with uncertainty and cultivating learning not only by acting agencies but also other agencies, the public, and legislatures as well.[219] These changes can thus increase the structural legal adaptive capacity of conservation governance by leveraging the capacities of different regulatory institutions to better manage emerging indirect cumulative stressors while promoting inter-governmental learning that helps manage uncertainty.

6. Conclusion

There is a moral imperative to future generations for current generations to get conservation governance right. In this essay, I have argued that governance of ecological phenomena in Western domestic and international laws is primarily based on outmoded goals, processes, and structures. Many have highlighted that, with limited exceptions, decision-making processes are not designed to manage uncertainty and promote regulatory learning. Yet, at least in the context of conservation law, substantive and structural legal adaptive capacity are as important in navigating the novel regulatory stressors raised by climate change and biotechnology. Prevailing Western conservation law continues to rely on strategies and goals that seek to keep or restore nature to subjective historical baselines, restrain human interaction with non-human systems, or maximize long-term production of certain favored resources—to the neglect of other, more direct conceptions of long-term ecological health. Meanwhile, dominant

[219] Camacho, 'De- and Re-constructing Public Governance for Biodiversity Conservation' (n 9) 153-54.

Western public institutional networks remain fragmented, frustrating the possibility of coordinated action on strategies to advance ecological health.

This governance framework is not well suited to managing the convulsive effects of global climate disruptions, or the emerging conventional and biotechnological strategies that have both the potential to promote ecological regeneration as well as impede it. While historical preservation, natural preservation, and sustained yield strategies may continue to play a significant role in the portfolio of resource management, it seems clear that conservation law and governance in the Anthropocene needs to develop rigorous risk assessment processes that can effectively consider, if not facilitate, active interventions in ecological resources to promote their fitness under future climatic conditions.

Yet this reframing is clearly just the beginning. Substantively, conservation science and law in jurisdictions throughout the globe must grapple much more thoroughly with how to operationalize ecological health in a changing climate. Governance processes can be adjusted to incorporate more adaptive management and back-end adjustments to decision-making. Structurally, within and across jurisdictions, there is significant potential to tailor allocations of authority for different governmental functions to leverage the advantages of different dimensional features of authority—such as decentralized and centralized, or coordinated and independent, authority—while minimizing their tradeoffs.

Of course, there is no incontrovertible, single conservation goal, strategy, structure, or process for effectively managing and reconciling the multitude of diverse ecological phenomena and resource conflicts in the many jurisdictions throughout the planet. The cascade of multi-

scalar, overlapping authority over ecological resources frustratingly can thwart comprehensive approaches to conservation. Nonetheless, this regime does have the considerable benefit of allowing for a broad range of alternative approaches for managing unprecedented ecological change and novel emerging technologies. By attending to the dimensions and functions of authority, policymakers can leverage this advantage while attempting to address its disadvantages.

As such, it will likely be vital for policymakers at various governmental scales to harness the advantages of decentralized, even independent decision-making by establishing adaptive, inter-jurisdictional institutional frameworks for fostering and integrating scientific information on the relative value of potential ecological constituents and adopted management strategies. Likewise, policymakers could work toward integrating such frameworks into robust, public decision-making. In many ways, the development of a coordinated network for instantiating regulatory learning across jurisdictions must be at the core of conservation law and governance in the Anthropocene.