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Review

Thermodynamic nexus between UNCBD and UNFCCC: Bounded openness over natural information and the Yasuní-ITT initiative

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Abstract: Consilience of biodiversity and climate change is achievable through reduction to non-equilibrium thermodynamics. Subsequent construction supports a policy to decrease carbon emissions and species loss in capital-poor countries that are mega-diverse and carbon-rich. Incentives for conservation underpinned The Yasuní-ITT Initiative, whereby Ecuador sought payment not to drill for oil. The same logic holds for not opening highways in the Amazon. Consilience marries *Living within Limits* by Garrett Hardin with *Half-Earth* by E.O. Wilson. Artificial Intelligence facilitates persuasion of the Conference of the Parties to the United Nations Framework Convention on Climate Change and the United Nations Convention on Biological Diversity.

Keywords: biodiversity; climate change; consilience; decision 16/2; Half-Earth; non-equilibrium thermodynamics; general theory of second best; taboo

1. Introduction

A perennial complaint heard at the Conference of the Parties (COP) to the United Nations Convention on Biological Diversity (UNCBD) and the United Nations Framework Convention on Climate Change (UNFCCC) is that Parties and stakeholders are "siloed". They enjoy the security of their specializations. Who can blame them? The fault may lie with Adam Smith. The first chapter of The Wealth of Nations (1776) is titled "On the Division of Labour" [1]. Or perhaps abstraction itself is to blame. Formidable are information overload and the jargon of other disciplines. A simpler explanation, however, is "opportunity costs", i.e. what one forgoes to grapple with other disciplines [2]. Most informed participants in the COPs struggle to keep abreast with their own field much less any far afield.

The late E.O. Wilson (1929–2021), arguably the greatest naturalist of our time [3], would extol the rewards that await scholars who embark on "consilience" and unify distinct fields [4]. His oeuvre *Consilience* is a work of science and of advocacy Uniting the disciplines begins with reducing collateral ones. Two decades earlier, Wilson explained the relationship of disciplines to anti-disciplines, where one reduces each to a level which cannot be further reduced [5]. Construction then begins upward and outward.

For the UNFCCC and the UNCBD, consilience is a means to realize treaty objectives. Toward that end, is the publication of this Review.

2. Methodology

2.1. Roadmap

Consilience for the UNFCCC and UNCBD begins with reduction. Where do biodiversity and climate change make contact at the lowest level conceivable? I will suggest non-equlibrium thermodynamics (NET). Which fields can realize the objectives of both conventions together? Article 2 of the UNFCCC seeks "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system" [6]. Article 1 of the UNCBD requires that "access to genetic resources" be accompanied by "fair and equitable sharing of benefits arising out of the utilization of genetic resources" [7], abbreviated as ABS.

Questions cascade. Can delegates to the COPs unify knowledge from disparate fields into the cognitive, affective and psychomotor domains of learning, as schematized by Benjamin Bloom in his famous pyramid of learning? [8] Would a narrative in the style of a story persuade Parties to accept a policy through "mutual coercion, mutually agreed upon", which was the modus operandi recommended by Garrett Hardin to avert collapse in "The Tragedy of the Commons"? [9].

Finding answers is an "intellectual challenge" that coheres with Wilson's hope for a "new age of synthesis" [4]. Artificial Intelligence epitomizes that age for the cognitive domain of learning. In the realtime of the COPs, delegates and stakeholders can avail themselves to ChatGPT or other platforms.

To unify fields relevant to the aforementioned objectives will require knowledge of terms that may appear esoteric. Where unfamiliarity is foreseeable for most readers, the term is explained in this Review. Explaining all terms, however, would quickly lose readership. Artificial Intelligence allows the reader to customize the learning of any unexplained term. Box 1 and Box 2 in the penultimate section illustrate a virtual dialectic that may take place by delegates to the COPs of the UNCBD and UNFCCC.

As central as is the cognitive domain for any persuasive argument, Bloom's affective and psychomotor domains will not be given short shrift in this Review.

2.2. Visualizing consilience

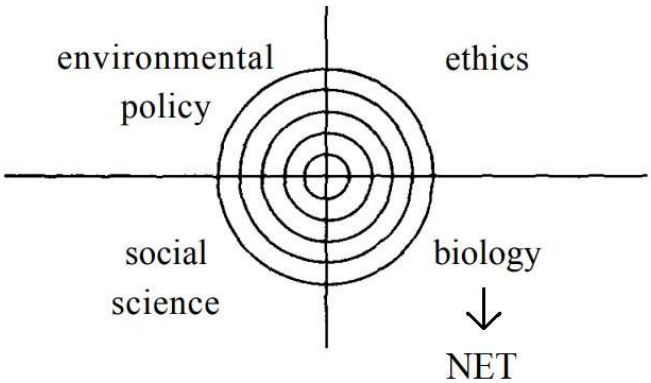

Figure 1. Untitled and revised drawing from *Consilience*, Wilson 1998.

Wilson believed that consilience could be visualized. **Figure 1** is adapted from an unlabeled drawing found in the opening pages of Consilience [4]. Embedded is a notable revision. In Wilson's Quadrant III (biology), I propose NET as the anti-discipline to biology (biology → NET).

For reduction-cum-construction, I swap "biological" for "NET" in Wilson's explanation of the drawing:

> Only in imagination can we travel clockwise from the recognition of environmental problems and the need for soundly based policy; to the selection of solutions based on moral reasoning; to the [NET] foundations of that reasoning; to a grasp of social institutions as the products of [NET], environment, and history. And thence back to environmental policy [4].

The challenge is to travel from quadrant to quadrant. The outer ring of the drawing represents the initial dialectic, which leads to inner rings of more penetrating questions and answers, where multiple fields become contiguous. One goes from the simple questions of "what?" to the non-obvious "why's?" and practical "how's?" Mindful that consilience is a "jumping together of knowledge" [4], the solution lies in the bull's-eye: a coherent policy that simultaneously realizes the objectives of the UNCBD and UNFCCC.

Consilience with the arrow pointing down from biology to NET in Quadrant III is fundamentally different from consilience without the arrow. Supporting this assertion is an accidental experiment. With sympathies for reductionism, Robert M. Sapolsky achieves consilience in *Behave: The Biology of Humans at Our Best and Worst* [10]. The author, both a neurobiologist and a primatologist, unifies collateral fields such as animal behavior and criminology through evolution. The narrative has won international acclaim and is a New York Times bestseller for non-fiction. Thermodynamics is not indexed. Climate change appears on just two of the 790 pages.

In **Figure 1**, queries into the evolution of human behavior can be inferred as potentially consilient with climate change and biodiversity loss through the adjective "non-equilibrium" in NET. The suggested anti-discipline of biology shifts the priority of queries about human behavior. Cognitive dissonance and goal-directed behavior, also not indexed in Behave, would quickly move center stage. One begins pursuit of consilience in Quadrant III (biology → NET), traveling clockwise or counterclockwise with frequent returns to NET. Each quadrant merits elaboration in this Review.

3. Quadrant III (biology → NET)

3.1. Climate change

The Economics of Climate Change (2006) by Sir Nicolas Stern is a 692-page tome and modern classic [11]. Like Sapolsky's *Behave*, Stern does not index thermodynamics. But unlike Sapolsky, Stern shows no sympathies for reduction. Economics is autonomous as implied in Stern's choice of title. For consilience of biodiversity and climate change through reduction, one must entertain what Albert Einstein was "convinced" was "the only physical theory of universal content concerning...that, within the framework of the applicability of its basic concepts, it will never be overthrown [viz., thermodynamics]" [12].

The First Law of Thermodynamics is that energy and matter are conserved. The Second, also known as the Entropy Law, is that disorder increases in a closed system. Heat death is, thankfully, not imminent. The Earth is an open system for energy but a closed one for matter, barring the occasional meteor or rocket. Order emerges on Earth at the expense of increasing disorder of the energy gradient (e.g., the food digested, the heat dissipated in crystalization, or the candle wax burned). Eric Schneider, a pioneer of NET, and Dorion Sagan, a science writer, explain the robustness of thinking thermodynamically:

> There are several differences between the gradient-fed cycling systems of weather and those of life. Living systems, for example, though gradient-based and cyclical, persist in the aggregate far longer than the average storm system. Nonetheless, both storm systems and those of life belong to the same class. Both are NET systems [13].

Ilya Prigogine, the 1977 Nobel Prize Laureate in Chemistry, describes emergent order in open-energy systems as "dissipative structures" [14]. One can tweak Schneider and Sagan's description: a storm system dissipates ocean-surface energy through its vortex; an organism dissipates food through its metabolism. Both are dissipative structures in NET systems.

Many phenomena can be reduced to Prigogine's core concepts of "cascading bifurcations", "boundary conditions", "non-linearity", "instability" and "fluctuations". Lawyers in the delegations of the COPs to the UNCBD and UNFCCC, please take note: thermodynamics is not a "theory" in the legal sense of that word, i.e. one of various explanations under consideration. For practical purposes, thermodynamics is a fact.

3.2. Biodiversity

The word "material" in the term "genetic material" was not defined in the UNCBD [7]. Is "material" both tangible and intangible or just tangible or just intangible? Just the intangible is the only reasonable answer for the objective of ABS in the UNCBD. Yet User Parties steadfastly defend the interpretation of material as just the tangible. Thermodynamic laws are uncompromising. Natural information is the object of access for R&D, regardless of whether the medium is biological matter or silico [15]. Any Party which insists otherwise should commission a scientist to denature a biological sample and carry out R&D.

By the First Law, all the matter in the sample will be conserved. By the Second, the information therein will have scrambled and made the sample worthless for R&D. Skeptics may save their money and cancel the commission. The expected results are indisputable by the Second Law; the experiment would belong to a class of wasteful exercises, such as the testing of a Perpetual Motion Machine [16]. Any interpretation of "material" in the definition of "genetic resources" as just the tangible is preposterous.

Genetic resources, interpreted as natural information for the purpose of R&D, covers transmission in any medium. In 2015, COP13 launched the placeholder "digital sequence information on genetic resources" (DSI), which restricts dematerialized genetic resources, prima facie, to the digital medium [17]. In so doing, COP13 created

a canyon-sized loophole for natural information communicated through other media, such as print or film.

The placeholder DSI duplicates the essential meaning of genetic resources, which is natural information. For DSI to ever become operative for the UNCBD, the COP would have to agree on a new decision which includes sequence information in media other than silico. Yet layering meanings contradictory to an official term would violate the Parsimony Principle. In a similar vein, redundancy belies the Multilateral Benefit-sharing Mechanism on DSI (MLM) of Decision 15/9 [18] and Decision 16/2 [19]. The MLM differs from Article 10 of the 2010 Nagoya Protocol to the UNCBD, titled "Global Multilateral Benefit-sharing Mechanism" (GMBSM), only for having introduced the loophole for non-digital sequence information [20].

3.3. What is life?

Let us fix our attention on the arrow pointing down from biology to NET in the drawing. The Nobel physicist Erwin Schrödinger posed a seemingly philosophical question in his 1943 lecture series *What is Life?*[21] Schrödinger's answer was, essentially, information. One human generation later, Francis Crick published "The Central Dogma of Molecular Biology", where "genetic information" figured prominently [22]. In the half-century since, much confusion has arisen over the role of information in the thermodynamic approach to evolution.

"Entropy" has two distinct meanings which share a similar mathematical formula. Equivocation ensues [23]. One meaning lies in the Second Law of Thermodynamics, the Entropy Law, whose statistical representation is the Boltzmann equation [24]. The other meaning comes from information theory, pioneered by Claude Shannon [25]. Counterintuitively, one can explore the Entropy Law and evolution without Shannon entropy or the Boltzmann equation. A ranking of structures for their dissipative impact on energy gradients obviates the need for quantifying their informational content á la Boltzmann or Shannon [26].

Synonymous with "dissipative structures" in the NET literature is the term "informed kinetic structures" [27]. The latter term advances consilience more than the former: some informed kinetic structures are natural, while others, human-made, i.e. artificial. One may affirm that "naturally informed, kinetic structures" and "artificially informed, kinetic structures" exhibit "structuring through dissipation" [28]. Life is, thermodynamically speaking, naturally informed, replicating kinetic structures while human culture and technology are artificially informed, kinetic structures.

3.4. Eusociality

One configuration of naturally informed, kinetic structures is eusociality in species, characterized by division of labor and complex social behavior [29]. Since childhood, Wilson was in awe of the social insects [30]. The self-deprecating "ant man" would emphasize that eusocial evolution has been extraordinarily successful (and rare) over the entire history of life. In lectures and publications, Wilson would ask his audience to compare the global biomass of ants to our own. We and they weigh roughly the same [29].

Homo sapiens sapiens is one of three mammalian species that evolved a high level of eusociality; the other two are African mole-rats, viz., *Heterocephalus glaber* and *Cryptomuys damarensis* [31]. Levered by eusociality, the population of *H. sapiens sapiens* expanded steadily 10,000 years ago through agriculture and colonization. Our biomass only took off in the last two hundred and fifty years through technological advances in industry and agriculture. By the Second Law, ever-improving artificially informed, kinetic structures have mediated and dissipated larger and more diverse energy and material flows into human flesh and voluminous waste destined for the sea, land and air. Climate change and biodiversity loss are the consequences of shifting boundary conditions in diverse energy gradients and thermodynamic sinks [32].

Seen through the lens of NET, the core concept of opportunity costs becomes more profound than economists realize. Wicken, who published foundational works on NET, emphasized that "*paths taken make other paths unavailable for the taking*" (italics mine) [27].

Consider two seemingly unrelated phenomena: The Yasuní Biological Reserve, a biodiversity hotspot in the Ecuadorian Amazon, and the current Fourth Industrial Revolution. The Reserve constitutes richly nested naturally informed kinetic structures in millions of species; the latter, artificially informed kinetic structures evidenced by millions of patents. The consquence of deforestation can be translated into NET. Oil exploration and drilling will extirpate naturally informed, kinetic structures which could have inspired an untold number of artificially informed, kinetic structures. Said less reductively, the concessions to drill have made paths of R&D unavailable for the taking in future industrial revolutions. Through the lens of reduction-cum-construction, the role of the COPs for both the UNCBD and UNFCCC is to keep all paths available for the taking.

Is this new? Don't economists already cover this in "option value"? They indeed do. The novelty lies in the impact of the synthesis. "Option value" does not trigger the same emotive reaction as do taking paths that will make other paths forever unavailable. Among the multiple emotions triggered are righteousness and remorse. Consilience through NET penetrates not only the cognitive domain but also the affective domain of learning. Neuroscientists tell us that the two are not separable, as philosophers had long thought [33]. Thus one understands Wilson's sentiment that "the loss of genetic and species diversity… is the folly that our descendants are least likely to forgive us" [34].

4. Quadrants I-IV (traveling the rings)

4.1. What is novel, useful and non-obvious?

In public lectures, Prigogine would speak of pragmatism in the pursuit of reduction, of how NASA used Newtonian equations to get a man to the moon and not Einsteinian relativity. Prigogine-the-reductionist set the bar high for deployment of reduction.

Wilson also sets the bar high for the complexity theory of Stuart Kauffman and fellow physicists at the Santa Fe Institute: "Their conclusions thus far are too vague and general to be more than rallying metaphors, and their abstract conclusions tell us

very little that is really new" [4]. That Wilson, like Prigogine, was unabashedly reductionistic, makes his assessment of Kauffman all the more stinging:

> [Kauffman's] arguments, like those of other leading complexity theorists, are original and directed at important problems. First time around, they sound good. But as an evolutionary biologist familiar with genetics, I have learned little from them. While wading through Kauffman's equations and peculiarly fustian prose, I realized that I already knew most of the results in a different context [4].

Aesthetics is not enough for consilience. An attorney might classify Kauffman's failure as not having met two of the three criteria for issuance of a patent, viz. novelty and utility. For biodiversity and climate change, consilience must provide a more persuasive argument than the same "results in a different context". So what then is new and useful in the thermodynamic nexus of the UNCBD and UNFCCC? Keeping all paths available for the taking is more persuasive than option values, even for economists such as myself, versed in the calculus of biodiversity valuation [35].

Wilson-the-field-biologist would have appreciated an example or two. Brazil is uniquely instructive, not only for being the most mega-diverse country on Earth but also for rushing headlong into the Fourth Industrial Revolution. Before I get ahead of myself, the arrow pointing down to NET in Quadrant III (biology → NET) must be further examined.

4.2. Bifurcation points

Barely perceptible conditions on the boundary can amplify and define the contours of an unfolding system, which would have been beyond anyone's lens of resolution before amplification. Only *ex post facto*, can one trace the causal chain. This is a central message from Prigogine.

One may say optimistically that the decisions of the COPs to the UNCBD and UNFCCC could be bifurcations points that will amplify to boundary conditions connoted with conservation and climate stabilization. Or one can be realistic. Impasse and irresolution are allowing artificially informed, kinetic structures to exacerbate biodiversity loss and accelerate the greenhouse effect [36].

At the COP15 of the UNFCCC, I launched *The Economics of the Yasuní Initiative: Climate Change as if Thermodynamics Mattered* [37], and spoke with delegates from developed and developing economies. Like the COPs to the UNCBD, power at COP15 to the UNFCCC seemed concentrated in nested dominance hierarchies within and among the delegations. This observation travels the ring clockwise from eusociality in Quadrant III (biology → NET) through Quadrant IV (social sciences) to Quadrant I (environmental policy) [37].

That the head of state is usually an alpha male is a cliché well deserved. Thinking reductively, one can say that Rafael Correa, president of Ecuador (2007 to 2017), strove to become a point of bifurcation when he proposed to the United Nations General Assembly in 2007 that developed countries pay Ecuador to forgo oil exploration in a hotspot of biodiversity, viz., The Yasuní Biological Reserve. Despite Correa's concerted efforts, the money never materialized. Of the $3.6 billion sought, only $116 million was pledged and $13 million, deposited [38]. The amounts pledged and deposited are more impactful when expressed as percentages of the monies

sought: less than 3% and 0.3%, respectively. Thinking reductively about these pledges and their non-fulfillment, the biologist might note that deception is an evolutionarily stable strategy across Animalia and Plantae. Only self-deception is uniquely human.

5. Quadrant IV (social science) to Quadrant II (ethics)

5.1. Rocking back and forth through Quadrant III (biology → NET)

Realpolitik must recognize that many carbon-rich countries are capital-poor. Try telling an alpha-male president that his constituents must continue in poverty and not do what capital-rich countries did to develop, i.e., industrialize with carbon. Correa spoke plainly: pay us half the worth of the oil and we will forgo the value of the other half. Even sympathetic delegates felt ill at ease. Why should any one OECD country fork over billions of dollars while fellow OECD countries free ride? Hardin's solution---mutual coercion, mutually agreed upon---did not obtain. In August 2013, Correa dismantled the Yasuní-ITT Initiative: "It was not charity that we sought from the international community, but co-responsibility in the face of climate change" [39]. Ecuador subsequently auctioned the petroleum blocks for drilling.

The ethicist might take the high road: Could not mega-diverse, carbon-rich but capital-poor countries follow the Golden Rule, i.e., doing to others what one wishes others would do unto them, i.e. support conservation? Hardin would say No. He insisted that ethics are situational in his ghoulish lifeboat metaphor [40]. Supporting conservation without compensation could translate into lost opportunities for human survival in the capital-poor countries (e.g. nutrition programs, water and sanitation projects, rural health clinics). That the Golden Rule does not prevail, also coheres with group selection in eusocial evolution.

The USA delegation was dismissive of the Initiative in a meeting with the Ecuador delegation. Later at COP15, Secretary of State Hillary Clinton announced that the US government would join other developed countries in a pledge of $100 billion for developing countries to adapt to climate change [41]. Fast foward. President-elect of Brazil Luiz Inácio Lula da Silva revisited Clinton's COP15 pledge at COP27 in Sharm-El-Sheik, Egypt in 2022, To the plenary, Lula said "I am here to collect!" (translation mine) [42]. The vigorous applause was acknowledgment *de facto* of the free riding that defeated The Yasuní-ITT Initiative ten years earlier.

Re-elected President Lula (2023–2026) persuaded the UNFCCC Parties to convene a COP in the Amazon basin. From 10–21 November 2025, 50,000 participants and some 150 heads of state will meet for COP30 in Belém, Brazil at the mouth of the Amazon River, where offshore oil drilling awaits a green light [43]. Belém is home to 2.5 million inhabitants, most of whom are impoverished. The Associated Press describes the slums as "plagued with pollution and violence" [44]. Traffic chokes Belém and will hamper the logistics of the tightly scheduled meetings. A newly constructed 13 km road extension of Avenida Liberdade will greatly alleviate congestion. It runs through a nature reserve [45].

Before participants traverse Avenida Liberdade, the view of ramshackle dwellings from the bus windows will juxtapose with the sleek infrastructure of the Convention Center. The short stretch of once virgin forest will be a unique opportunity

to tap into Bloom's affective domain of learning for delegates contemplating their collective role as a bifurcation point.

The BBC described Avenida Liberdade thus "along the partially built road, lush rainforest towers on either side - a reminder of what was once there" [46]. Scale matters, as Hardin emphasized in "The Tragedy". The 13 km of destroyed rainforest is miniscule by any country's standard, much less by Brazil's. In contrast, the planned re-building of BR-319, a 900 km dirt highway running from Manaus to Porto Velho, is gargantuan by any country's standards, including Brazil's [47]. The ethical issue is no longer whether Avenida Liberdade should have been extended through primary forest, but how to prevent BR-319, some 69 times longer, from being re-built. Delegates should recall that inauguration of the 1972 TransAmazonic Highway, helped usher in the Sixth Mass Extinction and accounts for "by far the largest source of GHG [greenhouse gas] emissions in Brazil since the early 1990s" [48].

The applause at COP27 to Lula's upbraiding of capital-rich Parties, drew on an innate sense of fairness, which cuts across Animalia as established in celebrated experiments by Frans de Waal [49]. *H. sapiens sapiens* is no exception. Brazilians are quick to remind the OECD that the Northern hemisphere was deforested in the 19th century and criscrossed with highways in the 20th. They ask rhetorically: is it fair that you deny us a single arterial road? In Bloom's cognitive domain, the answer is unexpected: Yes, it is fair.

The reason is the scale not only of deforestation on biodiversity and climate change but also the role of genetic resources in this the Fourth Industrial Revolution [50]. The abstraction of scale will not prevail in the decisions made by political leaders of impoverished peoples. Just as Correa needed tax revenue for social projects in Ecuador in 2007, Lula needs tax revenue for social projects in Brazil during his second presidency. The realpolitik is that without OECD payments to develop sustainably, the oils fields will be drilled and the highways, openned. This argument is also not specific to South America. It holds for many African countries (e.g. The Democratic Republic of the Congo).

The ethicist may persist: In the logic of the Initiative, will low-diversity, carbon-poor and capital-poor countries receive nothing? Although reasons exist to finance development of carbon-poor and low-diversity countries, storing carbon and conserving biodiversity are not among them.

The mainstream economist will object on distinct grounds, viz., subsidies are a distortion to the economy. Context and reflection are needed. The economy is already distorted by an almost instinctual insistence on equal treatment to drill and deforest, regardless of context. This insistence is as if there were no issue of scale in climate change or biodiversity loss—as if the 19th and 20th centuries never happenned. The insistence on equal treatment is also as if The Fourth Industrial Revolution were not ongoing in the 21st century.

By The General Theory of Second Best [51]—a watershed in microeconomics—one can justify the subisides as not only equitable but also effcient whenever they offset existing distortions that generate social costs or prevent social benefits. This is the economic justification of The Yasuní Initiative and applies to not re-building BR-319 as well as to suspending offshore drilling at the mouth of the Amazon River. The

logic finds footing in the "common but differentiated responsibilities and respective capabilities" established in Article 5 of the UNFCCC [6].

6. Four quadrants are not enough

6.1. Ecocriticism

From Section 5 one gleans that more fields of knowledge are requried to achieve a consilient environmental policy. **Figure 2** wedges in business administration, law, engineering and the humanities. While business administration, law and engineering are easily recognizable as relevant, less so are the humanities [4]. Why include them?

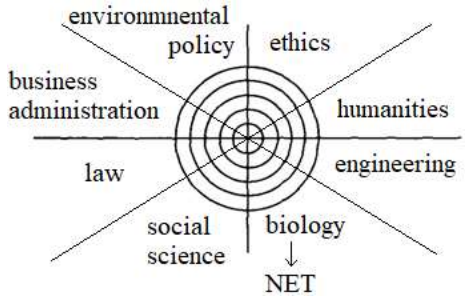

Figure 2. Untitled, revised and expanded from *Consilience*, Wilson 1998.

The reason is literally philosophical. French philosopher Jacques Ellul (1912–1994) claimed that public opinion is voluble and will shift with what people read in the morning newspaper. Ellul deduced:

> Government cannot follow opinion, opinion must follow the government. One must convince this present, ponderous, impassioned mass that government's decisions are legitimate and good and that its foreign policy is correct [52].

Through reasonable assumptions, public opinion is also self-misinformed. Regarding the UNCBD, people will assume that the treaty defines "conservation", which is its first objective. Unbelievably, the UNCBD does not define conservation. Without a definition, a reasonable interpretation of conservation is the absence of human activities on a scale that extinguishes species. This absence of human-induced extinction would have to occur over evolutionary time, which is measured in thousands of years.

To "convince this present, ponderous, impassioned mass" of the legitimacy, goodness and correctness of a conservation policy, will require sustainable preferences over 50 or more human generations. Yet only one or two human generations can induce extinction as attested by the TransAmazonic Highway. Grappling with intergenerational values lies in the eighth of **Figure 3** (humanities), where ecocriticism is defined as "the field of enquiry that analyzes and promotes works of art which raise moral questions about human interactions while also motivating audiences to live within a limit that will be binding over generations" [53].

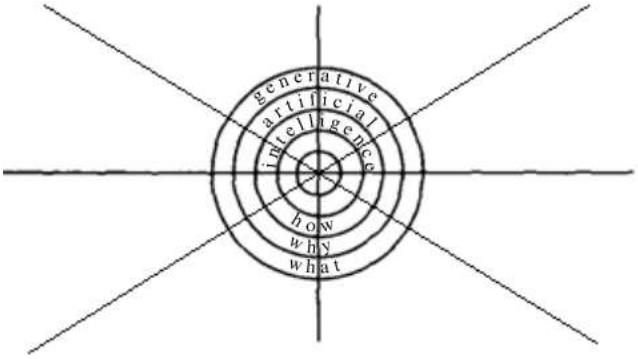

Figure 3. Untitled, stripped and revised from *Consilience*, Wilson 1998.

6.2. Ecocritic's choice

Given the visual proclivities of *H. sapiens sapiens*, film studies may be more effective for penetrating the affective domain than is literature. Helen Caldicott, founder of Physicians for Social Responsibility, which shared the 1985 Nobel Peace Prize with the NGO International Physicians for the Prevention of Nuclear War, speaks of how the 1956 novel *On the Beach,* was cathartic in her coming of age [54]. The novel was adapted into an award-winning movie. Because any work of art gets dated quickly, ecocritics would have to keep an updated filmography and bibliography, both popular and technical, which suggests how to live within limits [55]. Examples of popular works in the 21st century would be "Don't Look Up" [56] and *Under a White Sky* [57]. Governments would have to provide open access and promote the works.

6.3. The psychomotor domain

Complementing Bloom's cognitive and affective domains of learning is the psychomotor [58]. Wilson warns: "The most dangerous worldview is the worldview of those who have not viewed the world" [59]. "Collapse tourism" [60] and inclusive museums [61] lie in this third domain. For COP30, no conference daytrip would be required. As delegates board the Avenida-Liberdade bus to and for the meetings and Side Events, they need only look out the window.

6.4. Jumping together of knowledge

Returning to the cognitive domain of **Figure 2**, one may travel from humanities back to the social sciences. A contradiction belies introductory economics textbooks. Education is a public good largely financed by the State, yet preference formation is assumed outside the remit of mainstream economics. Etymology exposes the contradiction: the Latin root of the verb "to educate" (*educare*) means "to mold".

One returns to "biology → NET" in **Figure 2**. The preferences molded will channel what is dissipated, how it is dissipated, and into which sinks, the dissipated energy and matter flow. The policy implication is clear for the UNCBD and UNFCCC: the State should mold preferences to lever biophilia, suppress biophobia [62] and exalt a sustainable-life philosophy [63].

Mainstream economists will recoil. Ever since John Stuart Mill (1806–1873), most economists have embraced liberalism. They are also smitten with the aesthetics

of mathematics introduced into the discipline in the last half of the twentieth century. As Wilson wryly notes, economists have taken parsimony too far [4]. Logic dictates that sustainable preferences be molded and continuosly maintained. Granted, it is a tall order.

7. "The answer pre-exists…it is the question that must be discovered"—Jonas Salk [64]

7.1. Artificial Intelligence and dialectics

In **Figures 1** and **2**, the rings are unlabeled to draw the reader's attention to the quadrants and eighths. **Figure 3** does the opposite. The rings are labeled and the eighths are unlabeled.

Comprehension of eight or more fields is untenable. Each delegate will have a professional training which is a sliver in any one of the eighths of **Figure 3**. Just learning the vocabulary of disparate fields will discourage climbing the levels in Bloom's pyramid of the cognitive domain, viz., to understand, apply, analyze, synthesize and evaluate. The tribalism of eusociality will also come into play whenever unknown vocabulary is dismissed as jargon.

Generative Aritificial Intelligence can make the pyramid scalable. One begins with asking about definitions, i.e. the what-type questions. Platforms like ChatGPT maintain a registry of the dialetic as one progresses toward the more challenging queries in the inner rings. Answers are somewhere out there, as Jonas Salk presciently remarked.

7.2. Half-Earth, non-negotiability and taboos

The title of Wilson's 2016 book *Half-Earth* provokes why-type questions, which lie in the middle ring of **Figure 3**. Delegates to the COPs of the UNCBD may rejoin that The Global Biodiversity Framework already sets a target of protecting 30% of the planet's surface area by the year 2030 [65]. Wilson anticipates the obvious question:

> Why half? Why not one quarter or one third?... A biogeographic scan of Earth's principal habitats shows that a full representation of its ecosystems and the vast majority of its species can be saved within half the planet's surface. At one half and above, life on Earth enters the safe zone [59].

A thought experiment elucidates why not 30%, one quarter or one third. The expected lifespan in the developed countries is approximately 80 years. If the goal of half Earth is negotiable to something less than half, then few politicians would quibble with shaving off 1% of the remaining protected areas every year. Although such erosion would be imperceptible to the body politic, the accumulative effect over 80 years would be catastrophic. The half-Earth at one's birth would be approximately one-fifth Earth at one's death. Calculator.net can do the math [66].

The 50% limit must be "non-negotiable" in the sense advanced by philosopher John Rawls [67]. We return to the humanities. Caveat: uttering "non-negotiable" puts the discussion, ironically, in the mental frame to negotiate [68]. This takes us to the field of cognitive linguistics. We travel back and forth between the eighths of **Figure**

3. To be truly non-negotiable, shaving anything off half-Earth must never be uttered. In what eighth is the concept of taboo?

The universality of taboos [69] suggests an epigenetic rule that was selected over human evolution to dissipate energy gradients. One thinks of the psychological Westermark effect, which is not to mate with someone with whom one spent early childhood [70]. The taboo on incest solidifies the natural disinclination, which was selected to prevent homozygosity of deleterious recessive genes [70]. A similar epigenetic rule may exist on land use and could underpin a taboo over relaxation of half-Earth over thousands of years. The sacred forests and other prohibitions of indigenous cultures are reason for hope.

7.3. "How?" is the bull's-eye of the inner ring

Wilson left unaddressed how countries would transition to half-Earth. The economist will now ask: How should mega-diverse countries offset the opportunity costs of conserving huge swaths of habitats? One book review of *Half-Earth* was titled "Half-Earth or Half Solution?" [71]. The tried-and-true recipe for economic development is land-use conversion of forests and wetlands.

Realpolitik means financing a countervailing force to interests vested in expansion of the agricultural frontier. The nexus between the UNFCCC and the UNCBD extends to complementary sources of finance. The Nagoya Protocol to the UNCBD could be amended to capture and direct tens of billlion of dollars annually from ABS. Draft language has been proposed [72], whereby the GMBSM distributes "economic rents" to the coffers of government [73]. Distribution would be based on the percentage of geographic area of the species that harbor the natural information developed into commercially successful intellectual property [74]. The previous sentence may give pause to the delegates in the COP of the UNCBD.

"What do economists mean by rent?" ChatGPT generates an exhaustive answer. A follow-up query is more satisfying "Could one say that economic rent is the difference in the price one pays and the price under perfect competition?". ChatGPT explains the affirmative response concisely [75].

Scale always matters. In this the Fourth Industrial Revolution, almost two trillion dollars of biotechnology is being sold annually [76]. Collection of rent-rich royalties though the ABS modality of "bounded openness over natural information" [77] could align incentives toward living within the limit of half-Earth. Carbon emisisons would greatly decline as incentives align to protect habitats.

Regarding the abstraction of rents: the question pre-exists in the COP! Decision IX/12 asks: "Should economic rent be charged for access to genetic resources and what is the justification for such a rent or against such a rent? What should be the basis for the valuation of such rent?" [78] To date, not one COP or interessional meeting has vetted the question of rent in Decision IX/12. Within seconds, ChatGPT answers the question in the affirmative [79].

Other lacunae in the knowledge of delegates will emerge. Box 1 presents questions that they may put to ChatGPT. Box 2 are questions that university graduate students, having studied the UNCBD and UNFCCC, have already put to ChatGPT. The respective answers were generated in less than one minute.

Artificial Intelligence levels the playing field. COP after COP in both the UNCBD and the UNFCCC, capital-rich Parties have out-maneouvered their capital-poor counterparts. Decision 16/2 of the UNCBD is perhaps the most egregious manipulation, being "unencumbered by economic thinking" [80] and "fundamentally flawed" [81]. The alternative modality for the Decision 16/2, viz., bounded openness over natural information, is a few clicks away [82]. Doubts can be addressed through Artificial Intelligence.

8. Conclusion

Biodiversity and climate change are reducible to non-equilibrium thermodynamics. The reduction generates two policy implications that already exist: Garrett Hardin's "living within limits" and E.O. Wilson's "half-Earth". Realization of both polcies requires "mutual coercion, mutally agreed upon", as advocated by Hardin in "The Tragedy of the Commons". Amendments to the UNFCCC and UNCBD, or additional Protocols to the treaties, can achieve the necessary agreement to coerce.

Synergies can emerge from synchrony in the amendments or new protocols. Broad application of The Yasuni-ITT Initiative in the COP of the UNFCCC will diminish tropical biodiversity loss, while adoption of bounded openness in the COP of the UNCBD will reduce GHG emissions. Although consilience of the relevant fields will bring the unification into focus, delegates and stakeholders may be overwhelmed. Each delegate can address his or her lacunae in knowledge through queries put to an Artificial Intelligence platform.

Is such blue-skies thinking realistic?

Polymath Nicholas Georgescu-Roegen perceived an inexorable slide into extinction in *The Economic Process and The Entropy Law* [83]. He obsessed with this cheerless thought:

> Will mankind listen to any program that implies a constriction of its addiction to exosomatic comfort? Perhaps the destiny of man is to have a short but fiery, exciting, and extravagant life rather than a long, uneventful, and vegetative existence. Let other species -- the amoebas, for example -- which have no spiritual ambitions inherit an earth still bathed in plenty of sunshine [84].

Georgescu-Roegen was wrong. With a runaway greenhouse effect, not even the amoebas will enjoy all that sunshine. On Venus, where the greenhouse effect did run away, the temperate is 475 degrees Celsius [85]. Non-equilibrium thermodynamics offers a ray of hope and a peculiar consolation:

(1) *H. sapiens sapiens* can take a path that leads to a long and satisfying existence; or

(2) Naturaly informed, replicating kinetic structures have probably emerged elsewhere in the Cosmos. Some may be truly intelligent and not self-extinguishing. As I write these words, *The Guardian* reports that extraterrestial life may have been discovered a century of light years away [86].

Regarding number two, there is no good English translation for the Spanish expression *consuelo de tontos*.

Box 1. Professor queries to ChatGPT.

Knowledge is fragmented. No one has or will have full command. Ever since Socrates, learning has been conceived as a process of discovery. Both teacher and student discover their own lacunae and thereby how to strengthen his to her argument. Artificial Intelligence accelerates the process. Below are several queries corresponding to the rings of **Figure 3**. The answers through Artificial Intelligence constitute a virtual dialetic. The corresponding links have been placed in the public domain.

Outer ring: What is the meaning of dialectics, cascading bifurcations, alpha-male, dominance hiearchies, epigenetic rule, the Parsimony Principle, Perpetual Motion Machine? ChatGPT answer [87].

Middle Ring: Why does the term "natural information" better capture the notion of diversity than the number of species? Why is the General Theory of Second Best a watershed in microeconomics? Why is economic rent misunderstood in conversation? Why does the COP of the CBD not define basic terms like material or conservation? Why are Decisions in the COPs deemed toothless? ChatGPT answers [88].

Inner Ring: How do the Conference of the Parties choose delegates to the UNCBD and UNFCCC? How would a Party propose a Protocol? How much time may lapse between proposing a Protocol and ratification? How many species have been lost since ratification of the UNCBD in December 1993? How much have ppm of CO2 increased since the ratification of the UNFCCC in 1994. How long before extinction of extant biodiversity and unstoppable climate change become a fait acommpli? ChatpGPT answers [89].

Box 2. University gratudate student queries to ChatGPT.

Space is limited in any manuscript. Not every term can be defined. Nor can every implication of a policy proposal be entertained. Students submitted questions that they found unaddressed in the manuscript. Several of the most relevant questions were selected. The answers from Artificial Intelligence simulate movement to the bull's-eye of **Figure 3**.

Outer ring: What is bounded openness, collapse tourism, cognitive linguistics, natural information, nexus, option value, reduction in science? ChatGPT answers [90].

Middle ring: Why are the articles and provisions of the UNCBD and UNFCCC not enforced? Why is thermodynamics more robust than evolution as a foundation for consilience in an environmental policy? Why is "natural information" the preferable interpretation of "genetic resources" for the third objective of the CBD, viz. access and benefit sharing? Why does cognitive linguistics suggest that the mental framing of "non-negotiable" could be counterproductive for achieving the constraint? Why is the absence of a definition of "conservation" in the CBD more indicative of diplomatic dysfunction than intended ambiguity? Why do the recommendations of "living within limits" and "half-Earth" negate discounting future costs and benefits? Why do we care about conservation of biodiversity, given how depressing is thermodynamics in the long run? ChatGPT answers [91].

Inner ring: How is irreversibility intrinsic to the reduction of biology to NET? How does NET apply to ecosystem transitions? How does NET explain the evolutionary success of eusocial species like ants and humans? How could delegates of the COPs be educated in NET? How do infrastructure projects in biodiverse-rich habitats close paths for development of future R&D in biotechnology? How would the GMBSM distribute rent-rich royalty income fairly among Parties? How does international law presently govern DSI? ChatGPT answers [92].

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Abbreviations

ABS	"Access to genetic resources" and the "fair and equitable sharing of benefits arising out of the utilization of genetic resources"
COP	Conference of the Parties
DSI	Digital sequence information on genetic resources
GHG	Greenhouse Gas
GMBSM	Global Multilateral Benefit-sharing Mechanism
ITT	Ishpingo-Tambococha-Tiputini
MLM	Multilateral Benefit-sharing Mechanism on DSI

NET	non-equilibrium thermodynamics
UNCBD	Convention on Biological Diversity
UNFCCC	Framework Convention on Climate Change
UNSCBD	United Nations Secretariat of the Convention on Biological Diversity

References

1. Smith A. An Inquiry into the Nature and Causes of the Wealth of Nations; 1776. Available online: https://www.gutenberg.org/ebooks/3300 (accessed on 18 June 2025).
2. Samuelson PA, Nordhaus WD. Economics, 18th ed. New York: McGraw-Hill; 2005.
3. Zimmer C. Edward O. Wilson, top evolutionary biologist, dies at 92. The New York Times. 2021.
4. Wilson EO. Consilience. New York: Alfred A Knopf; 1998.
5. Wilson EO. The concepts of disciplines and antidisciplines. Routledge; 1977.
6. UN Framework Convention on Climate Change. Available online: https://unfccc.int/resource/docs/convkp/conveng.pdf (accessed on 18 June 2025).
7. UN Convention on Biological Diversity. Available online: https://www.cbd.int/convention/articles/default.shtml?a=cbd-01 (accessed on 18 June 2025).
8. Bloom BS. Taxonomy of Educational Objectives: The Classification of Educational Goals. In: Handbook I: cognitive domain. New York: David McKay Company; 1956.
9. Hardin G. The Tragedy of the Commons. Science. 1968; 162(3859): 1243-1248. doi: 10.1126/science.162.3859.1243
10. Sapolsky RM. Behave: The Biology of Humans at our Best and Worst. USA: Penguin Books; 2018.
11. Stern N. The Economics of Climate Change. London: HM Treasury; 2006.
12. Schilpp P. Albert Einstein, Philosopher-Scientist: The Library of Living Philosophers Volume VII. Open Court; 1998.
13. Schneider ED, Sagan D. Into the Cool: Energy Flow, Thermodynamics and Life. Chicago and London: University of Chicago Press; 2005.
14. Prigogine I, Stengers I. Order out of chaos: Man's new dialogue with nature. Boulder and London: Shambhala/New Science Library; 1984.
15. Vogel JH, Ruiz Muller M, Angerer K, et al. Bounded Openness: A Robust Modality of Access to Genetic Resources and the Sharing of Benefits. Plants People Planet. 2022; 4(1): 13-22. doi: 10.1002/ppp3.10239
16. Hardin G. Living within Limits. New York: Oxford University Press; 1993.
17. UN Convention on Biological Diversity. Report of the Ad Hoc Technical Expert Group on Digital Sequence Information on Genetic Resources. Available online: https://www.cbd.int/doc/c/4f53/a660/20273cadac313787b058a7b6/dsi-ahteg-2018-01-04-en.pdf (accessed on 18 June 2025).
18. UN Secretariat of the Convention on Biological Diversity. Decision 15/9, Digital Sequence Information on Genetic Resources. Available online: https://www.cbd.int/doc/decisions/cop-15/cop-15-dec-09-en.pdf (accessed on 18 June 2025).
19. UN Secretariat of the Convention on Biological Diversity. Decision 16/2, Digital Sequence Information on Genetic Resources. Available online: https://www.cbd.int/doc/decisions/cop-16/cop-16-dec-02-en.pdf (accessed on 18 June 2025).
20. Vogel JH. Submission of views on issues for further consideration for digital sequence information on genetic resources. Available online: https://www.cbd.int/notifications/2023-003\ (accessed on 18 June 2025).
21. Schrödinger E. What is Life? The Physical Aspect of the Living Cell. Cambridge: Cambridge University Press; 1944.
22. Crick F. Central Dogma of Molecular Biology. Nature. 1970; 227(5258): 561-563. doi: 10.1038/227561a0
23. Britannica. Equivocation: logical fallacy. Available online: https://www.britannica.com/topic/equivocation (accessed on 18 June 2025).
24. Cercignani C. The Boltzmann Equation and Its Applications. Springer New York; 1988.
25. Shannon C, Weaver W. The Mathematical Theory of Communication. Urbana, Illinois: University of Illinois Press; 1949.
26. Vogel JH. Evolution as an entropy driven process: An economic model. Systems Research. 1988; 5(4): 299-312. doi: 10.1002/sres.3850050403
27. Wicken JS. Evolution, Thermodynamics, and Information. New York: Oxford University Press; 1987.
28. Wicken JS. The cosmic breath: Reflections on the thermodynamics of creation. Zygon: Journal of Religion and Science. 1984; 19(4). doi: 10.1111/j.1467-9744.1984.tb00943.x

29. Wilson EO. The Social Conquest of Earth. New York: WW Norton; 2012.
30. Wilson EO. The naturalist. Washington DC: Island Press; 1994.
31. Deplazes-Zemp A. Fairness, equity and efficiency for the Convention on Biological Diversity and the Nagoya Protocol: Analysis of a rodent, a snail, a sponge and a virus. Available online: https://www.abs-biotrade.info/fileadmin/Downloads/Resources/Fairness-Equity-Efficiency-for-the-CBD-and-the-NP/Study-Fairness-Equity-Efficiency-for-the-CBD-and-the-NP-2021.pdf (accessed on 18 June 2025).
32. Vogel JH. Entrepreneurship, evolution, and the entropy law. The Journal of Behavioral Economics. 1989; 18(3): 185-204.
33. Damasio A. Descartes' Error: Emotion, Passion and the Human Brain. New York: Putnam; 1994.
34. Wilson EO. Biophilia. Cambridge, Massachusetts: Harvard University Press; 1984.
35. Dasgupta P. The Economics of Biodiversity: the Dasgupta Review – Full Report. London: HM Treasury; 2021.
36. Schmidt LJ. Scientists assess potential for super greenhouse effect in Earth's tropics. Global Climate Change. NASA; 2018.
37. Vogel JH. The Tragedy of Unpersuasive Power: The Convention on Biological Diversity as Exemplary. International Journal of Biology. 2013; 5(4). doi: 10.5539/ijb.v5n4p44
38. Marchán E, Vallejo J. Ecuador's Yasuní-ITT Initiative: the fate of one of the world's most biodiverse regions. Available online: https://americasquarterly.org/blog/ecuadors-yasuni-itt-initiative (accessed on 18 June 2025).
39. Watts J. Ecuador approves Yasuni national park oil drilling in Amazon rainforest. Available online: https://www.theguardian.com/world/2013/aug/16/ecuador-approves-yasuni-amazon-oil-drilling (accessed on 18 June 2025).
40. Hardin G. Lifeboat ethics: the case against helping the poor. Psychology Today. September 1974. Available online: https://www.garretthardinsociety.org/articles/art_lifeboat_ethics_case_against_helping_poor.html (accessed on 18 June 2025).
41. Khastagir A. ZCZC, BSS-, COP15-AGREEMENT. Available online: https://unfccc.int/sites/default/files/cop15_mw_cop15_stories.pdf (accessed on 18 June 2025).
42. Rede TVT. COP 27: Lula calls for rich countries to fulfill their climate promises (Portuguese). Available online: (accessed on 18 June 2025).
43. Hughes E. Brazil's Amazon megaprojects threatens Lula's green ambitions. Available online: https://apnews.com/article/brazil-lula-amazon-indigenous-oil-belo-monte-d47e9bbf748d7b2477333b1b4a09a40b (accessed on 18 June 2025).
44. AP. Video: Belem, host of COP30, is Amazonian city plagued with pollution and violence. Available online: https://apnews.com/video/brazil-amazon-river-waterways-pollution-violence-f67de7f82bc54b858229db807aac699f (accessed on 18 June 2025).
45. News9 Live. Video: Brazil denies COP30 link to controversial Amazon road. Available online: https://www.youtube.com/watch?v=xuq-uDQcI3A (accessed on 18 June 2025).
46. Wells I. Amazon forest felled to build road for climate summit. Available online: https://www.bbc.com/news/articles/c9vy191rgn1o (accessed on 18 June 2025).
47. Kelly B, Boadle A. Brazil's Lula backs highway through Amazon that could drive deforestation. Available online: https://www.reuters.com/world/americas/brazils-lula-backs-highway-through-amazon-that-could-drive-deforestation-2024-09-11/ (accessed on 18 June 2025).
48. Climate Action Tracker. Brazil. Available online: https://climateactiontracker.org/countries/brazil/ (accessed on 18 June 2025).
49. de Waal F. Moral behavior in animals. Available online: https://www.youtube.com/watch?v=GcJxRqTs5nk (accessed on 18 June 2025).
50. Witkowski JA. The Driving Forces of Biotechnology. Nature Biotechnology. 1993; 11(5): 620-621. doi: 10.1038/nbt0593-620
51. Lipsey RG, Lancaster K. The General Theory of Second Best. The Review of Economic Studies. 1956; 24(1): 11. doi: 10.2307/2296233
52. Ellul J. Propaganda: The Formation of Men's Attitudes. New York: Knopf; 1965.
53. Gomides C. Putting a New Definition of Ecocriticism to the Test: The Case of The Burning Season, a Film (Mal)Adaptation. Interdisciplinary Studies in Literature and Environment. 2006; 13(1): 13-23. doi: 10.1093/isle/13.1.13
54. Caldicott H. Helen Caldicott in her own words. Available online: https://www.wagingpeace.org/helen-caldicott-in-her-own-words/ (accessed on 18 June 2025).

55. Vogel JH, Robles J, Gomides C, Muñiz C. Geopiracy as an emerging issue in intellectual property rights: The rationale for leadership by small states. Tulane Environmental Law Journal. 2008; 21: 391–406.
56. McKay A. Don't look up. Hyperobject Industries and Bluegrass Films; 2021.
57. Kolbert E. Under a White Sky: The Nature of the Future. New York: Crown Publishing Group; 2021.
58. Bloom BS. Reflections on the development and use of the taxonomy". In: Bloom's Taxonomy: A Forty-year Retrospective. Chicago: National Society for the Study of Education; 1994.
59. Wilson EO. Half-Earth. New York: WW Norton; 2016.
60. Vogel JH. Collapse Tourism: Reflections Floating Face Down. Ometeca: Science and Humanties. 2010.
61. Vogel J. The Museum of Bioprospecting, Intellectual Property, and the Public Domain. Anthem Press; 2010.
62. Kellert SR, Wilson EO. The Biophilia Hypothesis. Washington DC: Island Press; 1993.
63. Schumacher E. Small is Beautiful: Economics as if People Mattered. London: Blond & Briggs, Ltd.; 1973.
64. Bill.moyers.com. Jonas Salk on Searching for the Next Medical Miracle. Available online: https://billmoyers.com/content/jonas-salk/ (accessed on 18 June 2025).
65. UN Secretariat of the Convention on Biological Diversity. COP15: Nations Adopt Four Goals, 23 Targets for 2030 in Landmark UN Biodiversity Agreement. Available online: https://www.cbd.int/article/cop15-cbd-press-release-final-19dec2022 (accessed on 18 June 2025).
66. Calculator.net. Available online: https://www.calculator.net/exponent-calculator.html?base=0.99&exponent=80&fresult=&x=60&y=21 (accessed on 18 June 2025).
67. Freeman S. Stanford Encyclopedia of Philosophy. Available online: https://plato.stanford.edu/entries/original-position/ (accessed on 18 June 2025).
68. Lakoff G. Don't Think of an Elephant: Know your Values and Frame the Debate. Vermont: Chelsea Green Publishing; 2004.
69. Britannica. Taboo. Available online: https://www.britannica.com/topic/taboo-sociology (accessed on 18 June 2025).
70. Shepher J. Incest: A bioSocial View. Cambridge, Massachusetts: Academic Press; 1983.
71. Rotkin M. Half-Earth or half solution?: E.O. Wilson's solution to species loss. Available online: https://www.thesolutionsjournal.com/article/half-earth-half-solution-e-o-wilsons-solution-species-loss/ (accessed on 18 June 2025).
72. Ruiz Muller M, Vogel JH, Angerer K. Fairness, Equity and Efficiency for the Convention on Biological Diversity and the Nagoya Protocol: Analysis of a Rodent, a Snail, a Sponge and a Virus. Available online: https://www.abs-biotrade.info/fileadmin/Downloads/Resources/Fairness-Equity-Efficiency-for-the-CBD-and-the-NP/Study-Fairness-Equity-Efficiency-for-the-CBD-and-the-NP-2021.pdf (accessed on 18 June 2025).
73. Vogel JH, Ruiz Muller M, Angerer K, May C. Movement Forward on ABS for the Convention on Biological Diversity: Bounded Openness over Natural Information. Available online: https://www.southcentre.int/tag/global-multilateral-benefit-sharing-mechanism-gmbsm/ (accessed on 18 June 2025).
74. Vogel JH, Jiménez-Revelles NC, Maldonado-Ramírez de Arellano XA. Decision 15/9 and the Nagoya Protocol: Who should get what in the Multilateral Benefit-Sharing Mechanism?. Available online: https://www.southcentre.int/wp-content/uploads/2024/09/RP210_Decision-15-9-and-the-Nagoya-Protocol_EN.pdf (acessed on 18 June 2025).
75. OpenAI. ChatGPT Response to 'What Do Economists Mean by Rent?'. Available online https://chatgpt.com/share/6808f793-7958-8005-8618-92978ee088b3 (accessed on 18 June 2025).
76. Cervicorn Consulting. Biotechnology market size, share, trends, report 2025 to 2034. Available online: https://www.cervicornconsulting.com/biotechnology-market (accessed on 18 June 2025).
77. Vogel JH, Santori-Aymat ME, Tomaiconza Ó, et al. Bounded openness over natural information. In: Elgar Encyclopedia of Ecological Economics. London: Edward Elgar Publishing Ltd.; 2023. Available online https://doi.org/10.4337/9781802200416.ch06 (accessed on 18 June 2025).
78. UN Secretariat of the Convention on Biological Diversity. COP9 Decision IX/12. Available online: https://www.cbd.int/decision/cop?id=11655 (accessed on 18 June 2025).
79. Open AI. ChatGPT. Should economic rent be charged?. Available online: https://chatgpt.com/share/6808fca7-f510-8005-ae6f-012ea8afc28e (accessed on 18 June 2025).
80. Vogel JH. UN biodiversity decision 16/2 is 'unencumbered by economic thinking' (analysis). Available online: https://news.mongabay.com/2025/02/un-biodiversity-decision-16-2-is-unencumbered-by-economic-thinking-analysis/ (accessed on 18 June 2025).

81. Maia BG, Bourgeois-Gironde S. Analysis of the Working Group's Recommendations and COP 16 Decision 1/62 on Digital Sequence Information. Available online: https://doi.org/10.1111/1758-5899.70013 (accessed on 18 June 2025).
82. Vogel JH. Alternative Modality for Landmark Decision of UN Convention on Biodiversity: Bounded Openness over Natural Information. SouthViews. Geneva: South Centre; 2025. Available online https://www.southcentre.int/wp-content/uploads/2025/08/SV291_250808.pdf (accessed on 18 June 2025).
83. Georgescu-Roegen N. The Economic Process and The Entropy Law. Cambridge, Massachusetts: Harvard University Press; 1971.
84. Georgescu-Roegen N. Energy and Economic Myths. Southern Economic Journal. 1975; 41(3): 347. doi: 10.2307/1056148
85. Venus. NASA Solar System Exploration. Available online: https://solarsystem.nasa.gov/planets/venus/overview/#:~:text=Surface%20temperatures%20on%20Venus%20are,and%20thousands%20of%20large%20volcanoes (accessed on 18 June 2025).
86. Devlin H. Scientists hail 'strongest evidence' so far for life beyond our solar sytem. Available online: https://www.theguardian.com/science/2025/apr/17/scientists-hail-strongest-evidence-so-far-for-life-beyond-our-solar-system (accessed on 18 June 2025).
87. OpenAI. ChatGPT Responses to What is the meaning of dialectics?. Available online: https://chatgpt.com/share/680bdaed-dee4-8005-8b94-ea4a925aaf3a (accessed on 18 June 2025).
88. OpenAI. ChatGPT Responses to Why does the term "natural information" better capture the notion of diversity?. Available online: https://chatgpt.com/share/680b00ff-5d0c-8005-8c70-7ca826eae220 (accessed on 18 June 2025).
89. ChatGPT Responses to How do the Conference of the Parties choose delegates?. Available online: https://chatgpt.com/share/680bdc5d-fd68-8005-8a9f-b08f91fb3dca (accessed on 18 June 2025).
90. OpenAI. ChatGPT Responses to What is bounded openness? Available online: https://chatgpt.com/share/681a3542-f20c-8005-b509-3a15808d56b8 (accessed on 18 June 2025).
91. OpenAI. ChatGPT Responses to Why are the articles and provisions of the CBD and FCCC not enforced?. Available online: https://chatgpt.com/share/681a36c4-4400-8005-9a08-1a485f09b5ff (accessed on 18 June 2025).
92. OpenAI. ChatGPT Responses to How is irreversibility intrinsic to the reduction of biology to NET?. Available online: https://chatgpt.com/share/681a3755-c544-8005-a5ae-229c53844789 (accessed on 18 June 2025).