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Decision 15/9 and the Nagoya Protocol: Who should get what in the Multilateral Benefit-Sharing Mechanism?

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SOUTH CENTRE

RESEARCH PAPER

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ABSTRACT

Article 10 of the Nagoya Protocol (NP), “Global Multilateral Benefit-Sharing Mechanism” (GMBSM), asks Parties to consider the distribution of benefits derived from the utilization of genetic resources in transboundary situations. A literature exists which applies the economics of information to genetic resources, when interpreted as “natural information”. The policy implication would incentivize reduction in the drivers of mass extinction, through economic rents in royalty obligations. Fifteen cases become thought experiments on how to share royalty income. A sixteenth case addresses the TP53 gene in elephants, which may revolutionize oncology. In parallel to Article 10 of the NP is Decision 15/9 of the fifteenth Conference of the Parties to the Convention on Biological Diversity. That Decision establishes a “multilateral benefit-sharing mechanism from the use of digital sequence information on genetic resources”. Redundancy with the GMBSM is only apparent. The Decision omits rents and thus renders its mechanism inefficient, unfair and inequitable.

L'article 10 du protocole de Nagoya (PN), intitulé « Mécanisme multilatéral mondial de partage des avantages » (MMPA), demande aux parties d'envisager la répartition des avantages découlant de l'utilisation des ressources génétiques dans les situations transfrontalières. Il existe une littérature qui applique l'économie de l'information aux ressources génétiques, lorsqu'elles sont interprétées comme des « informations naturelles ». L'implication politique inciterait à réduire les facteurs d'extinction massive, par le biais de rentes économiques dans les obligations de redevances. Quinze cas deviennent des expériences de réflexion sur la manière de partager les revenus des redevances. Un seizième cas concerne le gène TP53 chez les éléphants, qui pourrait révolutionner l'oncologie. Parallèlement à l'article 10 du PN, la décision 15/9 de la quinzième conférence des parties à la Convention sur la diversité biologique a été adoptée. Cette décision établit un « mécanisme multilatéral de partage des avantages découlant de l'utilisation d'informations sur les séquences numériques de ressources génétiques ». La redondance avec le GMBSM n'est qu'apparente. La décision omet les rentes et rend ainsi son mécanisme inefficace, injuste et inéquitable.

El artículo 10 del Protocolo de Nagoya (PN), «Mecanismo Global Multilateral de Participación en los Beneficios» (GMBSM), pide a las Partes que consideren la distribución de los beneficios derivados de la utilización de los recursos genéticos en situaciones transfronterizas. Existe bibliografía que aplica la economía de la información a los recursos genéticos, cuando se interpretan como «información natural». Las implicaciones políticas incentivarían la reducción de los factores de extinción masiva, a través de las rentas económicas en las obligaciones de regalías. Quince casos se convierten en experimentos de reflexión sobre cómo repartir los ingresos por derechos de propiedad intelectual. Un decimosexto caso se refiere al gen TP53 de los elefantes, que puede revolucionar la oncología. Paralelamente al artículo 10 del PN se encuentra la Decisión 15/9 de la XV Conferencia de las Partes en el Convenio sobre la Diversidad Biológica. Dicha Decisión establece un «mecanismo multilateral de participación en los beneficios derivados de la utilización de información digital sobre secuencias de recursos genéticos». La redundancia con el GMBSM es sólo aparente. La Decisión omite las rentas y, por tanto, hace que su mecanismo sea ineficaz, injusto e inequitativo.

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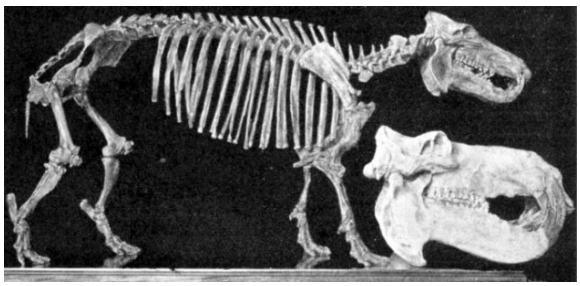
E.O. Wilson
(1929-2021)
Ragesoss, CC BY-SA 3.0

Multilateral
metaphor
Wmeinhart, CC BY-SA 3.0



HIPPO
(acronym, mnemonic, explanation)
Osborn, Public Domain

1. INTRODUCTION

The property-rights approach is pragmatic. Claims on attributes of property do not ensue if the costs in making a legal claim exceed the benefit.[1] Annual sales in biotechnology are now $1.4 trillion.[2] Claims for benefit sharing from the use of genetic resources in research and development (R&D) have greatly surpassed the cost of establishing a "global multilateral benefit-sharing mechanism" (GMBSM), which is the title of Article 10 of the 2010 Nagoya Protocol (NP) to the 1992 Convention on Biological Diversity (CBD).[3] The GMBSM is economically worthwhile. Benefits, shared rationally, could incentivize the conservation and sustainable use of genetic resources.[4] Counterintuitively, natural history throws light on how such sharing could be fair and equitable.

Efficiency militates against redundancy. The Conferences of the Parties (COPs) must not re-invent the wheel under the contentious placeholder "DSI".[5] Decision 15/9 of COP15 establishes a "multilateral mechanism for benefit-sharing [sic] from the use of digital sequence information on genetic resources, including a global fund".[6] The "multilateral mechanism" is essentially the GMBSM of Article 10 of the NP.[7]

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[1] Yoram Barzel, *Economic Analysis of Property Rights* (Cambridge University Press, New York, 1989), p. 63.
[2] See Precedence Research, June 9, 2024. Available from https://www.precedenceresearch.com/biotechnology-market.
[3] See Convention on Biological Diversity, "Global Multilateral Benefit-sharing Mechanism", Article 10, *Text of the Nagoya Protocol* (2011). Available from https://www.cbd.int/abs/text/articles?sec=abs-10.
[4] Joseph H. Vogel, Manuel R. Muller, Klaus Angerer and Christopher May, "Movement Forward on ABS for the Convention on Biological Diversity: Bounded Openness over Natural Information", Research Paper No. 160 (Geneva, The South Centre, 2022). Available from https://www.southcentre.int/research-paper-160-21-july-2022/.
[5] See "Sunk Costs: Avoiding the 'Double Down' Trap" in *Common trading biases and how to avoid them*, Britannica Money, 9 June 2024. Available from https://www.britannica.com/money/behavioral-biases-in-finance#ref360574.
[6] See CBD, "Digital Sequence Information on Genetic Resources", CBD/COP/DEC/15/9, 19 December 2022. Available from https://www.cbd.int/doc/decisions/cop-15/cop-15-dec-09-en.pdf.
[7] Joseph Henry Vogel, "Economics Affords Powerful Abstraction: A *Bauplan* Exists for the Isomorphic Global Multilateral Benefit-Sharing Mechanism", Submission of views on the issues set out in the Annex to the Decision Adopted by The Conference of the Parties to the Convention on Biological Diversity15/9, Digital Sequence Information on Genetic Resources, 19 March 2023. Available from https://www.cbd.int/notifications/2023-003.

2. LANDMARKS IN NATURAL AND HUMAN HISTORY COINCIDE IN 1993

Impetus for mass extinction began with the inauguration of the Transmigrasi resettlement policy in Indonesia in 1965[8] and the Trans-Amazonian Highway in Brazil in 1972.[9] By the mid-1980s, the threat was not just in the tropics.

No biologist sounded the alarm with more gravitas than did E.O. Wilson. How to stanch the hemorrhaging of life itself? The distinguished Harvard professor assumed the editorship of the 1988 volume *BIODIVERSITY*, which boasted 57 chapters drawn from an international forum held two years prior under the auspices of the National Academy of Science and the Smithsonian Institution.[10] The closing teleconference was downlinked to 10,000 participants at 100 sites.[11] That and other conscience-raising events led to the negotiation of the CBD in Nairobi, Kenya under the auspices of The United Nations Environmental Programme (UNEP).[12]

The treaty opened for signature by heads of state on 5 June 1992 at The Earth Summit, more commonly known as Rio'92. On 29 December 1993, ninety days after the 30th ratification of a signatory Party, the CBD became international law.[13] As of this writing, fifteen COPs have convened, where 196 Parties decide how the Convention will move forward on three interrelated objectives - conservation, sustainable use and "access to genetic resources", and the "fair and equitable sharing of benefits arising from their utilization" (known by the acronym ABS).[14] The year 1993 also coincides with the Nobel Prize awarded in Chemistry for the invention of polymerase chain reaction (PCR), which revolutionized biotechnology.[15] PCR was patented and derives from the extremophile *Thermus aquaticus*. No compensation was ever paid for the conservation of its habitat.

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[8] Mariël Otten, "TRANSMIGRASI: Indonesian Resettlement Policy, 1965-1985", International Work Group for Indigenous Affairs Document 57 (Copenhagen, 1986).
[9] Antenor Savoldi Junior, "Road network spreads 'arteries of destruction' across 41% of Brazilian Amazon", *Mongabay*, 22 September 2022. Available from https://news.mongabay.com/2022/09/road-network-spreads-arteries-of-destruction-across-41-of-brazilian-amazon/.
[10] Edward O. Wilson, ed., *BIODIVERSITY* (National Academy Press, Washington, DC, 1988).
[11] *Ibid.,* "Editor's Foreword", p. v.
[12] Convention on Biological Diversity, "Nairobi Final Act of the Conference for the Adoption of the Agreed Text of the Convention on Biological Diversity", Section IX in *Handbook on the Convention on Biological Diversity.* Available from https://www.cbd.int/doc/handbook/cbd-hb-09-en.pdf.
[13] Convention on Biological Diversity, *Text and Annexes* (2011), p. 1. Available from https://www.cbd.int/doc/legal/cbd-en.pdf.
[14] *Ibid*., Article I.
[15] Joe Fore Jr., Ilse R. Wiechers and Robert Cook-Deegan, "The Effects of Business Practices, Licensing, and Intellectual Property on Development and Dissemination of the Polymerase Chain Reaction: Case Study", *Journal of Biomedical Discovery and Collaboration* (2006).

3. ABS, HIPPO AND DECISION 15/9

Mass extinction had not abated by the ten-year anniversary of the CBD in 2002. Had urgency not been conveyed at Rio'92 or in any of the first six COPs? To communicate the drivers of extinction, Wilson published *The Future of Life* and promoted HIPPO as an acronym and a mnemonic.[16] The H was for habitat loss, followed by invasive species (I), pollution (P), human population (P) and over-harvesting (O). The order of the letters put habitat loss, first and foremost.[17]

Given the prominence of habitat loss, pragmatism dictated that the property-rights approach default to habitat loss, where genetic resources would be interpreted as "natural information"[18] and thus invite the economics of information.[19] How could policy align incentives between those who decide land use and those who benefit from an unencumbered access to genetic resources for the purpose of biotechnology? In the alignment, the IPPO of HIPPO got the short shrift. Their time may have finally come. Under Decision 15/9, who gets what could vary according to the driver.

A caveat is in order. Both the power and the weakness of economics lie in abstract reasoning. Powerful abstractions lose potency when influential participants shrug their shoulders to preempt discussion. Less influential participants pick up the cue. Feigned incomprehension[20] must be countered by perseverance. How would the GMBSM work in real life?

Alas, case studies do not exist because the GMBSM does not exist. Nevertheless, one can imagine how cases would have unfolded had a GMBSM existed which enjoyed economic rents, which is the linchpin to fairness, equity and efficiency in access and benefit sharing (ABS).[21] Rent, in economics, is the difference between what one pays and what one would have paid in a competitive market (e.g. subtraction of the off-patent price of a biotechnology from its price before expiry). Thought experiments confront artful users hellbent against paying any rent.

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[16] Edward O. Wilson, *The Future of Life* (Random House, New York, 2002), p. 50.
[17] *Ibid*.
[18] The neologism heeds the advice of James Madison in *Federalist No. 37* that "[p]erspicuity, therefore, requires not only that the ideas should be distinctly formed, but that they should be expressed by words distinctly and exclusively appropriate to them", 11 January 1788, at https://www.gutenberg.org/files/1404/1404-h/1404-h.htm#link2H_4_0037. For an explanation of "natural information" in the context of ABS, see Joseph Henry Vogel, María Eugenia Santori-Aymat, Oscar Tomaiconza, Bryan Steven Cortés-Lumbi, Miguel Fernandez-Maldonado, "BOUNDED OPENNESS OVER NATURAL INFORMATION", in *Elgar Encyclopedia of Ecological Economics,* Emilio Padilla Rosa and Jesús Ramos-Martin, eds. (Edward Elgar Publishing, London, 2023). Available from https://www.elgaronline.com/display/book/9781802200416/ch06.xml. In Spanish: https://www.actualidadambiental.pe/wp-content/uploads/2023/10/Entrada-de-Apertura-Delimitada-sobre-Informacion-Nacional-ENCICLOPEDIA-ELGAR.pdf.
[19] For a plain-English explanation of the economics, see Manuel Ruiz Muller, Joseph Henry Vogel, Klaus Angerer and Nicolas Pauchard, "'Access to Genetic Resources and Benefit-Sharing' in the Post-2020 Global Biodiversity Framework", Op-Ed, Enhanced Integrated Framework (EIF), 16 December 2019, also available in French and Portuguese. Available from https://trade4devnews.enhancedif.org/en/op-ed/access-genetic-resources-benefit-sharing.
[20] Feigned incomprehension is nothing new. Al Gore cites nineteenth-century novelist Upton Sinclair that "[i]t's difficult to get a man to understand something if his salary depends upon his not understanding it". *An Inconvenient Truth* (Rodale Books, New York, 2006), pp. 266-267.
[21] Sociedad Peruana de Derecho Ambiental, *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*, The ABS Capacity Development Initiative (Eschborn, Germany, 2021). Available from 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.

4. EXPANDING THOUGHT EXPERIMENTS FROM THE ANTECEDENT LITERATURE

Table I lists cases of who might have gotten what had a GMBSM existed under the modality of "bounded openness over natural information".[22] The antecedent literature is presented in the chronological order of publication in Table II. All the thought experiments imagine, unrealistically, that a patent was granted which subsequently realized full commercial success.

Twelve of the cases correspond to habitat loss H as the driver of extinction and three, to pollution, P. Whether any claim is still worthwhile does not concern us here. Rather we explore how the GMBSM could work in a variety of scenarios. Because no case has been developed for the least destructive driver of extinction, viz. "over-harvesting", O, we consider the case of elephants and the TP53 gene, which may someday revolutionize oncology (see Box 1).

Table I: Expanding thought experiments* to suggest who should get what

Case	Species	Market	Royalty % (L, M, H, VH)	Conceivable Annual Sales (USD millions)	Countries of Origin	Benefit: Share in royalty income
1	*Banisteriopsis caapi* (ayahuasca)	Pharmaceutical (psychotropics)	H	100	Nine countries of Amazon basin	From French Guiana and Ecuador at 1 & 2 to Peru and Brazil at 13 & 60%
2	*Thermus aquaticus* (TAQ)	Biotechnology (path-breaking)	VH	100	Seventeen countries where present (perhaps ubiquitous?)	Only geothermally independent sources from Parties count; further study required to approximate
3	Soil bacterium	Pharmaceutical (anti-depressant)	H	1000	Worldwide	Institutions of taxonomy located in Parties
4	Marine Halophilic bacterium	Bioremediation	M	100	UNCLOS	Parties to UNFCC with reductions beyond targets
5	Wasps	Agriculture (insecticide)	H	100	Worldwide	Institutions of taxonomy located in Parties
6	Malaria-resistant genes	Pharmaceutical (vaccine)	VH	1000	Mali	Mali 100%
7	*Allium cepa* (onion)	Pharmaceutical (psychotropics)	VH	1000	Turkmenistan and Uzbekistan	Turkmenistan 52%; Uzbekistan 48%
8	*Cucurbita pepa* (pumpkin)	Pharmaceutical (antifungals)	H	100	Mesoamerica	Mexico: 47%,Guatemala: 17 %, Belize: 4 %, El Salvador: 3 %, Honduras: 18 %, Nicaragua: 8 % and Costa Rica: 3 %
9	Agave	Diamond films for precision cutting	M	10	Mexico, USA (non-Party) and Central America	Mexico: 79 %, Guatemala: 4%, Belize: 1 %, El Salvador: 1 %, Honduras: 5 %, Nicaragua: 5 %, Costa Rica: 2 %, Panama: 3 %
10	*Epipedobates anthonyii* (poison dart frog)	Pharmaceutical (analgesic)	M	1000	Ecuador	Ecuador 100%
11	*Lepidium meyenii* (maca)	Food (nutritional additive)	H	100	High-altitude regions of Peru and Bolivia	Peru: 49 %, Bolivia: 51 %
12	Ebola	Pharmaceutical (vaccines)	VH	1000	Guinea	Guinea 100%

[22] See Note 18.

13	Conus (sea snails)	Pharmaceutical (analgesic)	H	100	UNCLOS	Parties to UNFCC with reductions beyond targets
14	*Tectitethya crypta* (sponge)	Pharmaceutical (antiretrovirals)	H	1000	UNCLOS	Parties to UNFCC with reductions beyond targets
15	*Heterocephalus glaber* (naked mole rat)	Pharmaceutical (oncology)	M	1000	Ethiopia, Somalia and Kenya	Ethiopia: 45%, Somalia: 22%, Kenya: 33%
16	Elephantindae (elephants)	Pharmaceutical (oncology)	M	1000	Countries of Africa & Asia	See Table III

* References appear in Table II Antecedent literature on thought experiments. Questions concerning the habitat of species were posed to ChatGPT on 2 June 2024 in the following format: In what countries is [species name] native? How many square kilometers are [habitat of the species] in [country of origin]?

Table II: Antecedent literature on thought experiments

Case	Bibliographic Information	Language
1	Rocío Alarcón and Manolo Morales, "Case Study One: *Banisteriopsis caapi*", Chapter 8, pp. 81-92 in Joseph Henry Vogel (ed.) *The Biodiversity Cartel: Transforming Traditional Knowledge into Trade Secrets*, CARE, Proyecto SUBIR, Quito, Ecuador, 2000	En Sp
2	Robert Lindstrom, "Case Study Two: *Thermus acquaticus*", Chapter 9, pp. 93-100 in Joseph Henry Vogel (ed.), *The Biodiversity Cartel: Transforming Traditional Knowledge into Trade Secrets*, CARE Proyecto SUBIR, Quito, Ecuador 2000	En Sp
3-9	"The Economics of Information, Studiously Ignored in the Nagoya Protocol on Access and Benefit Sharing" Joseph Henry Vogel, Nora Álvarez-Berríos, Norberto Quiñones-Vilche, Jeiger L. Medina-Muñiz, Dionisio Pérez-Montes, Arelis I. Arocho-Montes, Nicole Vale-Merniz, Ricardo Fuentes-Ramirez, Gabriel Marrero-Girona, Emmanuel Valcárcel Mercado, Julio Santiago-Rios, 7/1 *Law Environment and Development (LEAD) Journal,* 2011, pp. 51-65	En Ar Ch Fr Pt Sp
10	Klaus Angerer, "Case Study I: *Epipedobates anthonyii* under 'Bounded Openness'", pp. 98-109 in Manuel Ruiz Muller, *Genetic Resources as Natural Information: Implications for the Convention on Biological Diversity and Nagoya Protocol*, London, Routledge, 2015	En Sp
10	Joseph Henry Vogel, Manuel Ruiz Muller, Klaus Angerer and Nicolas Pauchard, "Even best case for bilateralism supports need for a Global Multilateral Benefit-Sharing Mechanism: Common ground in 'bounded openness over natural information' as the modality for ABS". In response to NOTIFICATION for Submission of views and information further to decisions NP-3/13 on Article 10 of the Nagoya Protocol, 28 June 2019	En Fr Pt Sp
11	Omar Oduardo-Sierra, "Case Study II: *Lepidium meyeni* under 'Bounded Openness'", pp. 110-117 in Manuel Ruiz Muller, *Genetic Resources as Natural Information: Implications for the Convention on Biological Diversity and Nagoya Protocol*, Routledge, London, 2015	En Sp
12	Omar Oduardo-Sierra, "Ebola", Appendix IV, pp. 104-108 in Sociedad Peruana de Derecho Ambiental, *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*. Report. The ABS Capacity Development Initiative, Eschborn, Germany, 2021	En
13	Nicolas Pauchard "Cone Snails: Family Conidae and Genus Conus" Appendix II, pp. 89-95 in Sociedad Peruana de Derecho Ambiental, *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*. Report. The ABS Capacity Development Initiative, Eschborn, Germany, 2021	En
14	Nikita Kent, "Marine Sponge: Tectitethya crypta", Appendix III, pp.. 96-103 in Sociedad Peruana de Derecho Ambiental, *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*. Report, The ABS Capacity Development Initiative, Eschborn, Germany, 2021	En
15	Anna Deplazes-Zemp "Naked Mole-Rat (*Heterocephalus glaber*)", Appendix I, pp. 82-88 in Sociedad Peruana de Derecho Ambiental, *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*. Report, The ABS Capacity Development Initiative, Eschborn, Germany, 2021	En
15	Joseph Henry Vogel, Manuel Ruiz Muller, Klaus Angerer, Omar Oduardo-Sierra, "Ending Unauthorised Access to Genetic Resources (aka Biopiracy): Bounded Openness", Inside Views. *Intellectual Property Watch* / International IP Policy News. 6 April 2018	En

Box 1: Discovery of TP53 lay in deductive reasoning

Biology is associated with inductive reasoning yet deductive reasoning has enjoyed stunning successes ever since Darwin (see Section 7). In 1977, Oxford University statistician Peter Peto deduced that humans should have much more cancer than rodents, simply due to the greater number of cells and longer lifespan in humans (frequency of mutations assumed invariant). At the other extreme of mammalia, elephants should be dead in infancy. Something must intervene. The search began to resolve, what is duly named, Peto's Paradox.

Scientists discovered the TP53 gene which encodes for the protein P53 that repairs damaged cells or impairs further cell division. Humans have a scant one pair and elephants, twenty. Nature also provides a cruel experiment: humans born with a defective TP53 gene usually succumb to childhood cancer. The literature on TP53 and P53 is rigorous and immense, as the stakes involved are nothing less than the prevention of cancer, a family of diseases.*

* Tim Gunn, "What Elephants can Teach us about Cancer", Cancer Research UK, 12 August 2023, https://news.cancerresearchuk.org/2023/08/12/can-elephants-get-cancer/#:~:text=Every%20cell%20in%20an%20African,won't%20even%20respond%20to

We emphasize that the identities of the beneficiaries and their share of royalty income, are tentative. This tentativeness coheres with the pragmatism of the property-rights approach. The basis for the percentage share in the royalty income, viz., Low, Medium, High or Very High (Column 3) depends on the industry in which the good is sold, the intellectual property protection granted, and the elasticity of demand for goods in that industry.[23] The thought experiment of elephants and the TP53 gene highlights how precision in calculating who gets what is contingent on the benefit of the claim exceeding the costs of making it.

Our findings support Paragraph 22 (c) (e) of Decision 15/9, viz. "disbursement of monetary benefits, including information on geographical origin as one of the criteria" as an "ISSUES FOR FURTHER CONSIDERATION" (capitalization in original).[24] For most terrestrial species, disbursement will be proportional to the geographic percentage of habitat. For most marine species, disbursement will reflect reductions in CO2 emissions beyond reductions already agreed under whatever is the latest COP to the United Nations Framework Convention on Climate Change (UNFCCC). For species threatened by overharvesting, disbursement will reflect populations and national efforts to prevent overharvesting. For ubiquitous non-marine species, international institutions associated with taxonomy will be the beneficiaries. From the vantagepoint of economics, these institutions are international public goods, deserving of international funding. They are also needed to make the GMBSM work.

Much of the information in the cells of Table I is culled from the internet through questions posed in ChatGPT. The data are, therefore, not authoritative. The purpose of the table is to illustrate how a GMBSM would trigger rigorous studies to ascertain the best estimates of the values merely suggested in the columns.

[23] Elasticity is the percentage change in quantity demanded to a percentage change in price. By the Ramsey Rule of Public Finance, the royalty should vary inversely with the elasticity of demand for the product. The Rule assures efficiency as "excess burden" is minimized. See "Box 10: The Ramsey Rule for Negotiating Royalty Rates" in "Fairness, Equity and Efficiency", Note 21, p. 59.
[24] See Note 6, p. 5.

A nexus of natural history and human history will lie in whether the delegates can grapple with these abstractions, eliminate the ambiguities of the royalty percentages and implement a GMBSM before mass extinction becomes a *fait accompli* and renders moot ABS.

5. REDUCTIONISM WITHOUT APOLOGY: HIPPO FOR ABS CAN BE REDUCED TO HPO

The literature on each of the drivers in HIPPO is abundant. Reductionism, often scorned by environmentalists, sheds light on how incentives can be aligned to arrest mass extinction. For example, invasive species can irreversibly displace native species. The habitat of the displaced species is a habitat lost, H. Incentives to control the pathways of introduction of pre-adapted species is protection of the habitat, i.e. control over I is control over H. HIPPO thus reduces to HPPO.

The second P of HPPO is human population. From a philosophical viewpoint, this P is the ultimate cause. Twenty-first century habitat loss, pollution and over-harvesting are only proximate causes because the scale of the human population has levered consumption. As Garrett Hardin reiterated in "The Tragedy of the Commons",[25] if the human population were low, there would be no tragedy. Nonetheless population policy is of little avail as most species will have gone extinct when the demographic transition is finally achieved. By Ockham's Razor, HPPO can be further reduced to HPO.

[25] Garrett Hardin, "The Tragedy of the Commons", *Science*, Vol. 162, No. 3859 (1968), pp. 1243–1248.

6. THE P IN HPO TAKES OFF

The importance of climate change for the property-rights approach to ABS has accompanied the entire trajectory of the COP. In 1992, the first author of this Research Paper wrote that "[T]here exists an overriding issue for this and any other [ABS] policy that attempts to preserve genetic information. That issue is global warming. The case can be easily made that global warming will sustain the current crisis…"[26] Fast forward. Over the 30+ years of the CBD, global emissions of CO2 have increased from 360 PPM to 420 PPM.[27]

Climate change is nowhere a more ominous driver than in the sea. Oceanic acidification risks lowering the pH below the threshold for calcification for several genera[28]. The horror of extinguishing Mollusca and Crustacea is truly inconceivable. From the vantagepoint of reductionism and the sea, HIPPO should be PHO.

Marine genetic resources are a major source of biotechnology invention.[29] Incentives must be aligned between those who reduce CO2 beyond the latest agreed commitments in the COP to the UNFCCC and those who benefit from access to marine genetic resources for the purposes of biotechnology.

Deduction leads to counterintuitive implications that do not abide diplomacy. Parties to the UNFCCC who reduce emissions beyond agreed reductions should receive the benefit from the GMBSM for marine genetic resources from the sunlight zone. Land-locked Nepal, for example, could become a beneficiary for having cut emissions beyond the Paris-agreed "sufficient goal", while Australia would receive nothing for having only satisfied the Paris-agreed goal, despite some sixty marine parks.[30] As if that implication were not unwelcome enough, comes another more fraught: the benefit shared for marine sources should be independent of whether extraction of the natural information occurred within or beyond national jurisdiction, viz. the exclusive economic zone. The rationale is literally liquid. Acidification of seawater does not stop 200 nm from any shoreline.

Another deduction comes from the deep, which is known as the twilight zone. A biological carbon pump exists that is threatened by a pent-up demand for fish meal from lantern-, bristlemouth and other deep-dwelling species. Collapse through harvesting for aquaculture may translate to a doubling of atmospheric carbon.[31] Benefits from any biotechnology that derives from these genetic resources should be allocated to research on deep-ocean species and conservation, which suffer "a persistent lack of funding and resources".[32]

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[26] Joseph Henry Vogel, *Privatisation as a Conservation Policy* (Special Limited Edition for the AIC Conference), Centre for International Research on Communications and Information Technologies (Melbourne, Australia, November 1992), p. 97. Market publication as *Genes for Sale* (Oxford University Press, 1994), p. 88.
[27] Rebecca Lindsey, "Climate Change: Atmospheric Carbon Dioxide", Climate.gov, 9 April 2024. Available from https://www.climate.gov/news-features/understanding-climate/climate-change-atmospheric-carbon-dioxide.
[28] US Department of Commerce, National Oceanic and Atmospheric Association, "Ocean acidification". Available from https://www.noaa.gov/education/resource-collections/ocean-coasts/ocean-acidification.
[29] Marcel Jaspars and others, "The marine biodiscovery pipeline and ocean medicines of tomorrow", *Journal of the Marine Biological Association of the United Kingdom*, Vol. 96, No. 1 (2016), pp. 151–158. Available from https://www.cambridge.org/core/journals/journal-of-the-marine-biological-association-of-the-united-kingdom/article/marine-biodiscovery-pipeline-and-ocean-medicines-of-tomorrow/1A12205C9881F2711D272E49A81E8208
[30] Katharina Buccholz, "Which countries are meeting their Paris-agreed goals?", Statista, 2 November 2021. Available from https://www.statista.com/chart/26102/emission-reduction-goal-and-projected-achievements-by-country/.
[31] Porter Fox, "There's a new reason to save life in the deep ocean", *The New York Times,* 29 July 2024.
[32] *Ibid*.

7. THE O IN HPO

Overharvesting can be the *coup de grâce* when the habitat is already diminished. An example often cited is the passenger pigeon (*Ectopistes migratorius*). Flocks of the pigeons, once numbering in the millions in North America, vanished within a human lifespan. The last passenger pigeon died on 1 September 1914 in the Cincinnati Zoo. Her name was Martha.[33]

If O means only depletion in the Party but existence in collateral jurisdictions, populations can rebound. Re-introduction of the species in an otherwise pristine habitat, could be incentivized by ABS.

The long gestation period of elephants epitomizes how reproductive potential is common to all life. In *On the Origin of Species*, Charles Darwin calculated that if a female elephant had six offspring over her reproductive life, and those six had six, and the third generation, six… in just 750 years Africa would be shoulder to shoulder in elephants.[34] A viable remnant population of any endangered species, once duly protected, can rebound. The insight of geometric growth, first perceived by 18th century economist Thomas Malthus and duly credited by Darwin, gives hope for recovery of ensconced populations in the 21st century.[35]

First Nations of North America will recall the history of the bison, whose population once numbered in the tens of millions. European settlers reduced the massive herds in the nineteenth century to induce famine on native peoples who had hunted sustainably for millennia.[36] Through the lens of HPO, Yellowstone National Park was established to grapple with H and the Yellowstone Park Protection Act of 1894, O. In less than a century, the bison has rebounded. The current population is approximately 500,000.[37]

Elephants in the not-so-distant future may be like the American bison or the passenger pigeon: abundant until suddenly extinct or reduced to a remnant population and recovered through concerted efforts.

The pragmatism of the property-rights approach encourages approximation. In less than 30 seconds, the ChatGPT lists thirty-two countries where elephants are natural and their respective populations. A quick check of the results with the statistics compiled by the International Union for Conservation of Nature (IUCN) lends confidence to deploying ChatGPT in the approximations necessary to move forward on ABS.[38]

For the sake of simplicity, we consider just the top ten countries where elephants are natural and group the remaining 22 as if they were an eleventh. How would benefit sharing work?

Inasmuch as overharvested populations can rebound, incentives should be aligned so that countries control illicit eradication. A simple incentive scheme would be a 5% reduction of the claim for a country that is not a regional leader in protecting native populations. This would

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[33] National Museum of Natural History, "Martha, the Last Passenger Pigeon", Smithsonian. Available from https://naturalhistory.si.edu/research/vertebrate-zoology/birds/collections-overview/martha-last-passenger-pigeon.

[34] Charles Darwin, "Struggle for Existence", in *On the Origin of Species*, 6th edition (1872), Chapter 3. Available from https://www.gutenberg.org/files/2009/2009-h/2009-h.htm.

[35] *Ibid.*, Introduction.

[36] J. Weston Phippen, "Kill Every Buffalo You Can! Every Buffalo Dead Is an Indian Gone", *The Atlantic*, 13 May 2016. Available from https://www.theatlantic.com/national/archive/2016/05/the-buffalo-killers/482349/

[37] PBS, "American Bison Fact Sheet", 6 July 2023. Available from https://www.pbs.org/wnet/nature/blog/american-bison-fact-sheet/.

[38] IUCN, "African elephant species now endangered and critically endangered", 25 March 2021. Available from https://www.iucn.org/news/species/202103/african-elephant-species-now-endangered-and-critically-endangered-iucn-red-list.

mean that the populations of elephants in a list of the top ten countries would be diminished in intervals of 5%, starting with the infracting country which is ranked second. Table III provides the statistics to answer who-gets-what for TP53.

Table III: Who Should Get What of Royalty Income from elephantine natural information*

Countries of origin	Population (000s)	Percentage of global population	Ranking of efforts to control over-harvesting**	Incentives through 5% incremental reductions based on efforts	Population adjusted by incentive scheme	Percentage share of royalty income*
Botswana	130	28	1 (tied w/India)	1.00	130.0	34
Zimbabwe	82	18	5	0.80	65.6	17
Tanzania	60	13	7	0.70	42.0	11
Kenya	36	8	4	0.85	30.6	8
Gabon	35	8	8	0.65	22.8	6
India	29	6	1 (tied w/ Botswana)	1.00	29.0	8
South Africa	24	5	3	0.90	21.6	6
Namibia	22	5	2	0.95	20.1	5
Zambia	21	4	6	0.75	15.8	4
Mozambique	11	2	9	0.60	6.6	1
Thirty-seven countries of lesser origin**	18	4	-	-	-	-

*Data generated from ChatGPT questions posed at 11:00 AM EST 29 May 2024: (1) What are all the countries in the world where elephants are native? (2) What is the global population of elephants? (3) What are the populations of elephants in the ten countries with the most elephants? (4) Which African countries best control overharvesting of elephants?

**Botswana and India rank first in their respective continents for efforts to prevent overharvesting.

** Average of estimates of global population = 467.5

8. SIMILARITIES IN THOUGHT EXPERIMENTS FROM DISSIMILAR CASES

Thought experiments facilitate identification of critical issues that will arise in implementing the GMBSM. The sixteen examples of Table I are not meant to be exhaustive in representation. Welcome are new cases that reveal policy implications not fully explored heretofore. For example, none of the cases involves the use of multiple sources of natural information, which raises the issue of royalty-stacking, i.e., cumulative obligations which could render commercialization uneconomic.[39]

Cases 1, 7, 8, and 11 involve domesticated, and 1 and 9, semi-domesticated species. Should the principal agent reside in the domesticated species and not in wild relatives, then the value derives from artificial information.[40] Should all the communities maintain confidentiality over the commercially valuable traditional knowledge, a multilateral mechanism could capture a rent. However, should just one community disclose, the status of the information will be public domain and indirectly protected as such by intellectual property law. The policy implication of bounded openness is to encourage billionaire philanthropists to fund the transformation of still unpublished traditional knowledge into trade secrets so that communities can capture rents through a multilateral benefit-sharing mechanism.[41]

Case 2 illustrates how the geographic area of some extraordinary species may have to be re-considered for calculating the share of benefits. An extensive network of boiling ponds denied geothermal energy is essentially one pond and should count as such in determining percentage shares. Should *Thermus acquaticus* also be found water heaters and hot tubs, then the benefits will be shared as in the next two cases.

Cases 3 and 5 involve species so cosmopolitan that any Party would be a country of origin. The royalty income should therefore remit to the global fund which, once having covered the operating costs of the GMBSM, should distribute the income to international institutions engaged in taxonomy. That the largest of such institutions resides in the non-Party is significant. They should get nothing, thereby creating pressure for the non-Party to ratify the CBD and NP. The same would also apply to Cases 2 and 9, where the geographic area of the non-Party would not be calculated in the distribution of royalty income.

Case 4 draws from a genetic resource found in the twilight zone. Benefits should be allocated among institutions that research deep-ocean species and conservation. Case 6 illustrates how one would have to engage a genomicist to sample geographically dispersed populations of a

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[39] See Questions & Answers in Jerome H. Reichman, “A Compensatory Liability Regime to Promote the Exchange of Microbial Genetic Resources for Research and Benefit Sharing”, in *Designing the Microbial Research Commons: Proceedings of an International Symposium,* NIH, National Research Council (US) Board on Research Data and Information, P. F. Uhlir, ed. (Washington DC, National Academies Press (US), 2011). Available from https://nap.nationalacademies.org/catalog/13245/designing-the-microbial-research-commons-proceedings-of-an-international-symposium. For an example of a royalty-stacking provision in the proposed GMBSM, see Joseph Henry Vogel, Klaus Angerer, Manuel Ruiz Muller and Omar Oduardo-Sierra, “Bounded Openness as the Global Multilateral Benefit-Sharing Mechanism for the Nagoya Protocol”, in *Routledge Handbook on Biodiversity and the Law,* Charles R. McManis and Burton Ong, eds. (London, Routledge, 2018), pp. 377-394, 386-387. In Spanish, Anexo 2: https://www.uni-giessen.de/de/fbz/fb11/institute/histor/ueberuns/mitarbeiter/mitarb_dwnl/Vogeletal2018aperturadelimitadacomolamodalidaddelmecanismomundialmultilateraldelABS.pdf.

[40] For this distinction, see Joseph Henry Vogel, Manuel Ruiz Muller, Klaus Angerer, Dino Delgado-Guitiérrez, Alfredo Gálvez Ballón, "Bounded openness: A robust modality of access to genetic resources and the sharing of benefits", *PLANTS PEOPLE PLANET*, Vol. 4, Issue 1 (2022). Available from https://doi.org/10.1002/ppp3.10239.

[41] Joseph Henry Vogel, “Economics Resolves ABS for Genetic Resources and Traditional Knowledge Once Both are Defined Accurately”, Submissions on Article 10 of the Nagoya Protocol pursuant to decision NP-2/10 (4 April 2018). Available from https://www.cbd.int/abs/submissions/np-2-10/joseph-henry-vogel-en.pdf. In Spanish: https://www.cbd.int/abs/submissions/np-2-10/joseph-henry-vogel-es.pdf.

vector species to determine the diffusion of genes that are pathogen-resistant. In this thought experiment, the royalty income has been calculated as if the natural information were endemic.

Cases 10, 15 and 16 concern research streams that are opened by natural information rather than principal agents to which value was added. The use was indirect rather than direct. This distinction should factor into the negotiation of fixed royalty rates for classes of use. There is more than one way to peel an apple or skin a cat. Indirect uses will command a lower royalty than direct uses.

Case 12 illustrates how speed in isolating, sequencing and uploading pathogens into the international medical research stream should be rewarded. Because the criterion is first-to-submit, subsequent strains only insignificantly different would not be rewarded.[42]

Case 13 lays to rest the red herring that genetic resources are so plentiful and redundant that the world need not worry about losing biotechnological opportunities through mass extinction.[43] All 800+ species of the genus Conus are threatened by ocean acidification. Claimants would be Parties which go beyond their agreed reduced targets of Green House Gases (GHG). Because only the CO2 emissions of GHG are acidifying the oceans, a more precise answer would be proportional to total metric tons of CO2 emitted beyond their target.

Case 14 reveals how uniform application of the same royalty percentage would be unfair and inefficient due to market segmentation and price discrimination by Big Pharma. To achieve fairness, equity and efficiency, the royalty rates would have to be adjusted inversely to the administered prices of the medication in the Organisation for Economic Co-operation and Development (OECD) countries. Like Case 13, claimants would be Parties which go beyond their agreed reduced targets of GHG.

Cases 9, 11 and 15 show that the geographic area of the habitat is not coincident with the geographic area of the Party.

Case 16 illustrates how measures should be adopted to prevent overharvesting whenever human-animal conflict and/or poaching exist, despite the seeming abundance of the population.

[42] Joseph Henry Vogel, Claribel Fuentes-Rivera, Barbara A. Hocking, Omar Oduardo-Sierra, and Ana Zubiaurre, "Human Pathogens as Capstone Application of the Economics of Information to Convention on Biological Diversity", *International Journal of Biology*, Vol. 5, No. 2, pp. 121-134 (April 2013). Available from http://www.ccsenet.org/journal/index.php/ijb/article/view/22760.

[43] R.D. Simpson, "The Problem with Making Nature Pay for Itself: Trying to make nature pay for itself has a disappointing track record", *Anthropocene Magazine,* 7 July 2019. Available from https://www.anthropocenemagazine.org/2019/06/the-problem-with-making-nature-pay-for-itself/.

9. Valuation of Biodiversity: Hubris at best and self-dealing at worst

In elaborating the GMBSM, Parties must not lose sight of conservation as the primary objective of the CBD, where ABS is a means to this end. Yet conservation is undefined in the Convention on Biological Diversity! A reasonable interpretation of conservation is the lack of human-induced extinction over evolutionary time. This begs the question: what is evolutionary time for humans?

Charles J. Lumsden and E.O. Wilson put into prose an answer that they had earlier derived mathematically "in as few as fifty generations---about a thousand years---[there is] substantial genetic evolution in the epigenetic rules guiding thought and behavior".[44] If we take 1000 years as the time frame for not allowing human-induced extinction, then continuous decreases every year, albeit seemingly infinitesimal, cannot be allowed to become a driver of extinction over one thousand years.

The math is not difficult. A loss of habitat through change in land use of 0.1% (0.001) year in and year out, will compound over one thousand years. This can be calculated by raising 0.999 to the 1000th power. The calculation equals 0.367. Biogeography indicates that one needs to preserve one-half of Earth to allow all species to continue their evolution.[45] Celebration of half-Earth in Year One with a 0.1% annual erosion, becomes 18% Earth (0.5 X 0.367) at the end of 1000 years and approximately 0% Earth at the end of 10,000 years, which is how much time has lapsed since the dawn of civilization. Infinitesimal erosion is politically acceptable because the cumulative impact is just too abstract to understand intuitively.[46] Extinction would run in slow motion.

The limit of half-Earth must be non-negotiable and enforceable, year in and year out. Can humans "live within limits", which was the title of Garrett Hardin's capstone oeuvre?[47] Can humans achieve half-Earth, Wilson's clarion call?[48] These are profound questions for the economics of biodiversity. They are implied in the very titles of the seminal works by Hardin and Wilson, who are luminaries in modern biological thought. What say the economists? Neither Wilson's or Hardin's thesis is referenced in *The Economics of Biodiversity – The Dasgupta Review.* Also absent in the 610-page tome is any analysis of ABS policy.[49]

Partha Dasgupta ends the Foreword to his Review that, "Nature nurtures and nourishes us, so we will think of assets as durable entities that not only have use value but may also have intrinsic worth. Once we make that extension, the economics of biodiversity becomes a study in portfolio management."[50] The twenty-fourth chapter in *BIODIVERSITY*, edited by Wilson, is David Ehrenfeld's "Why Put a Value on Biodiversity?"[51] The chapter ends with this fear: "I cannot help thinking that when we finish assigning values to biodiversity, we will find that we don't have very much biological diversity left".[52]

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[44] Charles J. Lumsden and Edward O. Wilson, *Promethean Fire* (Cambridge, MA, Harvard University Press, 1983), p. 152.
[45] E.O. Wilson, *Half-Earth* (New York, Norton, 2016), pp. 3-4.
[46] Daniel Kahneman, *Thinking Fast and Slow* (New York, Farrar, Straus & Giroux, 2011).
[47] Garrett Hardin, *Living within Limits* (Oxford University Press, 1993).
[48] See Note 45.
[49] Partha Dasgupta, *The Economics of Biodiversity – The Dasgupta Review* (London, HM Treasury, 2021). Available from https://assets.publishing.service.gov.uk/media/602e92b2e90e07660f807b47/The_Economics_of_Biodiversity_The_Dasgupta_Review_Full_Report.pdf.
[50] *Ibid*., p. 4.
[51] David Ehrenfeld, "Why Put a Value on Biodiversity?", in *BIODIVERSITY*, E.O. Wilson, ed., pp. 212-216, see Note 10.
[52] *Ibid*., p. 216.

Valuation is hubris at best and self-dealing at worst. The question for the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) is distinct: What are cost-effective strategies to get us through the bottleneck that Wilson described in *The Future of Life*?

Imposing limits is fundamental to law. A predisposition to accept limits may have evolved through group selection of humans as a eusocial species.[53] Bounded openness over natural information creates a countervailing force to powerful individual interests, which are blithely allowing HPO. Who gets what rests on the premise that rents are what Parties will get to incentivize the transition to half-Earth. Once achieved, humanity will not much need an IPBES.

[53] Edward O. Wilson, *The Social Conquest of Earth* (New York, W.W. Norton, 2012).

10. CONCLUSION

To identify or not to identify the beneficiaries of royalty income? This will become the question once the rent-enabling GMBSM is established, as proposed in this paper. The decision will depend on how much rent is collected from commercially successful intellectual property. Will the claim be greater than the cost? For terrestrial species that are not ubiquitous, the GMBSM will have to engage in ground truthing for any artificial intelligence (AI)-generated first approximations. For ubiquitous species, the beneficiary will be institutions engaged in international taxonomy and for marine species, Parties to the UNFCCC which have gone beyond agreed reductions in CO2 emissions. And for species vulnerable to overharvesting, the beneficiary will depend on the relative size of remnant populations and national efforts of recovery.

The “what” in “who gets what” will be largely determined by the fixed royalty rate assigned for classes of biotechnologies, which will be combinations of characteristics, such as the type of industry, the type of intellectual property, the elasticities of demand and whether the use was direct or indirect. These and other deductions from the property-rights approach are apolitical. In such abstractions lies power for mega-diverse countries, no matter how large or small. The challenge remains leadership.

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