Contact information	
Surname:	Vogel
Given Name:	Joseph Henry
Government	
(if applicable):	
Organization:	University of Puerto Rico-Rio Piedras
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E-mail:	josephvogel@usa.net
Title of document reviewed:	The Emergence and Growth of Digital Sequence Information in Research and Development: Implications for the Conservation and Sustainable Use of Biodiversity, and Fair and Equitable Benefit-Sharing – A Fact-Finding and Scoping Study Undertaken for the Secretariat of the Convention on Biological Diversity Available at: https://www.cbd.int/abs/dsi-gr/ahteg.shtml#peerreview

		I thank the Secretariat for crowdsourcing the evaluation of the study on Digital Sequence Information (DSI). Although accustomed to refereeing scholarly manuscripts, I recognise that the study was subject to constraints not imposed by academic journals. I also note that, unlike journals which identify experts, the table of comments would not be double-blind and that publication would ensue regardless of mine or any other recommendation. Nevertheless, I attempt to be equally rigorous and do not self-censor. Urgency exists as evidenced by the mass of facts that indicate an unauthorised access on a vast and almost unimaginable scale. Equally factual is the dysfunction in the bilateral system, which inhibits Parties and stakeholders to extend ABS to DSI. When appropriate, I suggest "bounded openness" as common ground, the principal article of which appears in the bibliography to the study (Vogel et al, 2018). The Secretariat commissioned the authors to "fact-find" and not to apply a theoretical framework. Any divorce of the two is illusory. Facts only have "implications" in the light of theory. The authors have selected facts without the light of economics, which is a discipline as old as biology. This is disquieting. Certain terms and descriptions only make sense in the light of economics. For example, the modification of "monetary benefits" with "speculative" begs for the explanation that can be found in any introductory textbook: when information is treated as if it were matter, then the competitive price falls to the marginal costs of its reproduction (Samuelson and Nordhaus 2005, 194-195). The observed low price is then equivocated as its value. Without the light of economics, Provider claims of significant monetary values will seem "speculative". In the light of the economics, the claims are uncontroversial. Should the aforementioned argument not persuade the authors and "speculative" survive revision, then the text will integrate with the "studied ignorance of the economics of information" (Oduardo-Sierra, et al, 2012, Vogel et al, 2011, Vogel 2013). Elsewhere in the study, concepts are presented as factual even though they were long ago debunked. For example, the assertion that increased efficiency reduces environmental stress ignores Jevons Paradox, which was formulated in 1865. Overall, the study is ahistorical: relevant antecedents are not cited. The lacuna is startling with respect to the Global Fund, which was hotly debated in the negotiations of the CBD (Glowka, 1994, 5). I hope that my suggestions will be received in the constructive spirit in which they are offered. I thank the authors for their hard work. I also thank the four dozen stakeholders and Parties who submitted thoughtful views that are surprisingly not reflected in the study. When relevant, I cite their submissions. Given the interconnectedness in the submitted views, I suspect that there will be similar interconnectedness in the comments. In science, the crowdsourcing of research is viewed by all the members of a network and not just by the node (see Silberzahn and Uhlmann, 2015). I look forward to the uploading of all the tables of comments in Documents to the Meetings. Only transparency will move us forward. Bibliographic information will appear outside the table and after the last comment.

1	7-9	Judging by over-the-transom enquiries from doctoral students around the world, I suspect that the study will be cited in the refereed academic literature. This seemingly trivial detail becomes vitally important for the issue to be fully vetted. In library science, titles are searchable up to 15 words in indices. The official title has 43 words. Indices will truncate it after the 15th word. I recommend a shortened title such as: "Fact-Finding and Scoping on 'Digital Sequence Information on Genetic Resources': Implications for the UNCBD".
9	9	This is the first use of the term "synthetic biology". Some mention should be made that the field has no agreed definition among those who identify with it. The AHTEG definition comprises 36 words, none of which is the word "information". The absence of "information" in defining "synthetic biology" generated withering criticism in the 2017 Online Forum on Synthetic Biology (CBD Secretariat, 2017).
14	2	"In addition to more speculative monetary benefits that might accrue from the system that manages." The adjective "speculative" is inaccurate for the reasons mentioned in the introductory remark, which is further elaborated in the comment corresponding to Page 15 and Lines 4-6. The modification of "monetary benefits" with "more speculative" should be eliminated.
14	8	"An important form of benefit sharing is access to publicly available databases." The sentence risks equivocation. It will be misconstrued as implying benefit sharing between Users and Providers. It would be more precise to say: "An important form of benefit sharing within User Countries is access to publicly available databases."
14	14	"However, some consider access to databases and technology an insufficient benefit, involving a loss of control over national patrimony." The sentence requires clarification. Accuracy would be achieved with the following revision: "However, many in Provider countries, especially traditional communities, do not consider access to databases and technology as any benefit whatsoever."
14	19	"Furthermore, countries rich in biodiversity may lack sufficient molecular research capacity or biotechnology infrastructure to make use of global database systems." With the exception of Australia, the mega-diverse Parties lack sufficient molecular research and so on. The present wording may mislead the reader to believe that there is a rough equivalence between those who have the capacity and those who do not. The correction would be: "With the exception of Australia, mega-diverse countries lack sufficient molecular research capacity or biotechnology infrastructure to make competitive use of global database systems."

15	4-6	"Monetary benefits growing from the use of digital sequence information are largely speculative to date, and are potentially complex due to challenges in identifying provenance and the value of any given sequence or part." The sentence is untrue. One must add an opening clause "under bilateralism" and edit as follows: "Under bilateralism, monetary benefits growing from the use of digital sequence information cannot eventuate because jurisdiction shopping eliminates any pure economic rent." The economics has been explained continuously in the literature since the early 1990s (Vogel 1992, 1994a Swanson, 1994, Stone 1995). A recent examples of dollar estimates of rents can be found in the transcript to the COP13 side event "New Approaches to Access and Benefit Sharing: The Case for Bounded Openness and Natural Information", a point fully developed in the comment on Page 53 Lines 15-27 (Peruvian Society of Environmental Law, 2017a). The term "pure economic rent" or just "rent" appears in any introductory economics textbooks and should be part of the working vocabulary of not only ABS policymakers but also of the Parties and stakeholders. Its absence is conspicuous.
15	9	"The practicalities of implementation remain undeveloped, however." The broad outline of the practicalities of implementation have already been developed (Vogel (ed), 2000, Vogel 2007) and appear under the modality of "bounded openness" (Vogel et al 2011, Ruiz Muller 2015, Vogel et al, 2018).
15	11	"Given the blurring boundaries between commercial and non-commercial user, all might gain access on the same terms." The use of the gerund implies a recent occurrence. The boundaries have always been blurred between commercial and non-commercial use. Moreover, the blurring has been voiced at least since COPII in 1995 and appears throughout the literature. A more accurate statement would be: "Given the often cited blurred boundaries between commercial and non-commercial user, all might gain access on the same terms."
16	18-20	"An additional challenge for identifying digital sequence information is that it is not immediately recognizable as belonging to a particular source, particularly as it undergoes modification." A more serious yet unmentioned problem, is the price-war which results when more than one country provides the genetic-material medium from which was extracted the digital sequence information. The price-war eliminates rents, which are justified for the production or preservation of information, artificial or natural. Inasmuch as the price-war is a far greater challenge than provenance, it should either replace the sentence or be added as an additional sentence. It is the desired consequence of jurisdiction shopping by Users.

16	22	"Monitoring is critical for effective benefit sharing, yet genetic sequences are far more difficult to monitor than physical genetic resources." Like the comment for page 15 lines 4-6 above, this sentence begs for an opening clause: "Under bilateralism, monitoring..." Under multilateralism, the possibility for which is suggested in Article 10 of the Nagoya Protocol, monitoring is only critical when intellectual property is asserted over the value added. To the degree which utilization does not involve an assertion of intellectual property and to the degree that those which do are unsuccessful, the set of genetic sequences to be monitored is a minute fraction of those accessed. Disclosure is also easier for natural information than for genetic material as it requires only disclosing Yes/No to whether natural information was utilized at the moment of asserting the intellectual property right. I introduced the issue in *Genes for Sale* (Oxford, 1994) and elaborated it in subsequent publications. "Bounded openness" obviates the justifiable concerns of bio-industry regarding insurmountable transaction costs in obtaining prior informed consent for genetic material and monitoring the movement of its disembodied information (Vogel 2015, Vogel et al, 2011a-e, 2018).
16	33	"Some are skeptical of the potential to monitor digital sequence information in any meaningful way, and express concern about the management, bureaucracy and expense involved in adding layers of legal documents and information to databases." On page 15 line 9 is the caption was "Determining value". Here we have a circumlocution for an economic concept which earned Ronald Coase the Nobel Memorial Prize in 1991: transaction costs. Yet a search of the narrative does not find one single reference to the discipline of economics much less to the economics of information, for which many of its pioneers have also won Nobel Memorial Prizes. As mentioned in the introductory remarks, the absence of economics opens the study to the criticism of "studied ignorance" (Oduardo-Sierra et al, 2012). Professors of biology should likewise be critical. Facts without theory are reminiscent of what Theodosius Dobzhansky famously wrote about biology without evolution: "a pile of sundry facts some of them interesting or curious but making no meaningful picture as a whole" (1973, 129).

17	10	"creates significant opportunities for non-monetary, and possibly monetary, forms of benefit sharing." The adjective "possibly" should be omitted for reasons stated in the comment for page 14 line 2. Professors of economics will be non-plussed that monetary forms of benefits play second fiddle to non-monetary benefits in what appears to be a near trillion dollar/annum market. The recurrent belittlement of monetary benefits undercuts the neutrality of the report and corresponds most closely to the non-Party and industry lobbyists. I hasten to add that *The Economics of Ecosystem & Biodiversity* (TEEB) also did not correct the error but aggravated it by applying the economics of matter to genetic resources. However, the TEEB authors can take cover for the misapplication in the disclaimer: "In the TEEB assessment, we largely follow the definitions of the United Nations 1992 Convention on Biological Diversity" (de Groot 2010,15).
17	15	"It behooves ABS policy makers to stay abreast of the profound developments shaping research today." This has always been the case, so why say it? Many of the problems with the CBD lie in its drafters not having been abreast of the profound developments which were shaping research in 1991-1992. Ditto for the COPs ever since the first meeting in the Bahamas in 1994. What would behoove ABS policy makers is a robust framework which can accommodate change. The view submitted by Ethiopia for the African Group made precisely that point: "To avoid a situation in which emerging biodiversity governance policy is (again) overtaken by rapid technological innovation and change we favour the use of a neutral and wide term like 'natural information', while remaining open to discussing the possibility that different types of natural information might eventually be subject to different governance regimes." (Ethiopia on behalf of the African Group, 2017, 2) The position of Ethiopia for the African Group should be cited.

17	24-25	"Such collaborations are typically underpinned by a philosophy supporting unencumbered and free exchange of materials and technology, often as a way of serving the greatest public good, and to avoid intellectual property and transaction costs." Even if intellectual property were eschewed, it would not be obvious that the resulting public domain of both the value added and the natural information would have been the choice of the countries of origin, thus not achieving the greatest good. Indeed Providers would have had no say over the decision. Did none of the interviewees mention sovereignty? "The greatest good" is not only unverifiable but also self-serving, embarrassingly so. To achieve neutrality, it would be better left omitted. However, if it were to remain, then it should be qualified "often as a way of purportedly serving the greatest public good...." Earlier we saw the subtitle "Determining value". Here we have the words "transaction costs" but again no mention of economics.
18	38-39	"Despite the short time-frame for the study we aimed to capture as broad and diverse a range of views as possible." This point should be emphasized. Three months is a ridiculously short period to comprehend and process a literature, which even pre-dates the drafting of the CBD. It is neither reasonable nor fair to expect that any study completed under such constraints will capture the potential of the existing literature which spans many decades and many disciplines.
18	39-41	"This report....does not explore the broader policy implications of digital sequence information, or make recommendations." By not citing the economics of information and by repeating thrice the unfounded assertion that "monetary benefits" are "speculative", the report does indeed explore a broad policy implication and does indeed make a strong recommendation, albeit not forthrightly. The artful choice of "speculative" casts an aspersion on the handful of economists who have thought deeply about the issues of ABS and published in favor of a multilateral system. None has engaged in speculation. Besides myself are Tim Swanson (1994), Chris Stone (1995) and more recently, Winands-Kalkuhl and Holm-Müller (2015).

18	12-15	"In addition, the Conference of the Parties requested the Executive Secretary of the CBD to commission a fact-finding and scoping study, the subject of this report, to clarify terminology and concepts and to assess the extent and the terms and conditions of the use of digital sequence information on genetic resources in the context of the CBD and the Nagoya Protocol (paragraph 3(b))." NOTIFICATION SCBD/SPS/DC/VN/KG/jh/86500 is entitled "Digital Sequence Information on Genetic Resources" and not "Digital Sequence Information". In the submission of the SPDA, both the term "on" and "genetic resources" were carefully analyzed in the analysis of "Digital Sequence Information on Genetic Resources". The analyses of "on" and "genetic resources" shed light the three objectives of the CBD. The preposition "on" also figures prominently in the submission of Biodiversity Institute of Ontario (2017). This point is further elaborated in the comment corresponding to page 21 lines 3-6.

19	15-17	"is that of intangible genetic resources, which include digital sequence information, in contrast to tangible physical genetic resources as defined within the Convention." Brazil and India argue that exclusion of the intangible, viz., information, from the definition of "material" is unfounded. The Oxford Dictionary provides two meanings of the word "material": "1. the matter from which a thing is or can be made; 2. Information or ideas for use in creating a book or other work." Had the first meaning been intended, then the CBD and NP would have achieved clarity by striking "genetic material" and inserting "genetic matter". They did not. Why would acceptance of information in the meaning of "material" be difficult for Parties and stakeholders? The answer may lie in cognitive linguistics, which is an underrepresented discipline in the COPs (the aforementioned Oduardo-Sierra being the notable exception). Until the last half of the twentieth century, biologists could not disembody information from matter, thereby creating the need for a term which would encompass the meaning of both. They found it in "genetic material". However, lawyers have always separated information from matter. Briefs are argued orally. For the lawyer, the meaning associated with material is only matter. Which meaning should prevail? The answer may lie in the title of the Convention on Biological Diversity. Although the CBD is law, the law is about biology. One can go further and say that the resistance to assimilate the Brazilian and Indian positions is because the ABS discussion has always been "very legalistic" (Vernooy and Ruiz Muller 2012, 3). Lawyers have conditioned the non-lawyers to equate "material" with "matter". The conditioning is reflected in the tautology expressed by Switzerland: > [T]he term 'genetic material' is defined as 'any material of plant, animal, microbial or other origin containing functional units of heredity'. According to these definitions, the terms 'genetic resources' and 'genetic material' clearly refer to tangible matter. In contrast, intangible digital sequence information does not fulfil the criteria of the definitions of either 'genetic material' or 'genetic resources' (Switzerland 2017, 2). A linguist might note that French, German, Italian and Romansch distinguish, matériel, Material, materiale and material, from matière, Materie, materia and materia. In the official languages of Switzerland as well as in English, both words sound similar, which may also partially explain why equivocation is not confined to English. Noteworthy is that the CBD re-used the word "material" in the definition of "genetic material" (Art. 2). Surely the lawyers present knew better! Legal Writing 101? "Material" is not so much evidence of sloppiness in drafting the CBD (Chandler 1993) as evidence of selection against "matter". The Brazilian and Indian interpretations survive examination and should be cited and duly developed.

20	14-17	"[H]armonizing terminology is something that is difficult if not impossible to achieve for dynamic terminologies that are used in multiple disciplines, and in fields that are actively evolving and changing over time, but in unpredictable ways". The quote loses force when one realizes just how young these sub-disciplines are and how pervasive is global interconnectedness which could facilitate harmonization. The explanation for the continued existence of multiple standards lies in network economics, where tremendous investments have already been made on existing standards (e.g., driving on the right or on the left; imperial or metric measurements, the QWERTY keyboard and so on (Samuelson and Nordhaus 2005, 114-115). Given the shallowness in time of bifurcations in the etymology of the terms under discussion, economics would suggest that harmonization is possible. "And if not now, when?" (Hillel the Elder, Pirke Avot I.14). The economist would also note that the the maintenance of differing standards is typical rent-seeking behavior, which reduces both efficiency and equity (Krueger 1974).
21	7-10	"Hammond (2017) also notes that since future information, or computer, systems, may not be 'digital', and since sequence information that is not stored digitally should also be included in the CBD discussions, it might be worthwhile to remove 'digital' from the definition." The point was made even more forcefully by Ethiopia on behalf of the African Group: "The mathematical and electronic models currently used for encoding information might be overtaken by information technology developments (e.g. quantum computing, 'DNA chips; etc.) in the medium term. What is relevant is the information itself, the fact of storage and world-wide accessibility and the modes of reconstitution and utilisation. Any outcome of the current discussion must be open for revision with regard to technological advances." (Ethiopia on behalf of the African Group 2017, 1). The Ethiopian position should be cited.
23	1-8	"Dutfield (2012) distinguishes between ways that 'information' is used in discussing DNA: information about DNA is used in relation to 'growth, development, regeneration, reproduction, disease, resistance to disease, and general cell functioning, of which vast amounts are being generated…' but which cannot be acquired by looking only at the sequence of bases." Clarity can be achieved through the appropriate use of a common economic term: value added. There is natural information in genetic resources and then there is value added to that natural information, which is artificial and transmitted in words.

23	17-18	"For others, the emphasis on physical material rather than the informational dimensions of genetic resources creates risks for benefit sharing (Ruiz Muller 2015)." The statement distorts the thesis of the source cited. A simple edit could render it accurate: "For others, policies for genetic resources as material eliminates the possibility of obtaining economic rents to be shared among countries of origin. Recognizing genetic resources as natural information would justify rents through a multilateral system (Ruiz Muller, 2015)."
23	19-23	"They recommend modifying 'information' with either 'natural' or 'artificial'. Because the provenance of a sequence is not clear from the term 'digital sequence information on genetic resources', and since sequences can also be synthesized and artificial, it is argued that the term runs the danger of extending the scope of ABS to artificial sequences, while not addressing the full range of natural information that should be included (Vogel et al, forthcoming)." The source is misquoted. Although Vogel et al (2018) do mention the point *en passant*, it is focal in the submitted view Peruvian Society of Environmental Law: "Unpacking 'Digital Sequence Information on Genetic Resources': Scaffolding of Errors to Preserve a Category Mistake" (PSEL September 2017).
33	34-35	"The increasing inclusion of environmental context data over the last decade makes it easier to trace sequences back to source countries, a critical step for ABS implementation." A literature now exists where ABS implementation does not depend on tracing as a critical step (Ruiz Muller 2015, Vogel et al, 2018). For this sentence to hold true, the adjective "bilateral" must be inserted, i.e., " a critical step for ABS implementation under bilateralism".
34	7-10	"We don't have the ability to curate individual records, we get submissions on average every 6 minutes, so we can't have a great deal of communication with submitters. We are working on this, though, and hope to get the community as a whole to take responsibility for this." And the cheque is in the mail.... An additional sentence may clarify the quote. After "to take responsibility for this" one could add "Incentives or the enforcement of penalties do not exist for submitters to disclose origins".

35	1-43	Reading these cases of access in these forty some lines, an overarching question is begged: did any of the folk interviewed obtain prior informed consent from a national competent authority? Did they realize that many in the South would classify their actions as "biopiracy"? It should be noted here that the transaction costs of prior informed consent create overwhelming incentives to access in the non-Party, which was the theme of the "new and emerging issues" that PSEL submitted to the UN Secretariat for both COP13 and COP14 (2015, 2017) .
36	12-13	"The day has arrived when individuals can easily and affordably sequence genes from physical material anywhere in the world, and send it via the internet to researchers, databases, foundries, and other institutions in regions far from the site of collection." Using the term "transaction costs", already introduced, would be appropriate as a follow-on sentence: "Inasmuch as information can also be encrypted, the transaction costs of monitoring and tracking sequences are insurmountable."
47	8-14	"Proponents of the conservation benefits of technologies associated with digital sequence information, including synthetic biology, argue that they can reduce consumption of fossil fuels by relying on biological processes that use renewable raw materials to produce biofuels, and so can mitigate climate change. New technologies have produced cleaner, more efficient manufacturing processes that pollute less and reduce waste; microorganisms designed for bioremediation and biosensors to clean up pollution; and new manufacturing processes to produce chemicals, plastics, and drug-precursorscurrently extracted unsustainably from natural resources or synthesized from petrochemicals." The statement reveals how the discipline of economics cannot be divorced from this "fact-finding and scoping study". Ever since Stanley Jevons perceived in 1865 that efficiency in engines did not reduce the overall consumption of coal, the paradox has borne his name. Nevertheless, the false assertion that efficiency-leads-to-conservation continues despite 150 years of contrary evidence (York 2006). It is easy for uncritical minds to grasp and not let go. The assertion re-surfaced in the Online Discussion on Synthetic Biology and was duly contested not just by the only economist participating in the forum but also by a professor of law (Winter, 2017, #8690). Silence ensued. No doubt the false assertion will resurrect among those participants as memories fade. Resurrection of disproven economic ideas go by the metaphor "Zombie" in the profession (Quiggin 2012)
47	35	"reduction in CO^2 emissions" Typo. Should read: reduction in CO2 emissions.

47	39-40	"could displace small farmer-grown products, rather than the petrochemical-produced products they are intended to supplant, thereby damaging local livelihoods (Bagley, 2017; TWN submission, 2017)." Industry will construe the statement as an endorsement of protectionism, which would violate multilateral and bilateral trade agreements to which most Parties are also party. An alternative argument from economics focuses on internalizing the positive externalities lost from diminishment of local livelihoods (Vogel 1994b). It is anchored in "Theory of Second Best" (see following comment).
47	19-24	"Biotech applications might also increase farm productivity per acre and reduce the environmental impact of agriculture in some cases (The One Acre Study, www.novozymes.com). Synthetic biology could potentially be used to control invasive species, tackle threats to endangered species, and restore habitats through modification of genomes; it can reintroduce extinct alleles; and synthetic biology tools could be used to recreate extinct species - the controversial concept of species 'de-extinction' (Kaebnick and Jennings, 2017; Redford et al, 2014; Redford et al, 2013; Desalle and Amato, 2017)." The second clause to the first sentence is a *non-sequitur* due to Jevons Paradox. Simply because industry repeatedly suggests that a reduction in environmental impact will take place does not make it so. The applications would have to be accompanied by imposing some sort of constraint on conversion of land use in order to achieve optimality. The theoretical argument, proven mathematically, comes from the seminal article "The Theory of Second Best" (Lipsey and Lancaster 1957) and has its parallel in ecology as expressed in the title of Garrett Hardin's last major work: *Living within Limits: Ecology, Economics, and Population Taboos* (1993).
48	13-16	"The use of digital sequence information presents opportunities and challenges for benefit sharing. Awareness of ABS within industry and academic research communities is obviously a critical first step, and although awareness of ABS has grown since the Nagoya Protocol came into force, significant gaps remain (Laird and Wynberg, 2013; 2015)." Biopiracy is now pronounced "gaps". It is disingenuous to excuse the unauthorized access of Users to unawareness twenty-five years after signature of the CBD. *Nature* is the most cited international journal and featured an article titled "Biopiracy ban stirs red-tape fears: Critics worry Nagoya Protocol will hamper disease monitoring" (Cressey 2014).

49	23-26	"New research arrangements, referred to by some as a 'protected commons' (www.BiOS.org) or 'contractually constructed research commons' (Reichman and Okedji, 2012), retain attribution and co-authorship as benefits, and in some cases more involved research collaborations, but eschew monetary benefits." For collaborators from the developed world, the non-monetary value can be greater than the monetary value of a Nobel Prize, if the publication leads to a tenured university faculty position: "the discounted present value (on this, check again with your local economist) of a permanent appointment is well over the present cash value of a Nobel" (McCloskey, 2002). So, the "research arrangements" are far from noble (pardon the pun) when one considers that the value of co-authorship differs by many orders of magnitude among collaborators according to nationality. Just as value does not equal price in economics, nor does co-authorship equal the same value among co-authors.
49	29-30	"Sequencing and analysis of the genetic diversity of countries lacking capacity is seen as a form of benefit sharing." The use of the passive voice is inappropriate as it implies a generality that does not exist. It would be better to say: "Sequencing and analysis of the genetic diversity of countries lacking capacity are allegedly a form of benefit sharing."

49	36-39	"North America, Europe, and Asia still dominate these technologies, but there are many emerging research powerhouses like Brazil, South Africa, and Singapore, that can work as equal partners in synthetic biology and other research programs." Would that be so. To assert a patent over value added through synthetic biology will require the applicant to file simultaneously in multiple jurisdictions. It is a most expensive proposition. Partners in North America, Europe and Asia often have in-house patent attorneys. Those in places like Brazil and South Africa will have to retain Northern firms which typically bill $600-$1000 per hour. The least-cost rule of microeconomics (Sameulson and Nordhaus, 2005, 133) suggests that the "powerhouses" are not sufficiently capitalized to justify such expenditures. Perhaps the sentence could be amended thus: "work as equal partners in research in synthetic biology and other programs, even though unequal in the the capacity to fully pursue intellectual property protection worldwide." The apparent conflict of interest of lawyers promoting bilateralism should somewhere enter the study. Here would be as a good a place as any. As Nobel Memorial Laureate Joseph E. Stiglitz remarked "[f]or lawyers, transaction costs are a benefit, because they are a source of their income" (2008, 1706). With the pending enforcement of the Nagoya Protocol, attorneys are waiting in the wings, salivating (Watanabe and Teh, 2011, 874). For them, a GMBSM is anathema.
49	2	"In addition to more speculative monetary benefits". The adjective "speculative" should be eliminated for the aforementioned reasons, cited in comments to Page 15 Lines 4-6, Page 14 Line 2 and our introductory remarks. Repetition of "speculative" in the study greatly undercuts its desired neutrality.

49	16	"Most countries do not have the funds or capacity to manage comparable systems, and so the INSDC databases serve as a resource for the global community." The statement assumes that the countries which do not have the funds or capacity to manage comparable systems, nevertheless have the funds or capacity to benefit from the comparable systems if managed elsewhere. This is false. Although the last paragraph on the page acknowledges this reality, some foreshadowing of that thought is required when the issue is first introducted. Perhaps: "Most countries do not have the funds or capacity to manage comparable systems, and so the INSDC databases serve as a resource for the global community which has the funds or capacity to access it." See comment for Page 14 Line 8
49		"scientific community, but not with each other". Proper English requires: "scientific community, but not among one another."
50	11-22	A scholarly literature exists regarding the gradations of access. It was pioneered by the political scientist Chris May (2010) from University of Manchester who launched the neologism "bounded openness". I picked up the term for the ABS literature (Vogel 2011), which was subsequently expanded by Ruiz Muller (2015) and Vogel et al (2018).
51	12-15	Open access over natural information does not prevent the assertion of intellectual property for the valued added to it. This point seems conflated in the paragraph and reflects unjustified fears of a restriction in access to natural information when the restriction is only over access to the value added protected by intellectual property.
51	36	"Capacity development and research collaborations present a significant opportunity for benefit sharing." This categorical statement is wrong on many levels. The first is empirical and is the focus of a large economic literature which goes under the rubric "truthful revelation". How does one know the opportunity is significant when it is incommensurable? When indicators exist, the value may be insignificant (e.g., co-authorship may be of little other than psychological value, see comment to Page 49 lines 23-26) or even counter-productive (e.g., facilitating a brain-drain). The statement should eliminate the adjective "significant". Indeed, one could even make a strong case to replace "significant" with "ballyhooed".

53	15-17	"Monetary benefits growing from the use of digital sequence information are largely speculative to date, and are potentially complex due to challenges in identifying provenance and the value of any given sequence or part." One assumes that the first meaning of "speculative" was intended: "1. engaged in, expressing, or based on conjecture rather than knowledge: 2. (of an investment) involving a high risk of loss" (Oxford Dictionary). The Laird & Wynberg statement in quotes can be easily shown to be false. A substantial refereed literature quantifies the benefits which would ensue were ABS policy to be grounded in the economics of information. To render the sentence non-objectionable, one would have to amend it thus: "Under bilateralism, pure economic rents in monetary benefits deriving from the use of digital sequence information cannot emerge due to jurisdcition shopping." A good example of the potential rents not realized is "based on...[the] knowledge" of the diabetes drug Glumetza owned by Valeant, Inc. The active compound derives from the French lilac. At the price of $572/patient/annum and a 15% royalty, one calculates that $85/patient/annum could have been generated for ABS. The quantity of pills sold would not have been diminished due to the imposition of the royalty. Demand at the price $572 proved itself inelastic when Valeant increased the price to $3,432/patient/annum. The case was explained in the side event to COP13: "New Approaches to Access and Benefit Sharing: The Case for Bounded Openness and Natural Information" (Peruvian Society of Environmental Law, 2017). The best example of monetary benefits not realized is *Thermus aquaticus.* Over the patent life of polymerase chain reaction (PCR), which derives from *T. aquaticus*, sales have been $2 billion (Fore et al, 2006). Had there been a 15% royalty on PCR, then $300 million dollars would have gone to ABS. Institutional history can also elucidate the visceral objection of not just the economists but also the citizenry of the developing world to the adjective "speculative". When Edmund Pratt, then CEO of Pfizer, Inc. used his network to promote TRIPs in the 1980s and early 90s, no one rejoined that the potential royalties from the inaccurately alleged* "intellectual piracy" were "speculative". That history is easily retrievable from the award-winning legal scholar Peter Drahos in "Intellectual Property Engineering: The Role of the Chemical, Pharmaceutical and Biotechnology Industries" (2004, 260-264). --- *"Inacurrately alleged" as patents on human drugs were unconstitutional in the principal manufacturing countries, viz., Argentina and India.

53	21-24	"As a result of the uncertainties associated with monetary benefits from bi-lateral agreements, many have suggested the establishment of a global fund to address benefit sharing from public databases (e.g. Bagley, 2015 and 2017). Experience from funds established under the ITPGRFA and the WHO PIP Framework may provide relevant lessons in this regard." This is also ahistorical. Note well that the fondly remembered Cyril de Klemm, the *de facto* father of the CBD, vocally advocated a Global Fund for ABS. His tireless efforts were frustrated in the drafting the of the CBD in 1991-1992 (see Glowka, 1994, 5). To render the phrase unobjectionable, "As a result of the reality that the object of R&D is information and not matter, many have embraced a suggestion that was argued in the drafting of the CBD, viz., a global fund (see Glowka, 1994, 5). Although experience from funds established under the ITPGRFA and the WHO PIP Framework may provide relevant lessons in this regard, the technologies heretofore described could help identify claimants to countries of origin. For widely dispersed or ubiquitious sequences not already in the public domain, it has long been suggested that the royalties collected finance the fixed costs associated with a global multilateral mechanism for benefit sharing (see Vogel, 1994b, Ruiz Muller 2015, Vogel et al 2018). The issue has also been taken up by Bagley (2015 and 2017)."
54	1-10	Value for the consumer can be conceived as the difference between what the consumer paid and the maximum price that he or she would have been willing to pay. Value for the society would be to sum of those differences for all individuals and is called "consumer surplus" (Samuelson and Nordhaus, 2005, 96). Prices in a competitive market for information is a meaningless signal of value as the price will be driven down to the marginal cost of provision, essentially nothing. The lines 1-10 are about economics yet are are uninformed by economics. The lines 1-10 should be re-thought.
54	14-17	"As Welch et al (2017) describe: "… an individual sequence or 'part' has more value in a library where it can be screened with other sequences to find the connections between a particular trait and its function and use in other things… As a result, the value of an individual sequence from a species may be very difficult to quantify". The synergistic problem can be resolved by some sort of rule regarding apportionment of the royalty to be levied. The royalty would be flat percentage for a combination of characteristics and the claims weighed by the total number of utilizations in any final product. This was suggested in Vogel (2015) and elaborated further in Vogel et al (2018).

54	19-26	Section 8.2 is titled "Monetary benefits". Are we to assume that "value" refers to theoretical construct of consumer surplus? or the common-parlance synonym "price"? or just functional use? The lines imply the last option which contradicts the Section sub-heading "Monetary beneifts". Readers will easily commit the fallacy of equivocation over the distinct meanings of value used in these lines.
54	27-33	The indicated lines are also uninformed by economics. One does not need to determine commercial value to expect monetary benefits. A flat rate typical for a combination of characteristics of utilization and apportioned according to agreed rules, would generate *ex post facto* a quantified lower-boundary indicator of value in the economic sense.
55	1-34	The issue of diffusion has been core to the economics of information approach since its conception (Vogel 1992). Diffusion will vary from natural information found in all life forms. At one extreme of diffusion is ATP synthase, found in all life forms, at the other, useful mutations specific to an individual, e.g., the famous case of the MO cell line of John Moore. When the costs of establishing who are claimants is greater than the royalties to be claimed, then the economic argument is to remit the money to the required infrastructure of the system. See also the comment corresponding to Page 53 Lines 21-24.
56	24-31	"Remarked a molecular biologist: 'There is a massive influx of data already – for example, roughly 115,000 bacterial genomes are stored in GenBank, and more all the time. Things are moving at an incredible pace. If I can't find pathways or genes from organisms from one country, I will move to another country – from one genetic background to another. Genetic material is shared across organisms, kingdoms, and countries, so it is harder to claim it is owned by a particular country. Geopolitical boundaries are human constructs. Just because India or Brazil or some other country wants to place restrictions on the material they hold doesn't mean I can't find something similar and just as useful in some other geographic area.'" The quote reveals a contradiction that appears to have escaped the authors.The molecular biologist refers to "material" and says that he/she can find "something similar and just as useful in some other geographic area." Matter cannot be in two places at the same time, quantum mechanics notwithstanding. The quote only has meaning with the Brazilian and Indian interpretation of "material" as inclusive of "information." It should be noted that the intended meaning of material as inclusive of information emanates from a molecular biologist and not from a lawyer, which coheres with the earlier comment to Page 19 Lines 15-17.

56	32-33	"Additionally, users might seek 'favorable' jurisdictions where they can have legal certainty over resources (PSEL, May 2017; Vogel et al, forthcoming)." This is a mischaracterization of the bibliographic sources cited and ignores the fiduciary responsiblity of most Users to jurisdiction shop. An accurate statement would be: "Additionally most users have a fidicuiary responsibility to shareholders to obtain the natural information in the cheapest jurisdiction (PSEL, 2017, Vogel 1996, Vogel 2007, Vogel et al 2018,).
56	3-7	"Outside of agriculture, homologous or conserved sequences mean the value of any given sequence, or collection of sequences from a particular country, is likely to be diminished, since many sequences might be found in other regions, including countries that are not Parties to the CBD. As a result, companies are unlikely to invest significant resources to gain access to raw digital sequence information from a particular country." Scientific evidence exists that species bioprospected are usually cosmopolitan (Oldham et al, 2013, 6); the same probably holds for sequences. Should Users not be obligated to pay benefits when the sequence are highly diffused then those which are highly threatenned will not be able to compete with those that are highly diffused. The solution would be a flat royalty rate for specific combination of characteristics in utilization regardless of diffusion (Vogel, 1992, 1994, Vogel, 2007, Vogel et al, 2018).

56	28-30	"As a researcher asked: 'What percentage similarity of a gene sequence requires you to consider benefit sharing? Small introduced changes can have massive effects on the genes being used, turning them from unusable to very valuable. How would this be accounted for?'" The researcher alludes, unwittingly, to the (Marxian) "labor theory of value". Implicit in the quote is that the value derives from the work added to the small change. If he or she needed any particular sequence to add value, then that sequence was a limiting factor in production. The price for the sequence should be established by the future system which establishes royalty rates by the characteristics of utilization. Implicit recourse by industry spokesmen to the Marxist precepts in defense of open access was first ridiculed by Jack Kloppenberg and Daniel Lee Kleinmann (1988, 189). The frequent repetition of the labor-theory-of-value argument is evidence that "studied ignorance" extends beyond the economics of information to large swaths of economics. Like increased-efficiency-reduces-environmental-stress, one suspects that the argument persists because it is easy for uncritical minds to grasp and not let go. The Zombie metaphor is again apropos.
57	32-33	"Core elements of benefit sharing under the Nagoya Protocol are challenged by the emergence of digital sequence information, and the 'dematerialization' of genetic resources." Brazil (2017) and India (2017) would disagree as their interpretation of "material" includes information in their well argued submitted views.
58	1-2	"Identification is the first step in monitoring and establishing an effective benefit sharing system (Garrity et al, 2009)." This is false. It can be rendered true if one inserts "bilateral": "Identification is the first step in monitoring and establishing an effective benefit sharing system under bilateralism (Garrity et al, 2009)." Under bounded openness, identification comes *ex post* commercial success, which means that no identification is necessary for probably 99% of the natural information accessed.
58	27-29	"epidemiological and demographic information (if available) about the influenza virus. In this case, the identification of contributors and users of genetic sequence data serves multiple goals, and does not interfere with the timely sharing of data during health crises." In a health care crisis, bounded openness can also be used to give incentives for the rapid entry of strains into the international research network, which reflects a survey of opinions of researchers on human pathogens. (Vogel et al, 2013)

59	1	"Identification of the provenance of digital sequence information." The page speaks to a bilateral system where provenance is virtually impossible (no pun intended) to ascertain. In keeping with the title of the scoping study which includes the word "implication", one should say that the impossibility of ascertaining provenance in a bilateral system is solved for a multilateral system. One determines the possible provenance *ex post* commercial success through a variety of GIS techniques which predict habitat, followed by field sampling (commonly called by the respective experts as "ground-truthing.")
59	40-42	"researcher commented, 'It's easy to hide where your sequence came from. I can take a natural sequence and have it codon optimized in such a way that one could not determine the original gene sequence again'". Under the bilateral approach, the likelihood of falsifying provenance is higher than under bounded openness. Falsification eliminates the hassles of prior informed consent while celebrating a research-lab culture which flaunts restraints, especially so in the non-Party. ""Getting RAFI'd" is said facetiously (McManis, 2004, 460). In contrast, under bounded openness, there is little incentive for the researcher to falsify provenance inasmuch as his or her research can proceed unencumbered without falsification. The bravura of biopiracy will lose its appeal. Should a company wish the researcher to falsify provenance in order to save it a future royalty expense, then the company would be recklessly exposing itself to whistle-blowing and attendant liability.
60	5	"there appears widespread agreement within the database and research community that, going forward, inclusion of the origin of digital sequence information is critical." Should inclusion of the origin of digital sequence information be disclosed with the sequences, then Users will have divulged confidential business information regarding research streams. The system of bounded openness does not require public disclosure at the point of access. It requires only disclosure of utilizatan (Yes/No) of natural information at the moment of application of an intellectual property right (Ruiz Muller 2015). It would thereby behoove Users who wish to retain confidentiality over incipient research streams.
60	6	"8.3.2 Monitoring the Utilization of Digital Sequence Information" Once again, clarification is necessary in the subtitle. It should read "8.3.2 Monitoring the Utilization of Digital Sequence Information under Bilateralism".

61	9	"link to publications and authors (Oldham in Scott and Berry, 2017)." Bounded openness as the modality for the GMBSM would eliminate the aforementioned transaction costs of monitoring (Vogel 2007, Vogel et al, 2018). The elimination of bureaucratic costs should tip the balance in the submitted view by the Royal Society of Biology (2017) against inclusion of digital sequence information within the scope of ABS.
61	16-17	"the lines between them have grown indistinct in recent decades, as academic and government researchers increasingly partner with industry." The sentence is ahistorical. Some metnion of the US Bayh-Dole Act of 1980 (Pub. L. 96-517) could clarify the date of the bifurcation point when commercial and non-commercial research began to blur.
63	11	"creates significant opportunities for non-monetary, and possibly monetary, forms of benefit sharing." The adjective "possibly" should be struck for reasons heretofore explained.
63	14	"problems of determining value;" The phrase is erroneous, economically speaking. It should read "problems of capturing a pure economic rent in a bilateral system;".....
63	16	"It behooves ABS policy makers to stay abreast of the profound developments shaping research today." So, when is that not true? One needs a system that will be robust over time. This was the salient point made by Ethiopia on behalf of the African Group and not cited in the scoping study. The African Group favored "natural information" in order to achieve robustness.
63	26	"free exchange of materials and technology, often as a way of serving the greatest public good, and to avoid intellectual property and transaction costs." The "greatest public good" is contestable. If it is retained, then it should read: "free exchange of materials and technology, purportedly to serve the greatest public good, while also avoiding intellectual property and transaction costs.

63	28	"It might be that the strengths of ABS, open science, and other approaches could be.." Despite umpteen initiatives, workshops and projects over twenty-five years, the Parties and stakeholders have failed miserably to achieve ABS. This is an empirical fact (Carrizosa, et al. 2004, Pauchard 2017). The non-ironic use of the word "strengths" is chillingly Orwellian. Faithful to reality yet expressing the intended meaning, would be: "It might be that the professed commitment of Parties and stakeholders to ABS, open science, and other approaches could be..." Albeit alienating, inclusion of the word "professed" is warranted by the abject failure to achieve ABS and the steadfast refusal to entertain the solution found in the refereed and rigorous economic literature.
		Concluding Remarks: Journals send referees a box to check one of the following categories: Title: "The Emergence and Growth of Digital Sequence Information in Research and Development" To publish as is: [ ] Publish with Revisions: [ ] Not to Publish: [ ] It pains me to say that I am tempted to choose the last option. Not to Publish: [X] The subtitle reads "Implications for the Conservation and Sustainable Use of Biodiversity, and Fair and Equitable Benefit-Sharing". The three objectives of the CBD are intrinsically economic. To render implications about the facts of DSI without the light of economics is bizarre. The study is not a journal article and will be published. So, the challenge is to heavily revise it before publication. Garrett Hardin wrote that theory is a "compactor" (1993, 103). Through the application of economics---even at the introductory level of the classic textbook Samuelson and Nordhaus (2005)----the authors will not only be able to make sense of the sundry facts amassed, but will also be able to compact them for the much desired implications.

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