Boosting CITES

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International wildlife trade remains a leading threat to biodiversity conservation (1) and is a common vector for infectious diseases (2, 3) and invasive species (4) that also affect agriculture, livestock, and public health. With 175 member countries, the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES) is the most important global initiative to monitor and regulate international trade of plants and animals (5). CITES regulates trade of nearly 34,000 species and has reduced threats associated with overharvest of imperiled species for international trade.

Credible biological and trade data are core to informing decisions and garnering political will and consensus among CITES parties (6). This does not preclude party bargaining, as occurred during the March 2010 Conference of Parties (CoP) debate over bluefin tuna [e.g., (7)]. Nevertheless, CITES decisions are also frequently hindered by a lack of basic data [e.g., (8–10)]. We highlight CITES limitations and describe potential solutions related to systematic data collection, rigorous data analysis, flexible research methods, and peer review.

Systematic, Standardized Data Collection

The CITES secretariat, Animals and Plant Committees (APCs), and external agencies [e.g., International Union for Conservation of Nature (IUCN) Specialist Groups] depend on national agencies to regulate trade. Yet many CITES parties fail to systematically monitor and report international wildlife trade [e.g., (11–13)]. Some of the largest exporters and importers of wildlife products are not fully compliant: Brazil, a significant source country for illegal fauna (14), lacks a functioning central mechanism for reporting wildlife confiscations (15). The United States, a leading importer of wildlife, lacks a coordinated national authority for monitoring wildlife imports (3).

Many CITES parties fail to collect domestic population and harvest data, and CITES lacks a standard international reporting mechanism for species-level information (16). Yet this information is central to CITES function (9, 15), as exporters must present nondetriment finding (NDF) reports to prove that international trade is not harming populations of regulated species (17). Such baseline data are also fundamental to listing species for CITES protection; commercially high-value species have been listed on the basis of robust, empirical population data [e.g., (6, 18)]. However, most taxa are understudied, and there is a lack of coordinated, systematic data collection within and among parties [supporting online material (SOM)].

Data collection at all levels depends on proper species identification (19), which remains a leading challenge. For example, more than 50% of documented live-animal imports into the United States from 2000 to 2006 were identified only by class; only about 14% were identified to species (3). Weak data sets overlook species introductions, substitutions, and exporter misidentifications [e.g., (20)]. Traditional identification protocols and methods are proving inadequate (3, 15) and require revision and innovation (19, 21).

Rigorous Analysis

When data are available, analyses under the Secretariat, APCs, and their collaborators often remain insufficient to identify species threatened by trade and to detect trade inaccuracies and loopholes. For instance, ~20% of species threatened in four mega-diversity countries (Brazil, China, Colombia, and the Philippines) have not been assessed at the international level (22). Similarly, the IUCN holds “no information” about the status of most of the Orchidaceae (23); only three species were added to the Red List of Threatened Species from 2007 to 2009, although sufficient information exists to list many others (24). A handful of studies have highlighted the need for enhanced, rigorous analysis (SOM), yet critical trade linkages often remain undetected when CITES relies on the interest, resources, and often informal or irregular input of independent researchers and organizations (25). Encouragingly, CITES partners are developing tools to enhance analysis capacity, such as the Trade Data Dashboard (26).

Flexible Methods

Wildlife trade occurs openly at public border markets (27) and discrete black markets (28). Trade activity shifts and cycles among countries as wild populations are depleted (12, 29), and innovative smuggling techniques are adopted in response to enforcement pressures (28). However, trade data are collected using conventional techniques implemented along easily accessed trade routes (e.g., airports), which cannot capture the true dynamics. For example, CITES reports an insignificant fraction of CITES-regulated wild orchid trade into Thailand from Lao People’s Democratic Republic (see the chart), Myanmar, Cambodia, and Vietnam. A single small-scale trader at an informal border market on the Mekong can sell

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more plants in a single day than reported by CITES over a 9-year period (SOM, see the charts on page 1752). Similar trade inaccuracies are evident across taxa (bears, edible tubers, medicinal plants, seahorses, bushmeat, and frogs) and regions (12, 20, 27, 30–33). Some efforts have been made to integrate alternative, investigative approaches into CITES (e.g., the Lusaka Agreement and CITES-INTERPOL collaborations), but the overall CITES “airport bias” fails to detect the majority of illicit trade.

CITES shortcomings may be overlooked because the convention lacks internal and external checks and balances. CITES relies exclusively on country self-reporting, although incentives are high for biased analyses and misreporting (34), and most CITES-listed species occur in the tropics where governance is often weak and corruption high (35). This is especially problematic when CITES National Management Authorities lack independence from their advisory Scientific Authorities (SOM) and because parties’ submissions to CITES are not publicly available (36).

Critical, independent peer-review offers a legitimate means of party validation, particularly when addressing contentious issues such as harvest quotas, approvals of NDFs, proof of captive breeding, and national management procedures for protected species (8). These reviews may meet with party resistance that could hamper future investigatory efforts, especially if they are followed by legal action. However, the recent pilot CITES Policy Review Project in four exporting countries provides an encouraging precedent for future external reviews (37) (SOM).

Solutions in Context
CITES credibility, effectiveness, and success at catalyzing consensus depend heavily on punctilious data collection, analysis, and synthesis. Yet the convention is bound by political and economic realities. General strategies through which to improve CITES (table S1) must recognize that some measures may overlap, prioritization depends on party needs and resources, and recommendations may vary in their political feasibility.

CITES has improved party compliance and science-based decision-making despite political sensitivities, through provision of technical support; mission visits and recommendations; simplified reporting procedures; and legal strategies, such as warnings and threats of trade suspensions (5, 36). Such progress demonstrates CITES recognition of the importance of enhanced enforcement and data collection. Further increasing the demands on CITES parties and secretariat is necessary, but remains administratively demanding, costly, and politically challenging.

Some of the most urgent solutions (table S1) require the greatest coordination among parties and institutions. For example, collection of baseline biological data on traded species will require coordinated activities among diverse stakeholders, ranging from rural harvesters to multilateral agencies. CITES has already enhanced data-sharing and analysis through collaborations with nongovernmental organizations and partnerships, such as the Wildlife Enforcement Monitoring System. At the March 2010 CoP, CITES instituted an illegal-trade database working group to enhance data collection and analysis (38). The majority of proposed solutions depends on enhanced active, sustained, and reciprocal engagement of CITES parties with external partners.

Funding remains a principal limitation to CITES, especially for on-the-ground execution of mandates and for proposed enhancements (table S1) (25). The secretariat operates on meager party donations (25, 36) of U.S. $5.2M per year for 2009–11 (39). National-level funding for CITES enforcement is similarly restricted, especially in many tropical exporting countries. There is a need for parties, particularly importing nations, to increase contributions dramatically. CITES costs should also be extended to participating industries and consumers, consistent with the “polluter pays” principle, while doing no harm to poor harvesters (40). This can be accomplished through trade levies on CITES-listed wildlife (9), increased infraction penalties (19), and wildlife certification schemes (41). Only through increased resources can CITES move toward proactive, real-time monitoring and regulation to strengthen enforcement and data quality.

After 35 years, the CITES framework remains highly relevant, and the secretariat and CoP should continue to facilitate progress among noncompliant countries and should exercise legal tools to create consensus. However, current rigors are inadequate, and meaningful improvements will require greater financial and political commitments. We propose targeted CITES negotiations to establish new partnerships; to review financial commitments; and to develop clear rules and progressive standards for data collection, analysis, and review. A strengthened convention is essential to protecting imperiled biodiversity.

References and Notes
26. CITES, Trade Data Dashboards; http://cites-dashboards.unep-wcmc.org/about.
42. Funding for J.P. provided by the Harry S. Truman Foundation, for E.L.W. from the Singapore Ministry of Education, grant no. R-154-000-400-133.

Supporting Online Material
www.sciencemag.org/cgi/content/full/330/6012/1752/DC1
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ERRATUM

Policy Forum: “Boosting CITES” by J. Phelps et al. (24 December 2010, p. 1752). The heading for the fourth potential solution was missing. “A Peer-Review Process” should have appeared before the paragraph on the second page that begins, “CITES shortcomings may be overlooked because the convention lacks internal and external checks and balances.” The header has been added in the HTML version online.
Letters

Recognizing Scientists and Technologists

On 17 November 2010, President Obama presented the National Medals of Science and the National Medals of Technology and Innovation. These medals are the highest honor that the nation can bestow in science and technology, yet they are rarely mentioned by the popular media. Because Congress does not appropriate funds to implement the “outreach” of these medals, for many years the only national recognition was a private award ceremony with the President.

In 1991, George Rathmann, one of the founders of the biotech industry, facilitated the formation of what is now the National Science and Technology Medals Foundation. The mission of the Foundation is to promote the National Medal Laureates as role models for students and thereby encourage interest in science and math. To accomplish this goal, the Foundation hosts a banquet in conjunction with the White House ceremony. This banquet features videos highlighting the technical accomplishments of the Laureates, which then become the basis for stories that appear throughout the country.

Over the years, the Foundation has accumulated a wealth of electronic material on the Laureates, including biographies, interviews, and descriptions of their accomplishments. This recognition not only is a way to recognize the Laureates’ enormous efforts, but also serves to focus our attention on the seminal ideas in science, mathematics, and engineering. The stories behind these accomplishments often provide inspiration to others, which is essential to promote further achievements.

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Reference


Genetics-Based Field Studies Prioritize Safety

M. Ensink’s News of the Week Story on the open release trials of genetically modified mosquitoes in the Cayman Islands (“GM mosquito trial alarms opponents, strains ties in Gates-funded project,” 19 November 2010, p. 1030) highlights the growing pains associated with bringing new technologies out of the laboratory into the field. Unlike for vaccines, drugs, and insecticides, no industry-wide standards are yet in place to guide either public or private efforts in the development of these technologies. However, it is important for the public to know that the scientists working on these new technologies are aggressively supporting the formulation of best practices for their safe, efficient, ethical, and regulated application, and are reaching out to experts from a range of relevant disciplines for advice and counsel. A series of publications document the evolution of this process (1–5). Indeed, efforts are currently under way to develop a guidance framework for quality standards to assess safety and efficacy and to address regulatory, legal, social, and cultural issues, as recommended by an international consultation held at the World Health Organization in 2009 (5). Thus, although we have not achieved harmonized international standards, as has taken decades for other technologies, we are much closer than most people realize. We recognize the need to ensure that our enthusiasm for the promise of these approaches as powerful public health tools does not outstrip our responsibility to apply scientifically validated and socially acceptable product development practices. The tragedy would be if this important but complex birthing process were to stifle creativity in the development of not only genetics-based solutions, but all truly novel approaches that seek to reduce the serious health threat of diseases such as malaria and dengue fever. We hope that debates over specific circumstances do not cloud the urgent need for the development and deployment of new tools to mitigate these disease scourges.

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References


Origins of Biodiversity

The Origin of the High Neotropical Biodiversity has been a controversial topic since Darwin. The debate has focused on the relative influences of the climate changes during the Pleistocene (the past...
~2.6 million years) and the tectonic and geographical reorganizations that occurred before the Pleistocene (1). In their Review “Amazonia through time: Andean uplift, climate change, landscape evolution, and biodiversity” (12 November 2010, p. 927), C. Hoorn et al. conclude that the biodiversity patterns of the Amazon basin were largely shaped before the Pleistocene, facilitated by the Andean uplift. The authors dismiss Pleistocene diversification by arguing that, in the Neotropics, the refuge hypothesis (proposing that species diversified in isolated forests during glacial periods) has already been abandoned, and that fossils and molecular phylogenetics support mostly pre-Pleistocene diversification.

However, Pleistocene diversification could have resulted from a variety of mechanisms other than isolated forest remnants (2–4). Furthermore, Hoorn et al. cite my meta-analysis (5) in support of the pre-Pleistocene diversification, yet I drew from that study contradict those of Hoorn et al.’s Review. I concluded that about half of the dated extant neotropical species originated during the Pleistocene and the other half before it, and that speciation proceeded in a continuous fashion with no evident bursts (5). In addition, phylogenetic evidence provided by Hoorn et al. is based on the dating of complexes of extant species (the crown clades) that in fact records the age of the oldest species within each group (6) but not necessarily the age of all the extant species, which should be necessarily younger. This overestimates pre-Pleistocene diversification. Earth’s biodiversity gradients are the result of a long and complex history of evolutionary trends, mediated by ecological processes and governed by external forces, in which not only speciation but also extinction should be considered, especially in extratropical areas (7).

The topic requires the synergy of many disciplines, in a wide range of spatial and temporal scales. Pleistocene speciation is one more element and should not be neglected; after all, we ourselves are a Pleistocene species barely 200,000 years old.

References

Response

IN OUR REVIEW, WE LINK THE OUTSTANDING species richness in northern South America to the cataclysmic changes induced by Andean mountain building. Evidence for this is the correlation between sedimentary records, the paleontological record, dated molecular phylogenies, and present species distributions. Our conclusions contradict the hypothesis that has dominated for more than 40 years: that the outstanding levels of Neotropical species richness and current distribution patterns were mainly produced by Quaternary climatic fluctuations (1, 2), i.e., in the past 2.6 million years. All evidence in our meta-analysis points toward an older origin of Amazonian biodiversity.

Rull argues that we ignore Quaternary evidence on speciation, in part by erroneously referring to his previous meta-analysis (3) as evidence for pre-Quaternary diversification. Rull’s finding that about half of all extant species analyzed originated during Quaternary times (3) is not surprising. Assuming the average species longevity is some 100,000 to a couple of million years (3–5), at any point in time we would expect to find that most species originated in the past few million years. Rull’s evidence that extant species originated recently does not contradict the idea that the total number of species was just as high (and for most organism groups higher) before the Quaternary, even if the species that existed then have since become extinct. Moreover, if Pleistocene glaciations had indeed produced most of the species richness observed today—as implied in the original formulation of the “refuge theory” (1)—this would unrealistically imply that all previous diversity was produced by entirely different mechanisms. This realization severely undermines the role of glaciation dynamics in accounting for Neotropical species richness.

Rull’s suggestion that we underestimated pre-Quaternary diversification by using genera instead of species as taxonomic units in our meta-analysis is misleading. Extinction is more likely to affect older lineages than younger ones—simply because species that have arisen recently have had less time to go extinct (6)—meaning that Pre-Quaternary speciation events were probably underestimated in Rull’s meta-analysis (3).

Stochastic diversification models (6) can correct for the effect of background extinction in diversification rate estimates, but these models have proven unrealistic because of their oversimplified assumptions (7) and sensitivity to incomplete taxon sampling (8), a common feature in Neotropical phylogenies. Estimates of crown ages of genera are, arguably, less sensitive to incomplete taxon sampling, because in most species-level phylogenies, sampling is aimed to cover the geographic and morphological variation within a genus. This should lead to more robust age estimation of deeper nodes even when many species are missing.
The data we assembled show that the blueprint of present Amazonia was laid out in pre-Quaternary times, but they also have the potential to provide us clues on how the rainforest may react to future global warming. It is also clear that Amazonian biota withstood large geodynamic (9) and climatic fluctuations but that humans, the young product of Quaternary evolution, pose the biggest threat to this wealth of biodiversity.

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References

CORRECTIONS AND CLARIFICATIONS
Perspectives: “The feeding habits of ammonites” by K. Tanabe (7 January, p. 37). The legend should read as follows with corrected genus names: “(Top) Polyptychoceras sp. with Baculites-like lower and upper jaws… (Bottom) Anagaudryceras limatum (a lycoceratid) with a nautilids-like lower jaw.”

News Focus: “U.N. biodiversity summit yields welcome and unexpected progress” by D. Normile (10 December 2010, p. 1475). There is a shift in the increments on the vertical axis of the graph indicating the number of individuals making overseas visits. From 0 up to 10,000 individuals, the graph uses increments of 2000; above 20,000, it uses increments of 20,000.

News of the Week: “CITES shortcomings may be overlooked page that begins, “CITES shortcomings may be overlooked because the convention lacks internal and external checks and balances.” The header has been added in the HTML version online.

News of the Week: “How to boost CITES” by J. Phelps et al. (24 December 2010, p. 1752). The heading for the fourth page solution was missing. “A Peer-Review Process” should have appeared before the paragraph on the second page that begins, “CITES shortcomings may be overlooked because the convention lacks internal and external checks and balances.”

Letters to the Editor
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