The IUCN global assessments: partnerships, collaboration and data sharing for biodiversity science and policy

Thomas E. Lacher, Jr.[1], Luigi Boitani[2], & Gustavo A.B. da Fonseca[3,4]

[1]Department of Wildlife and Fisheries Sciences, Texas A&M University, College Station, TX 77843, USA
[2]Department of Biology and Biotechnologies, Sapienza Università di Roma, Viale dell'Università 32, Roma 00185, Italy
[3]Global Environment Facility, 1818 H Street NW, P-4–400, Washington, DC 20433, USA
[4]Department of Zoology, Universidade Federal de Minas Gerais, Belo Horizonte, MG, Brazil

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Correspondence
Thomas E. Lacher, Jr., Department of Wildlife and Fisheries Sciences, Texas A&M University, College Station, TX 77843–2258, USA.
Tel: 979–845-5750; Fax: 979–845-3786.
E-mail: tlacher@tamu.edu

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Abstract

The development of standards, data sharing, and initiatives like the Global Biodiversity Information Facility and others have advanced research in many fields, including in conservation of biodiversity. Global assessments of extinction risk to species have been completed by IUCN for multiple taxa. The IUCN global assessments have had a major impact on conservation science and practice as well as biodiversity funding mechanisms though the Global Environment Facility, the World Bank, and the Critical Ecosystem Partnership Fund (CEPF). A signature of the assessments is a process of sustained interaction between conservation organizations and the research and academic community, effectively integrating science and policy on global scale. The model relies on several critical components: openness of the conservation community to scientific input and debate, engagement of the scientific community, conservation organization mediated data collation, and data sharing with ease of access. This model can be applied to other challenges to conserve biodiversity and assess how biodiversity loss affects the well-being of societies across the world. The recognition of the importance of biodiversity in meeting the Millennium Development Goals and the recognition of the failure to meet the 2010 Biodiversity Target illustrate the gap between what needs to be achieved and our current trajectory.

Introduction

The past 10 years have provided biodiversity researchers with a revolution in data management, compatibility, and accessibility. The development of metadata standards (www.dublincore.org; Graham *et al.* 2004), the facilitation of data sharing among researchers (manisnet.org; www.herpnet.org), and the creation of intergovernmental initiatives like the Global Biodiversity Information Facility to manage data standards, intellectual property rights, and data sharing practices (www.gbif.org; Edwards 2004) have greatly advanced research in many fields (King & Penman 2009; Thomas 2009). There are now also national and regional information networks (www.conabio.gob.mx; www.mma.gov.br; www.iabin.net).

The sharing of genomic databases has accelerated research in biomedicine (Field *et al.* 2009) and evolutionary biology and systematics (www.ncbi.nlm.nih.gov/Genbank). Open access publishing is now common, ranging from full open-access journals to express online publication in many of the most prestigious scientific journals. The sharing of data for the biomedical sciences has been of clear benefit to society and has accelerated research in many fields. Data sharing and open access are now having the same effect on the conservation of biodiversity. In order for this to succeed, we need to shepherd a new era of collaboration and partnership among natural history collections, academic researchers, conservation organizations, funding institutions, and direct beneficiaries of conservation action. We present a model for open collaborative partnership between research and applied

science organizations, based on our experience with the IUCN Red List.

The IUCN global assessments: influencing policy and action

The IUCN Red List first began developing lists of threatened species in the 1950s, using differently and more subjectively defined criteria and categories from those now used (Mace *et al*. 2008). The standards were defined with the first publication of the Red List Categories and Criteria in 1994 (IUCN 1994) and these were revised to the current standards in 2001 (IUCN 2001). The criteria require documented evidence of status and trends in one of five areas: rates of decline in population size, size of the range and decline, small population size and decline, very small population size alone, and quantitative analysis and modeling of demographic data (Mace *et al*. 2008). The decision process on how data and numbers are applied to decisions on categories of extinction risk are detailed and well documented online (http://www.iucnredlist.org/technical-documents/categories-and-criteria) and beyond the scope of this article, however they have been scientifically vetted and are widely used. These data and the application to extinction risk have been applied for years by the Species Specialist Groups (SSG) of the Species Survival Commission of the IUCN. For years, assessments were dependent upon which SSG were in place and were active, so the assessments were less than comprehensive and often species assumed not to be under threat were not documented and reported. In 2000 the first Red List Partnership involving IUCN, Conservation International, BirdLife International, and NatureServe was formed to expand the scope and utility of the Red List. One of the first initiatives was the establishment of a plan for global assessments, involving all species within large taxonomic groups (Baillie *et al*. 2004; Mace *et al.* 2008). The global assessments pooled all previous IUCN assessment resources, such as the BirdLife International work on birds, the various SSG, the Red List Authorities, and work of partners like Kew Botanical Garden, the Zoological Society of London, and others into a process to integrate data and add additional regional workshops either taxon based or geographically focused. This process provides global coverage for all species in groups at levels as high as Class, with justification for criteria and range maps publicly available. This has opened opportunities for researchers to access data of regional relevance and has facilitated the use of biodiversity data for conservation purposes worldwide.

IUCN recently presented the update of the 2011 IUCN Red List of Threatened Species, covering 61,900 species. In the last decade, comprehensive global assessments of all species in major taxonomic groups have been published for birds (BirdLife International 2008), mammals (Schipper *et al*. 2008), amphibians (Stuart *et al*. 2004), reef-building corals (Carpenter *et al.* 2008), and cycads, conifers, and seagrasses (Hoffmann *et al*. 2010); selected other groups such as freshwater crabs (Cumberlidge *et al.* 2009) reptiles, bony fish, and cartilaginous fishes are either completed or underway (Vié *et al*. 2009; Hoffmann *et al*. 2010; Stuart *et al*. 2010). Assessments have also started on representative samples of speciose taxonomic groups, for example dragonflies (Clausnitzer *et al*. 2009) following the methodology of Baillie *et al*. (2008).

A feature of the global assessment approach is to place the data generated for each species during the assessments online and with open access at http://www.iucnredlist.org. These databases are periodically revised to include changes in nomenclature, distributions, the description of new species, and revisions to threat status. The revisions are based on ongoing participation, ownership and critical review by IUCN staff and outside contributors, reinforcing ownership, networking, and learning. The information available from the websites can be accessed and analyzed for any number of conservation projects or activities (Ricketts *et al*. 2005; Rondinini *et al*. 2005, 2006; Isacc *et al*. 2007), as well as setting targets for national and regional conservation plans, as in the Global Strategy for Plant Conservation and partners like the South Africa National Biodiversity Institute (SANBI) and the Centro Nacional de Conservação de Flora in Brazil. In addition, these data sets are extremely valuable for biogeographic and macroecological analyses (McKnight *et al*. 2007; Kreft & Jetz 2010; Lamoreux & Lacher 2010). The publication of the Global Amphibian Assessment in 2004 (Stuart *et al*. 2004), stimulated a wave of new research and action on amphibian conservation (Andreone *et al*. 2005; Sodhi *et al*. 2008) including an ambitious plan for the conservation of the world's amphibians (Mendelson *et al.* 2006; Gascon *et al*. 2007).

A signature aspect of the assessments has been the sustained interaction between conservation organizations and the research and academic community. The Global Mammal Assessment (Schipper *et al*. 2008) involved the participation of over 1,700 researchers from universities, museums, natural science collections, and government research agencies, all of whom participated either through Specialist Groups of the Species Survival Commission of IUCN or in workshops dealing with evaluations of taxonomic or regional subsets of data. The combined expertise contributed by local and regional specialists in developing countries interacting with a number of developed country mammalogists resulted in a dynamic collaboration and dedication to the task that greatly enhanced the quality of the resulting assessment.

In an era of electronic communication, spending funds and time in traveling to workshops may seem to be inefficient or redundant. However, scholars relish the opportunity to unite in intense and focused workshops, especially when these are held in regional forums where they can interact with international colleagues that they rarely see otherwise or have never met. Many important collaborations and partnerships are born in such surroundings. Most research scientists are deeply concerned about the conservation status of their study organisms. They desire that their research be used in developing solutions to conservation problems. However, they have neither the time, because of heavy teaching loads, grant deadlines, and tenure and promotion pressures, nor the means to be actively involved in the long, slow, process of implementing conservation on the ground. The global assessments have been an effective and near ideal way to bring together the biodiversity research and the biodiversity conservation communities. The organization and direction provided by conservation professionals keep the data compilation focused on addressing conservation priorities. The subsequent open-access to the final databases makes all participants feel that they can share in the success of the whole. Collaboration can be difficult when the rewards are not mutually transparent, and the global assessment process has been effective in demonstrating these mutual benefits. The IUCN approach to the global assessments has and will continue to have a major impact on conservation science and practice.

The global assessment process for the integration of science and conservation

Openness of the conservation community to scientific input and debate

There has historically been less than ideal collaboration between academic research scientists and the conservation community. The former are often viewed as detached, little interested in practical applications, and unwilling to appear to be advocates; the latter too concerned about quick fixes and not willing to rely on peer-reviewed data or wait for the completion of additional research. The complicated relationship between academia and NGOs has changed in the past 10 years, and many large international NGOs created core science units, like the Center for Applied Biodiversity Science at Conservation International, NatureServe (www.natureserve.org) and the newly created Luc Hoffmann Institute at WWF, which publish regularly in high-impact journals in collaboration with academic scientists. The opportunity to have scientists from both worlds working in a peer relationship has bettered conservation research broadly. Conservation organizations must continue to develop and support their internal science programs and promote the collaborative research interactions that have transformed this relationship. Even with the expansion of research capacity in NGOs, their bottom line mission is not to maintain in-depth research capacity and sophisticated laboratories, library resources, and computational capacity, tasks more central to major universities across the biological, and social sciences spectra. But it is important that the positive attitude for collaboration is scaled down also to national and local NGOs and researchers and the local communities that are often on the frontline of conservation action without adequate scientific and logistical support. International NGOs can facilitate opportunities for developed country researchers to work at the local level through their country programs.

Broad engagement of the global scientific community

The success of the global assessments has been contingent upon engaging not only North American or European partners, but also researchers in the developing world. This is where many of the most compelling and critical conservation challenges exist and where a lot of field information is being freshly generated, and local input in IUCN workshops conducted on a regional geographic basis, with true collaboration and access to data and recognition on publications, is an essential element for conservation success, especially in the biodiversity hotspots (Myers *et al*. 2000; Mittermeier *et al*. 2004). As scientific capacity expands in developing countries, researchers from the region provide increasingly valuable insights not only on local biodiversity but on the logistics of new methods and field approaches and local challenges for the implementation of conservation on the ground (Rodríguez *et al*. 2007). They also have the most to lose as a result of poorly designed conservation initiatives. Like much conservation action on the ground that can fail without sincere community engagement, conservation science can also fail without engaging and promoting local expertise. Regional or taxon based workshops located in globally important sites for biodiversity conservation value and promote local expertise and enhance international collaborations. The Global Mammal Assessment sponsored 28 workshops in 18 different countries as an example (for the list of workshops see the SOM for Schipper *et al.* 2008). Keeping the workshops relatively short in duration, but intense in activity, allows more people to find the time to be involved and results in an excellent team dynamic. This also greatly facilitates the level of interaction among researchers. Face-to-face interaction and open discussion of problems and issues are

always superior to debates in the literature and via email, because it creates bonds and generally results in timely, creative solutions to thorny issues.

Conservation mediated collation of data

One of the major gaps in the translation of research data into conservation action is the difficulty in placing the data into a format useful for informing conservation-related decisions. A hallmark of the global assessment workshops is the mentoring of researchers during workshops by conservation professionals and the entering of data into the Species Information Service (SIS), software used by IUCN and partner organizations to organize, store, and retrieve data on threatened species relevant for conservation applications (much like GenBank). This guarantees consistent metadata standards so that the data are immediately in a format that can be used and disseminated.

Much of the most valuable data on historical and current species distributions and taxonomy resides in the natural science and biodiversity repositories of museums and university collections. Bringing together researchers from academia and the curatorial communities in IUCN workshops has greatly enhanced the value of the data collected, especially with regard to time series and spatial information which is critical for effective application to conservation and monitoring. Collections and museums, and the databases and reports that they have generated over time, can provide data on historical occurrences, often extending back hundreds of years. There has been a recent revolution in publishing open access data sets to stimulate research in a variety of fields including *Earth System Science Data* (www.earth-system-science-data.net), *Data.gov,* which publishes raw data and apps for enhancing data analysis, and *GigaScience* (www.gigasciencejournal.com) an online, open access journal which publishes big data studies from across the full spectrum of the basic and applied life sciences. These efforts serve as a model for expanded sharing of not only Red List information, but all sort of biodiversity monitoring data sets as well (Andelman, 2011).

Data sharing and ease of access

As much as possible all researchers who contribute substantively to the generation of research products should be acknowledged with authorship, providing their engagement meets the standards for consideration as an author. The Global Mammal Assessment (Schipper *et al*. 2008) had the participation of over 1,700 experts in workshops and meetings of Species Specialists Groups, 130 of whom were recognized with authorship on the scientific publication, and the coral (Carpenter *et al*. 2008) and recently published mangrove (Polidoro *et al.* 2010) assessments also involved broad collaboration and shared authorship. Moreover, all contributors to the global assessments have their name attached to the species information they provided on the IUCN Red List website, which is also a citable document. Although this ensures knowledge of responsibility for the information it also provides recognition.

Data that are of critical value to human and environmental well being should be open access and fully shared without restriction. We expect this in medical research, where the benefits are obvious. The scope of impact of environmental problems is making the public increasingly aware of the value of solid science to the mitigation of environmental threats. Funding sources, including federal agencies, foundations, and private donors are increasingly demanding free and open access to scientific data of conservation value. We strongly endorse this perspective. The data for all of the over 60,000 assessed species in multiple taxa are available on the IUCN Red List web page (www.iucnredlist.org) and a user guide to the Red List databases is available on line. Researchers are openly encouraged to use these data and, through periodic reassessments, to help improve it. This generates a broad sense of ownership.

Conservation science to influence policy

The status and distribution of species, drawing from the IUCN Red List, are also being used for the purpose of allocating financial resources to developing countries for conservation projects. The Global Environment Facility (GEF) is the largest funding mechanism dedicated to financing the conservation of biodiversity on a global scale. Over the past 19 years, the GEF has invested about $3.1 billion in direct financing and leveraged $8.3 billion in cofinancing for over 1,000 projects that address the loss of globally significant biodiversity in 155 countries (http://www.thegef.org/gef/pubs/Behind_the_Numbers_2010). Behind these numbers much has been accomplished—for example, GEF has been the driving force to ensure 10% of the world's terrestrial areas are conserved through support to the improved management and enhanced financial sustainability of 2,302 protected areas covering 634 million hectares. These, in turn, span the habitat of at least 700 globally threatened species (www.gefweb.org). Since 2004, a Global Benefits Index (GBI) for biodiversity, that draws data fundamentally from the IUCN Red List, has been used to allocate scarce resources to countries on the basis of their capacity to generate biodiversity benefits

globally, under its first Resource Allocation Framework (RAF). A revised formulation of this system (System for Transparent Allocation of Resources [STAR]) uses information that has been updated from global species assessments, in particular amphibians and mammals. The IUCN Red List data contribute the key information on extinction risk that is a component of the GBI used to prioritize investments; details of this complex process are available (http://www.thegef.org/gef/policy/STAR). As additional taxa are assessed at a global scale, and these assessments are updated more regularly, the GBI is poised to become an increasingly robust proxy indicator of GEF biodiversity funding priorities.

Other funding mechanisms for conservation rely on Red List data. The newly created Save Our Species fund, with close to US$14 million in initial resources from the GEF, the World Bank, and other partners, is housed at the IUCN Species Programme and is funding projects on highlighted Red List species. The Critical Ecosystem Partnership Fund (CEPF), another partnership between Conservation International, the GEF, the World Bank, the MacArthur Foundation, Japan, and France (targeted funding, US$300 million) uses IUCN Red List data in the development of ecosystem profiles that guide prioritization of funding within hotspots (www.cepf.net). Other Red List influenced funds or prioritization schemes include the Mohammad bin Zayed Fund, and the development of Important Bird Areas, Key Biodiversity Areas, and the Alliance for Zero Extinction all of which are incorporated in guiding financial investments.

There are many other areas of conservation where there is an urgent need for the integration of science and policy, broadly defined. There is a need for the development of tools for monitoring and assessing trends in biodiversity, first to establish a baseline for measures of environmental degradation or conservation success (De Fries *et al*. 2010; Andelman 2011; www.teamnetwork.org) and several proposals have suggested methods and processes (Pereira & Cooper 2006; Scholes *et al*. 2008). Agreement on which taxa to monitor is difficult, and this is compounded by disagreements of which aspects of the biology of organisms should be monitored (genetic diversity, survival and growth, population trends, and extinction risk). An additional difficulty has been finding scientific consensus on the biodiversity indicators to monitor so that they are of value to Convention of Biological Diversity goals and targets, such as the 2010 Target (Walpole *et al*. 2009; Butchart *et al*. 2010) and work towards the Millennium Development Goals and benefits of conservation for human well being (Sachs *et al*. 2009).

Discussions are under way to finalize an independent international body to provide an officially mandated scientific voice on biodiversity, the Intergovernmental Platform on Biodiversity and Ecosystem Services, IPBES (www.ipbes.net), much as the Intergovernmental Panel on Climate Change does for climate change. We need to develop similar databases for the compilation of biological monitoring information and assessments of ecosystem service value. Perrings *et al*. (2010, 2011) highlight critical components needed for defining and assessing targets for the biodiversity and ecosystem services nexus with the development of IPBES. These include identification and prioritization of policy relevant science, the performance of assessments on our knowledge of the biodiversity and ecosystems service relationship at local to global scales, and the development of capacity of researchers and policy makers. The global assessment approach addresses all of these issues in assessing extinction risk, and the model of the global assessments seems particularly appropriate as a mechanism for bringing together expertise on biodiversity science, ecosystem function, and explicit conservation solutions and outcomes. There is still considerable lack of understanding of these relationships, which might best be addressed with more clarity at more local scales, and then integrated into a more global policy structure. The key challenge is to bring together all components of the science and conservation policy. This panel must find agreement among representatives of the ecological research community and the agencies and organizations that will be implementing conservation action based upon measures of ecosystem services.

There is one especially effective process, in our estimation, to achieve the necessary integration of basic science and policy to advance conservation on global scale, and it is based upon the success of the global assessments, which have to a degree followed the genomics model of big science. These endeavors are large, complex, and costly over the short term, but create lasting data that have been specifically generated to meet policy objectives. They also tie a bold, overarching goal to grassroots participation and engagement, a critical component of success.

Partnering, collaboration, and the ultimate sharing of information have often been viewed with skepticism or even with suspicion by some in the scientific community. But other large collaborations like the LBA (Large-scale Biosphere-Atmosphere Experiment) in the Brazilian Amazon (http://lba.cptec.inpe.br/lba/index.php?p=19&lg=eng), NEON (National Ecological Observatory Network) and the Tropical Ecology, Assessment and Monitoring (TEAM) Network (Andelman, 2011) that make their data public, often in near real time, have seen increased productivity of the participating researchers and broad application of the results for dealing with applied questions, with no "theft" of the data.

Indeed, new, productive collaborations and international dialogue have been the result. The IUCN global assessments are a proven model for the integration of science with conservation action. The global assessments bring together researchers and conservationists on a common ground regarding key data and the format needed for policy; the need to speak a common language has never been so urgent. This model should be applied to other looming challenges in the conservation of biodiversity, especially in the context of the recent 2010 meeting of the CBD in Nagoya (Marton-Lefèvre 2010), and the ultimate impacts of biodiversity loss on the well being of societies across the world. The recognition of the importance of biodiversity in meeting the Millennium Development Goals (Sachs *et al.* 2009) and the recognition of the failure to meet the 2010 Biodiversity Target (Butchart *et al.* 2010; Hoffmann *et al.* 2010) illustrates the gap between what needs to be achieved and our current trajectory. There are logistical difficulties in applying the global assessments model to other conservation science-policy questions, but one can only be encouraged with the lasting energy and commitment that exists among the over 7,000 volunteer scientists of the Species Survival Commission. One reason is that these scientists see the policy benefits of the application of their data. Only open, collaborative partnerships between the scientific and conservation communities, from large international organizations to on-the-ground local expertise, will provide a means for addressing these discouraging trends, though much more dedicated effort will be required to reverse them.

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