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Science

Conserving Biodiversity

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Biodiversity Conservation: Challenges Beyond 2010

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The continued growth of human populations and of per capita consumption have resulted in unsustainable exploitation of Earth's biological diversity, exacerbated by climate change, ocean acidification, and other anthropogenic environmental impacts. We argue that effective conservation of biodiversity is essential for human survival and the maintenance of ecosystem processes. Despite some conservation successes (especially at local scales) and increasing public and government interest in living sustainably, biodiversity continues to decline. Moving beyond 2010, successful conservation approaches need to be reinforced and adequately financed. In addition, however, more radical changes are required that recognize biodiversity as a global public good, that integrate biodiversity conservation into policies and decision frameworks for resource production and consumption, and that focus on wider institutional and societal changes to enable more effective implementation of policy.

Biodiversity—the variety of genes, species, and ecosystems that constitute life on Earth—provides numerous essential services to society. These include material goods (for example, food, timber, medicines, and fiber), underpinning functions (flood control, climate regulation, and nutrient cycling), and nonmaterial benefits such as recreation (*1*). Biodiversity can contribute to agriculture through pollination and pest control (*2*), provide carbon storage and sequestration (*1*), and positively affect human physical and mental health (*3*). Biodiversity also secures long-term flows of benefits from nature by providing resilience to disturbance and environmental change (*2*). These and other economic and social contributions are substantial (*4*), with recent estimates claiming that the economic value of benefits from biodiverse natural ecosystems may be 10 to 100 times the cost of maintaining them (*5*).

The imperative to reduce human impacts on biodiversity has wide political recognition. The United Nations Convention on Biological Diversity (CBD), agreed at the 1992 UN Conference on Environment and Development, is one of the most widely ratified treaties in the world. Since 2002, 193 parties to the CBD have committed themselves to substantially reducing rates of biodiversity loss by 2010; this goal was later endorsed by the World Summit on Sustainable Development and incorporated into the UN Millennium Development Goals in 2005 (*6*). There is an increasing array of national, regional, and international policy mechanisms aimed at biodiversity conservation; for example, 87% of the signatories to the CBD have now developed National Biodiversity Strategies and Action Plans, and thus have frameworks for tackling biodiversity loss at national scales (*7*).

Millions of people worldwide actively support biodiversity conservation. The Nature Conservancy in the United States and the Royal Society for the Protection of Birds in the United Kingdom have a combined membership exceeding 2 million, and the World Wide Fund for Nature (WWF) network has more than 5 million supporters worldwide. In developing countries, membership of conservation organizations is much smaller than in wealthy nations but is often influential and growing rapidly (*8*). Of course, support extends well beyond this to a growing range of local, national, and regional civil society organizations and community groups that are involved in activities related to biodiversity, in some cases building on indigenous knowledge of its management (*9*). Conservation biology has become a recognized academic discipline, with its own journals and postgraduate courses, although most of this capacity remains concentrated in the developed world (*10*) despite recent growth in developing-world professional training programs (*11*).

Yet biodiversity continues to decline, even though worldwide conservation efforts are increasing (*1*, *7*, *12*). In this article we review the scope and achievements of these efforts, and outline the key challenges that we believe must be

Fig. 1. Community tree nursery in Harapan Forest, lowland Sumatra, Indonesia, where an innovative 2007 law enabled management of logging concessions for ecosystem restoration rather than timber extraction. Harapan's is the first such license, and the concession now covers nearly 100,000 ha of biodiversity-rich habitat (**inset**) with restoration being carried out under a joint project of Burung Indonesia, the Royal Society for the Protection of Birds (UK), and BirdLife International. The Indonesian government is committed to expanding the area licensed for forest restoration to 2 million ha by 2020. [Photo: Harapan Rainforest Initiative/M. Lambertini]

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met for conservation to succeed post-2010. We draw on a broad range of individual perspectives across the natural and social sciences, as researchers and practitioners from both developed and developing countries.

Conservation Approaches

Conservation paradigms, practices, and policies have shifted over time and have been variably successful (*13*). In recent decades, traditional approaches to conservation—such as the creation of national parks—have evolved to encompass awareness of the diverse benefits provided by protected areas, the importance of local conservation initiatives and interests in protected area management, and the need to address the opportunity costs of conservation among the rural poor. Ecological restoration, both within and outside protected areas, is being increasingly applied worldwide (*14*). Actions for species, such as targeted habitat management, removal of invasives, captive breeding, and reintroduction, have yielded notable successes; among many examples, at least 16 bird species extinctions have been prevented by such means between 1994 and 2004 (*15*).

Since 1992, the global network of protected areas has continued to grow steadily, increasing yearly by an average 2.5% in total area and 1.4% in numbers of sites, and by 2006 covering more than 24 million km^2 in about 133,000 designated sites (*7*). Despite some failings, protected areas overall remain a core element of biodiversity conservation (*16*, *17*).

Fig. 2. A flower collector in Flower Valley, South Africa, harvesting pincushions (*Leucospermum* spp.) as part of a sustainable use initiative. Sales of sustainably harvested wild fynbos flower bouquets help to subsidize the conservation costs of the site. [Photo: Juan Pablo Moreiras/Fauna & Flora International]

Landscape-scale approaches to reducing biodiversity loss have become increasingly important, especially in wealthier countries (*18*). These include trans-boundary conservation [e.g., the Great Limpopo Transfrontier Park (*19*)], payments for environmentally sensitive farming (*20*) [such as under the Farm Bill in the United States (*21*) or in the Agulhas National Park in South Africa (*22*)], and large-scale habitat creation and restoration, as seen, for example, in the Oostvaardersplassen project in the Netherlands (*23*) and the Harapan Forest in Indonesia (Fig. 1). These initiatives reflect scientific research showing the importance of maintaining suitably managed habitats, which should be large (*24*) and connected rather than isolated (*25*), within a hospitable matrix (*24*).

Many other approaches to biodiversity conservation have been developed, especially those linked to economic benefits, including sustainable consumptive use (*26*) (Fig. 2) and nonconsumptive uses such as ecotourism (*27*). Some of these help meet the opportunity costs of conservation, which would otherwise preclude conservation choices among poor rural communities. Mechanisms that provide revenue streams from biodiversity through direct payments for conservation (*28*) or payments for ecosystems services (*29*)—for example, through REDD+ schemes (*30*)—are as yet largely experimental in implementation but have potential for considerable impact. (REDD+ is a mechanism for reducing emissions from deforestation, forest degradation and other activities affecting forest carbon stocks.)

Pressures on Biodiversity

Despite these efforts, biodiversity loss is not slowing down. Recent assessment shows a continued, steady overall decline in wild species' population sizes and in the extent, condition, and connectivity of many habitats, with accelerating levels of extinction risk and accelerating or steady declines in the benefits people derive from biodiversity (*7*) (Fig. 3). Although species extinctions are the most conspicuous result of biodiversity loss, it is estimated that distinct subpopulations are becoming extinct some three orders of magnitude faster than species (*31*).

Pressures on biodiversity continue to increase. The key pressures driving biodiversity loss are overexploitation of species, invasive alien species, pollution, climate change, and especially the degradation, fragmentation, and destruction of habitats (*7*). Agriculture is an expanding land use in about 70% of countries (*32*), generally at the expense of biodiversity. Much of the global timber trade is based on unsustainable or illegal logging that destroys biodiversity-rich habitat, as shown across five major timber-producing countries in 2009 where, on average, only 14% of licensed logging area was sustainability-certified, while up to half of all harvesting was illegal (*33*).

Over-abstraction of water for agriculture, industry, and domestic demands contributes to shifts in agricultural patterns; this imposes greater pressure on biodiversity in other locations, as does soil salinization resulting from irrigation in arid regions (*34*). Increasing demand for vegetable oils—for food, cosmetics, and biofuels—has put further pressure on biodiversity; oil palm plantations, for example, cover 13 million ha of the humid tropics, and global demand (largely driven by rising consumption levels in developed and emerging economies) is pushing up prices and incentivizing further expansion (*35*). Remaining terrestrial biodiversity is therefore increasingly confined to fragmented patches separated by expanding cultivation, infrastructure, and residential and industrial development. Marine biodiversity is also under increasing pressure. Steep declines in fish populations and loss of marine habitats have resulted from overexploitation of marine protein, focused on fish at the top of the food chain; increases in poorly managed aquaculture; and direct habitat destruction from coastal development, extractive industries, and pollution (*36*).

Biodiversity also faces new pressures and novel threats (*12*). Further anthropogenic climate change and rising human resource demands will pose immense interlinked challenges. Climate change may force species to shift their ranges (*37*) and disrupts ecological communities (*38*, *39*). Lack of continuous semi-natural habitat or networks of connected habitat patches can restrict the capacity of species to adjust to changing conditions (*40*). Enhanced levels of atmospheric CO_2 also threaten corals through ocean acidification (*41*). New initiatives and technologies aimed at mitigating climate change may have negative effects on biodiversity. For example, technological developments in biofuel production from cellulose could drive the planting of high-yielding perennial C4 grasses, such as *Miscanthus*, on millions of hectares of temperate-zone land not currently used for agricultural production (*42*). Increasing demands for food production resulting from human population growth and dietary shifts require intelligent and integrated solutions, and severe impacts on biodiversity could occur in the absence of such solutions (*43*). On top of these reasonably well-known threats are others that are less well understood, including possible threats from microplastic pollution, nanosilver, biochar, and artificial life (*44*).

Filling Knowledge and Capacity Gaps

Although we now have a great deal of information on the state of biodiversity, the biological and social processes that affect it, and the pres-

sures and underlying drivers that result in its continued decline (*1*, *7*, *12*), there are also some key knowledge gaps. There are few data on the status, trends, or functional importance of microbes, invertebrates, and many plant groups, or of wild genetic diversity (*45*). Even relatively well-known groups, such as vertebrates, are far better documented in temperate regions than in the much more diverse tropics (*46*). How different components of biodiversity contribute and relate to the provision of services (*47*, *48*) (Fig. 4) or create resilience to environmental change (*49*) is poorly understood. Our knowledge of ecosystem management and restoration is inadequate to meet the challenges of reconciling increased production with sustaining ecosystem services, or of ameliorating the negative effects of climate change. Existing knowledge, often including extensive traditional knowledge (*9*), is generally underused in decision-making at local, national, and international levels. There is an urgent need both to learn from practical experience and to disseminate research findings to practitioners (*50*). Horizon scanning—the systematic search for potential threats and opportunities that are currently poorly recognized—needs to be expanded to identify the currently "unknown unknowns" (*51*).

Moreover, scientific capacity is not equally shared across the globe, and in particular is concentrated in rich developed countries rather than in the regions that face the most substantial challenges to maintaining and enhancing biodiversity. The proposed establishment of an Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services may help to close knowledge gaps and link science and economics to the policy step-change needed to conserve biodiversity (*52*). To be effective, though, it must empower developing country institutions and knowledge-to-policy mechanisms, a process requiring sustained investment and support, combined with enhanced linkages and experience sharing among developing countries.

Scaling Up Success

Conservation interventions that are deemed effective, and the conditions under which they work, need to be identified more consistently, and these successes need to be replicated and scaled up in intelligent and evidence-based ways (*50*). For example, protected areas can be an effective tool for conserving biodiversity, but current networks have considerable gaps; some 20% of 3896 threatened vertebrates are not included in any protected area (*53*), and many protected areas are under-resourced (*54*) or weakly managed (*55*). Although 12% of Earth's land surface has protected-area status, only 0.5% of oceans and 5.9% of territorial seas have been so designated, and more than two-thirds of critical sites for biodiversity have incomplete protection or none at all (*7*). New protected areas can draw on a broad range of possible governance models, including community and indigenous conserved area approaches, to fit their particular circumstances (*56*, *57*). Protected areas need to be managed as a coherent network rather than as isolated habitat islands in order to sustain biodiversity, particularly in the face of climate change (*39*). The challenges of working across administrative and national boundaries are considerable, but experience suggests they are not insurmountable (*58*).

Scaling up successful approaches requires much greater investment in biodiversity conservation, by at least an order of magnitude (*59*, *60*). National investment is poorly documented but is increasing (and diversifying) in at least some biodiversity-rich countries, such as Mexico (*61*). International financial investment in biodiversity conservation has been slowly increasing (*7*) and is estimated to have grown around 38% in real terms between 1992 (when the CBD came into force) and 2006 (*62*). The sums involved are still tiny relative to the amounts spent on environmentally damaging subsidies (*63*). They need to be enormously scaled up (*59*) to benefit those countries that hold the richest biodiversity (*64*).

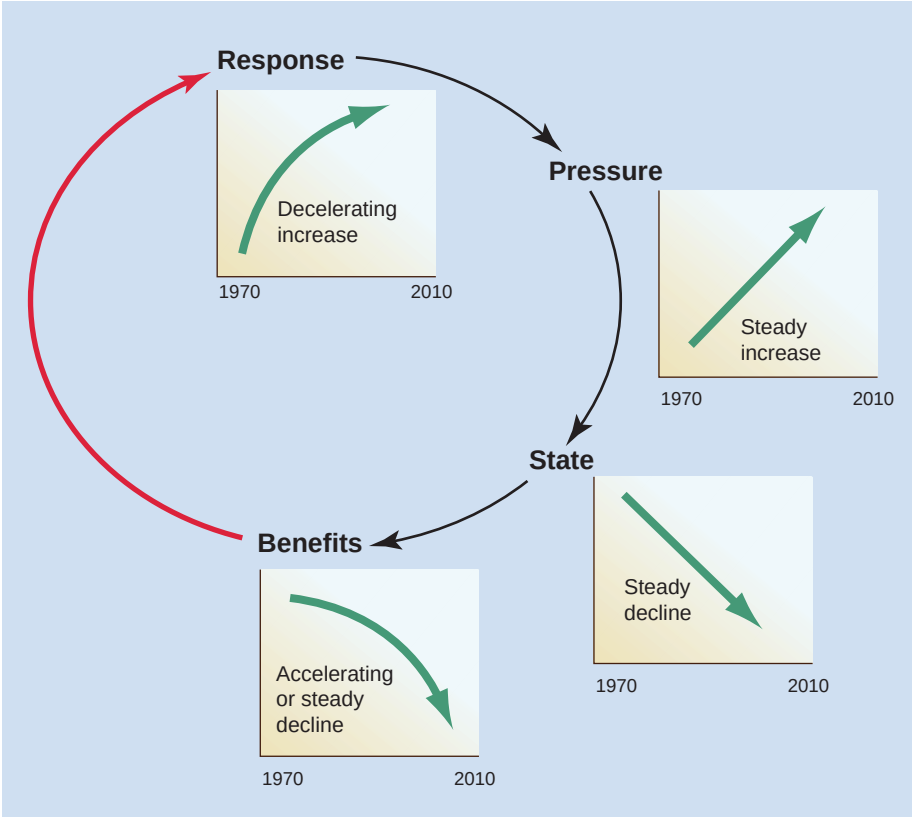

Fig. 3. The feedback loop between responses to biodiversity loss, the pressures on biodiversity, the state of biodiversity, and the benefits it provides. The arrow linking benefits to responses is highlighted because of its particular importance: Responses are put in place in relation to how far the maintenance of biodiversity is valued as a benefit to society and individuals. Thumbnail graphs show the overall trend in each of these aspects over the past 4 decades [simplified from (*7*)]. Although responses continue to grow, the rate of increase is slowing and not keeping pace with the steady rise in pressures. A corresponding steady decline in state is linked to a steady or possibly accelerating decline in benefits.

Fundamental Challenges Beyond 2010

Filling gaps in our knowledge and building on success, through scaling up and further investment in conservation that works, are critical if we are to gain some breathing space for biodiversity but will not suffice to achieve its maintenance long-term. This year the global community has an opportunity to go much further. The UN has declared 2010 the International Year of Biodiversity and has agreed to hold a special session of this year's General Assembly devoted to biodiversity, partly in the context of reviewing progress in achieving the Millennium Development Goals. At the 10th Conference of the Parties of the CBD (Nagoya, Japan, October 2010), governments will not only assess whether they met the 2010 biodiversity target, but are expected to adopt a new strategic plan containing a vision for 2050 and new biodiversity targets to be achieved by 2020.

To address the continued global loss of biodiversity, we propose the pursuit of three interconnecting priorities: (i) to manage biodiversity as a public good, (ii) to integrate biodiversity into public and private decision-making, and (iii) to create enabling conditions for policy implementation.

Managing biodiversity as a public good. An appreciation of biodiversity as a public good (*65*) and of its economic value (*66*) is, we believe,

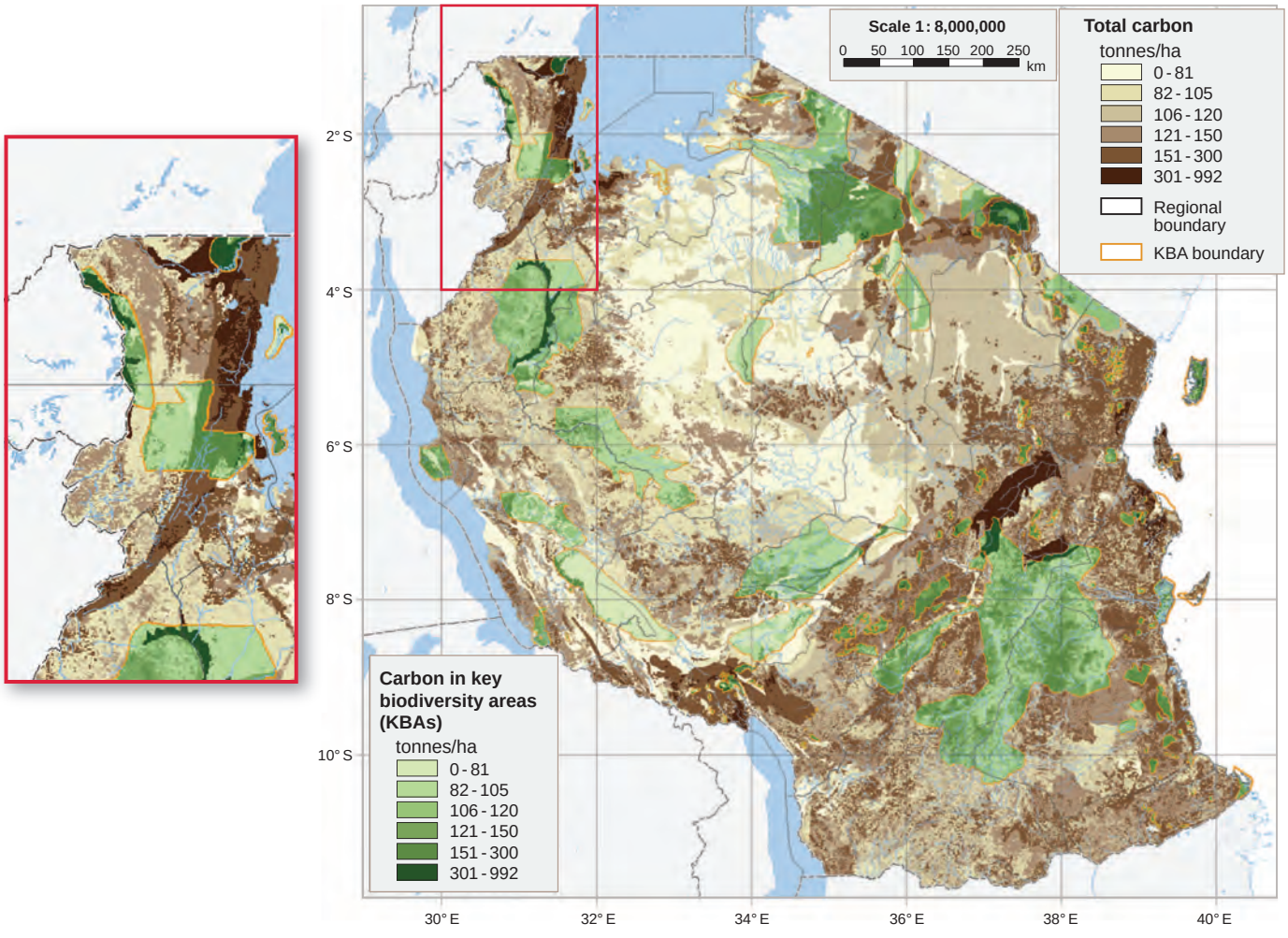

Fig. 4. Key biodiversity areas and carbon density (in biomass and soil) in Tanzania [from (*48*)]. Integrating data on terrestrial carbon with areas important to biodiversity conservation can help decision-makers to take account of multiple benefits and trade-offs when developing REDD+ schemes, a promising example of payments for ecosystem services.

central to future effective conservation. Biodiversity loss is rarely the intended consequence of human actions; more often it is an unintended side effect of decisions taken for other reasons—an economic "externality" (*67*). Biodiversity is a special kind of externality, as the impacts of a particular action are often distant in space and time (e.g., local rainforest loss may affect the global carbon cycle, with consequences for future generations). This makes effective regulation difficult, as no single body has jurisdiction over the world's biodiversity. It also makes transaction-based solutions difficult, because those who damage biodiversity are often widely separated, in space or time, from those who experience the consequences. Actors have few incentives or opportunities to change their behavior, whether they are smallholder households planning their annual agricultural cycles or large multinational companies determining their corporate priorities. Thus, understanding and managing biodiversity as a global public good, which must be provided through conscious collective choices (*68*), is fundamental to achieving its conservation (*5*).

The recognition of biodiversity as a public good is not a new concept, and in recent years economists have made substantial progress in developing valuation techniques that quantify the local and global benefits of biodiversity (*69*). Measuring the economic values of biodiversity (*5*) and estimating spatially explicit economic values of services across landscapes to inform management decisions (*70*) are vital. However, making these values explicit is insufficient to bring about a change in behavior, unless supporting public policies are in place that either reward positive individual actions or penalize harm. Economists need to work more closely with conservationists and policy makers to develop intervention strategies that shift individual actors toward more biodiversity-friendly behavior, using regulatory devices as well as incentives, thereby securing the provision of biodiversity conservation as a global public good.

Integrating biodiversity into public and private decision-making. The value of biodiversity must be made an integral element of social, economic, and political decision-making, as is starting to happen with carbon and climate change. Government, businesses, and civil society all have crucial roles in this transition.

For government, maintenance of stocks of natural capital must become an explicit, accountable, and implemented element of policy. Concern for biodiversity cannot be restricted to a nation's environment ministry but must extend across all sectors of government, such as treasury, industry, and defense. Policy change will require clear and cost-effective metrics of natural capital consumption and depletion (*71*) and the development of systems of public accounts that include both sustainability (*72*) and the specific issue of biodiversity loss (*5*). Government staff and politicians may need in-service training in biodiversity science and ecological economics, with effective research support. Research investment will need to focus on applied transdisciplinary problems. Government will need to remove perverse subsidies detrimental to biodiversity, such as in agriculture, forestry, and fisheries. Fishing subsidies encourage overexploitation of two-thirds of fish stocks across the globe, threat-

ening both the fishing industry (worth $80 billion to $100 billion per year) and the 27 million people dependent on it (*5*, *73*). Government policy needs to integrate biodiversity conservation, poverty alleviation, and the demands of a sustainable economy (*74*) to meet the Millennium Development Goals (*75*).

The actions of the private sector are central to the future of biodiversity, as the CBD recognized in the context of the 2010 biodiversity target. Corporate environmental performance is increasingly important to investors and therefore corporate leaders (*76*), and many initiatives now exist to address corporate biodiversity impacts in particular business sectors or individual corporations (e.g., in minerals extraction). Yet a recent survey found that only two of the Financial Times Stock Exchange (FTSE) 100 companies recognize biodiversity to be of strategic importance to their business (*5*). Biodiversity lacks the visibility achieved by energy and climate change as issues important to corporate decision makers (*77*). Consistent government regulation is important in providing a level playing field for corporate environmental innovation and competition, but there are challenges in extending regulation internationally (*78*).

Civil society organizations have an important role in building tri-sector partnerships with government and business to promote effective action to conserve biodiversity, and in encouraging their supporters as citizens and consumers to demand reform by the government and business. Consumer initiatives such as certification schemes that seek to influence how products are produced across global supply chains (e.g., the Forest Stewardship Council, Marine Stewardship Council, Fair Trade) have a symbolic and educational value, but the real challenge is to transform production and consumption into sustainable patterns so that such arrangements are the norm and not the exception (*79*). Public education about biodiversity must extend beyond the ecology of near-extinction to explain the links between biodiversity loss and consumption choices. Debates about these links are particularly urgent in emerging markets in countries with rapid economic growth, especially India and China.

Creating enabling conditions for policy implementation. Good decision making at all levels is necessary but insufficient to achieve biodiversity conservation. We believe that policy responses to biodiversity loss generally fail to include a vital step: the establishment of appropriate institutions, governance, and behaviors.

Potential responses to environmental degradation can be placed into three broad tiers (Table 1) (*80*). Existing efforts to address biodiversity loss have tended to jump from tier 1, the generation of knowledge, to tier 3, the design of appropriate instruments (such as national legislation or international treaties), without ensuring that the enabling conditions are in place.

For example, in the case of direct payments for conservation in developing countries, a sound knowledge base demonstrates how biodiversity can be damaged when it is treated as an open-access resource not managed by common-property institutions, and one proposed response aims to pay resource users directly to achieve conservation goals (*28*). However, the critical, but often missing, middle tier is the existence of institutions and governance for designing and implementing payments, together with the associated monitoring and regulation (*81*).

Although REDD+ is not specifically designed to address biodiversity conservation, it has the potential to provide such co-benefits and it illustrates the lack of attention to middle-tier strategies in contemporary environmental policy. With REDD+, a sound knowledge base shows the impacts of forest loss on global carbon emissions. A proposed response aims to use markets and incentives to pay resource users in order to alter their current patterns of land management to stem the loss of forest cover. However, the critical middle tier that has been underemphasized is the need for appropriate institutions and governance that would permit the efficient operation of markets for forest carbon (*82*). Markets cannot work without clear property rights and enforceable contracts. Having decided that a market for forest carbon is an appropriate instrument for delivering desired outcomes, a range of countries are making considerable efforts and investment to develop relevant institutions and governance structures, but it is far from clear that the regions that have the most potential from a forest carbon perspective are also the ones where conducive institutions and governance structures exist or can be created.

Table 1. The three different tiers within which responses to biodiversity loss are typically located. Each tier is equally important, but experience suggests that the crucial element that is missing from many current initiatives is the middle tier. It is important to ensure that appropriate institutions and governance structures exist to enable the effective use of targeted instrumental interventions to address biodiversity loss. [Adapted from (*80*)]

Tier 1: Foundational	• Knowledge about social and biological dimensions of biological loss
Tier 2: Enabling	• Institutions/ governance • Social/behavioral patterns
Tier 3: Instrumental	• Legislation • Markets/incentives • Technology

Conservation appears to succeed best where an adequate knowledge base is combined with appropriate institutional structures and patterns of societal behavior that enable the adoption of targeted instruments. Globally, and unsurprisingly, current conservation success is strongly linked to good governance (*83*). This is evident in the many examples of effective communal management (*84*, *85*) as well as in "traditional" national parks such as Yellowstone in the United States, which was created at a time of rapid state-sponsored scientific exploration and strong federal governance (*86*).

There are often good reasons for failure to address the enabling factors for appropriate action. Institutions and governance are not easy to change, especially if there are deeply entrenched cultures of patronage and corruption that govern the use and management of natural resources; moreover, governance mechanisms at different levels (local, regional, and national) may differ or even be contradictory (*87*). Conservationists may not feel that it is appropriate to address wider political problems and may be poorly equipped to do so. However, creating enabling conditions for conservation is an essential component of the solution, requiring conservationists to join with wider civil society groups pressing for governance reform and institutional change. Achieving political recognition of the economic value of biodiversity and its role in underpinning human development and welfare is an important element of this approach. As the obviously artificial but symbolically important 2010 milestone is passed, this imperative can only grow stronger. Within this bigger picture, a key element involves "reconnecting" people—the growing majority who now live in urban areas and lack daily contact with farms or forests—to nature (*88*). Alongside this, there is a need for a better understanding of the ways in which such a reconnection can be translated into the mobilization of the political constituencies that are necessary to create resilient conservation institutions (*89*).

Outlook

The challenges of addressing the social and behavioral contexts for biodiversity conservation are daunting. We are far from including biodiversity in our conventional measures of well-being, which focus on wealth creation and internationally recognized estimates of GDP (*90*). Although there have been attempts to redefine these (including, for instance, the Human Development Index and green national accounts), the mainstream view of well-being and of national development remains focused on narrowly defined economic growth (*68*). Furthermore, the current recession only strengthens the emphasis on growth. The transition to sustainability will not be easy, but it is central to securing a future for biodiversity (*91*). Conservation strategies, in concert with other environmental policies, must address seemingly intractable and politically unpalatable issues. In both developed and emerging economies, we need to reduce the carbon and material throughput demanded by current patterns of production and consumption if we are to create viable and democratically acceptable trajectories of contraction and convergence in resource use. In parallel, we must recognize that successful human

development agendas are underpinned by functional ecosystems, and by biodiversity. This is the year in which governments, business, and civil society could decide to take seriously the central role of biodiversity in human well-being and quality of life (*92*) and to invest in securing the sustainable flow of nature's public goods for present and future generations.

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POSITIONS OPEN

DIRECTOR POSITION
Description for the Institute for Advanced Cyber-Enabled Research at Michigan State University

Michigan State University (MSU) seeks a Director of the recently formed MSU Institute for Cyber-Enabled Research (iCER). Computational sciences and their underlying mathematical theories have become core methodologies in all areas of modern science. iCER aims at capitalizing on significant algorithmic advances and rapid progress in massively parallel computer architectures to employ large-scale computational approaches as a predictive research tool in a wide range of scientific disciplines. Candidates will be entertained in any discipline at Michigan State University included in the Colleges of Engineering, Natural Science, and Social Science. Additional information can be found on the iCER **website: http://www.icer.msu.edu.**

The successful candidate will be an internationally prominent, highly visible scholar who will lead the computational science efforts at MSU. The Director will report directly to the Vice President for Research and Graduate Studies. The Director will be empowered to build a high-profile research program in high-performance computing and/or computational science with an academic home in one or more departments. MSU is committed to further faculty hires in high performance computing and computational science and anticipates that the iCER director will take a leadership role in attracting high quality faculty, will interact with the current affiliated faculty, and will spearhead the development of large interdisciplinary programs to obtain major high-impact research grants. The iCER facility is located in newly renovated space on campus. There is support available for an associate director to manage day-to-day operations, a faculty scholars program, postdoctoral and visiting scholars, graduate students, and provisions for educational resources (courses, workshops, and seminars), and for training in the use of computational hardware and software. Facilities and resources associated with iCER include MSU's high-performance computing center (HPCC) that is on a continual upgrade path to make sure that MSU remains competitive as a University scale computing facility.

Application materials including curriculum vitae, research statement, and a list of four references should be submitted to the iCER search committee at **e-mail: vprgs@msu.edu.** Consideration of applications will commence September 1, 2010, and continue through November 30, 2010, or until the position is filled.

MSU is an Affirmative Action/Equal Opportunity Employer. MSU is committed to achieving excellence through cultural diversity. The university actively encourages applications and/or nominations of women, persons of color, veterans, and persons with disabilities.

WEILL CORNELL MEDICAL COLLEGE
The Methodist Hospital Research Institute

The Molecular Imaging Program of the Department of Radiology develops novel agents and new technologies to image molecular processes and treat diseases. The research focuses on cancer, cardiovascular disease, neurodegeneration, cell therapy, stem cell biology, gene therapy, and nanotechnology. In November 2010, our program will be moving into a brand new 440,000 square foot Methodist Hospital Research Institute building with open laboratory space design, core facilities to enhance interdisciplinary research, a Good Manufacturing Practice (GMP) facility to prepare clinical-grade imaging and therapeutic agents, state-of-the-art imaging equipment for preclinical studies, a cyclotron and hot cell facility and, a specialized laboratory for infectious disease research. The Molecular Imaging Program has created a number of new **POSTDOCTORAL FELLOW** and **RESEARCH ASSOCIATE** positions. Self-motivated scientists with expertise in liposomes, peptides, nanoparticles, radiochemistry, bioconjugation, MR physics, molecular biology and/or animal models are encouraged to apply and join our dynamic research team. Please e-mail curriculum vitae and contact information of three references to **Dr. Ching H. Tung** at **e-mail: ctung@tmhs.org.**

POSITIONS OPEN

ASSISTANT PROFESSOR
in Pharmacology

The Department of Basic Pharmaceutical Sciences in the School of Pharmacy at The University of Louisiana at Monroe (ULM) invites applications for a twelve-month tenure-track faculty position of Assistant Professor. This position includes an attractive recruitment package of salary, startup, and laboratory space. Candidates should have an earned doctorate in physiology or pharmacology and postdoctoral research experience, preferably in the areas of cancer biology, endocrinology, or neuroscience. The successful candidate is expected to develop an independent, externally funded research program, and contribute to teaching professional and graduate courses in the areas of physiology and pharmacology. Located in Monroe, a city whose metropolitan area population exceeds 100,000, the ULM campus offers a tranquil and cordial setting encompassing 238 acres, over 50 buildings, and an off-campus farm. Candidate screening will begin December 15, 2011, and candidate interviews will start soon afterwards and continue until the position is filled. Qualified individuals should submit their curriculum vitae, list of three references, and a statement of current interests and future goals emphasizing how their interests might complement the strengths of the Department to: **Dr. Paul W. Sylvester, Pharmacology Search Committee, College of Pharmacy, University of Louisiana at Monroe, 700 University Avenue, Monroe, LA 71209-0470. Email: sylvester@ulm.edu**. *The University of Louisiana at Monroe is an Equal Opportunity/Affirmative Action Employer.*

FACULTY POSITION
in Molecular, Cellular, and Developmental Biology University of Colorado at Boulder

The Department of Molecular, Cellular, and Developmental Biology invites applications for a tenure-track **ASSISTANT PROFESSOR** in the area of molecular, cellular, or developmental biology with an emphasis on basic molecular biological problems. Applicants must have a Ph.D., M.D., or equivalent in addition to postdoctoral research experience. The candidate is expected to develop a vigorous and innovative research program, and have enthusiasm for teaching at the undergraduate and graduate levels.

Review of applications will begin on November 1, 2010 and continue until the position is filled. Application materials are accepted electronically at **website: https://www.jobsatcu.com,** posting number **810875.** Applicants should submit a curriculum vitae and a concise statement of research and teaching interests, and arrange to have three reference letters sent.

For questions or concerns on submitting your materials electronically, please contact **e-mail: mcdbsrch@colorado.edu.**

See **website: http://www.colorado.edu/ArtsSciences/Jobs/** for full job description. *The University of Colorado at Boulder is committed to diversity and equality in education and employment.*

POSITIONS OPEN

ASSISTANT PROFESSOR in GENETICS
Hendrix College

The Biology Department invites applications for a tenure-track position at the rank of Assistant Professor in genetics beginning in the fall of 2011. Geneticists of all specialties are encouraged to apply, especially those with interest in microbial genetics and/or bioinformatics. The college seeks to extend its tradition of excellence in teaching and scholarship by attracting faculty who combine mastery of their disciplines with broad intellectual interests and commitment to the aims of a liberal arts college. Development of an externally funded research program involving undergraduate students is expected and supported through appropriate course release. A doctorate or ABD at the time of appointment is required. Postdoctoral experience is welcomed but not required.

Applications should include a letter addressing the candidate's interest in teaching in a demanding but supportive liberal arts environment, curriculum vitae, teaching and research philosophy statements, three letters of recommendation (including the telephone numbers and e-mail addresses of the references), and graduate and undergraduate transcripts. Application materials should be sent to: **Dr. Matthew Moran, Chair, Department of Biology, Hendrix College, 1600 Washington Avenue, Conway, AR 72032.** Review of materials will begin on October 15 and continue until position is filled.

Hendrix College is a Phi Beta Kappa, Carnegie Baccalaureate institution, with an endowment of $145 million located in Conway, Arkansas, thirty miles from Little Rock. The College, affiliated with the United Methodist Church, has a strong commitment to excellence in teaching liberal arts. *Hendrix is an Equal Opportunity Employer. Women and members of minority groups are especially encouraged to apply.* Please visit our **website: http://www.hendrix.edu.**

NON-TENURED RESEARCH ASSISTANT PROFESSOR, RESEARCH ASSOCIATE, SENIOR POSTDOCTORAL FELLOW
Department Environmental and Occupational Health Graduate School Public Health University of Pittsburgh

Several positions are available in the laboratory of **Dr. Valerian E. Kagan** (Center for Free Radical and Antioxidant Biochemistry, Department of Environmental and Occupational Health, University of Pittsburgh). Candidates with interests in research on: (1) mass spectrometry/oxidative lipidomics/metabolomics, (2) mass-spectrometry and oxidative neurolipidomics, (3) lipid signaling in apoptosis and phagocytosis, (4) lipidomics of immune cells in cancer, or (5) mechanisms of nanoparticles interactions with cells in vitro and in vivo—are invited to apply. Participation in ongoing collaborations with laboratories in Sweden, Ireland, and Russia are possible. Candidates should have Ph.D. or M.D. with background in analytical biochemistry/chemistry, molecular/cell biology, redox biochemistry/biophysics or related fields. Experience with mass spectrometry of lipids and other small molecules, analytical chemistry/biochemistry as well as live cell (fluorescence) microscopy, immunoblotting, immunocytochemistry, and DNA transfection are desirable. Interested applicants should send curriculum vitae and names of three references to: **Dr. Valerian E. Kagan, e-mail: kagan@pitt.edu.** *University of Pittsburgh is an Equal Opportunity Employer.*

MARKETPLACE