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BIODIVERSITY AND DEVELOPMENT RESEARCH AGENDA

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MEASURING IMPACT

Contract Information

This program is made possible by the generous support of the American people through the United States Agency for International Development (USAID) under the terms of its requisition number REQ-EGAT-12-000014 (Measuring Impact) implemented by prime recipients Environmental Incentives, LLC, Foundations of Success and ICF International. The Measuring Impact project has been issued under contract number AID-OAA-C-12-00078 and supports the same program objectives as described in RFP number SOL-OAA-000050. The Measuring Impact project is funded and managed by the USAID Office of Forestry and Biodiversity, and Bureau for Economic Growth, Education and the Environment.

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TABLE OF CONTENTS

EXECUTIVE SUMMARY

The USAID Biodiversity Policy views biodiversity as a foundation for human welfare that is intricately connected to other development sectors and fundamental to meeting the Agency's development goals. USAID programs over $200 million in biodiversity funding annually in more than 30 countries, making it one of the largest funders of biodiversity conservation. With its implementing partners, USAID has long been a thought leader in the field.

USAID is also committed to evidence-based programming to improve outcomes and contribute to the global knowledge base. USAID's Scientific Research Policy underscores the importance of research to design, test, improve, and assess the effectiveness of approaches and interventions that target key concerns in developing countries. While the Agency is not a research institution and can only support limited research directly, it can influence, leverage and, above all, use relevant research. Given the importance of USAID as a conservation donor, a research agenda that identifies key questions for the Agency is an asset to scientists and research institutions that want to carry out policy-relevant research.

The Office of Forestry and Biodiversity and Agency colleagues met in a Research Agenda Working Group (RAWG) to define and prioritize the most critical questions in biodiversity conservation and to support of USAID's development objectives. This agenda seeks to build the evidence base for the links between biodiversity conservation and development outcomes, particularly in the context of major Agency initiatives: food security, global health, global climate change, good governance, economic development and gender equality and women's empowerment. In line with the Biodiversity Policy, a second goal is to improve the effectiveness of conservation projects.

The Biodiversity and Development Research Agenda (BDRA) has wide-ranging applicability to the work of the Agency's Bureaus, Missions and partners. For example, Bureaus, Missions, universities and research institutions, nongovernmental organizations (NGOs) and donors can refer to the BDRA to guide them in the identification of priority research topics. It provides a wealth of information on key themes that can be tailored to specific approaches, programs and stages in the program cycle.

The BDRA will help build outreach to the research community, especially key USAID partners in the Consultative Group on International Agricultural Research (CGIAR), AidData, Higher Education Solutions Network (HESN), Partnerships for Enhanced Engagement in Research (PEER) and local institutions working with Missions that want to carry out policy-relevant research. In partnership with universities, research institutions, NGOs, the private sector and donors, the BDRA is an instrument to promote critical thinking and build capacity in identifying research questions and methodologies.

As research findings accrue, the BDRA will contribute to the development of a body of data, evidence and knowledge to inform USAID and partners' biodiversity and integrated programs. As such, the BDRA supports the Agency's call for leadership in science and technology.

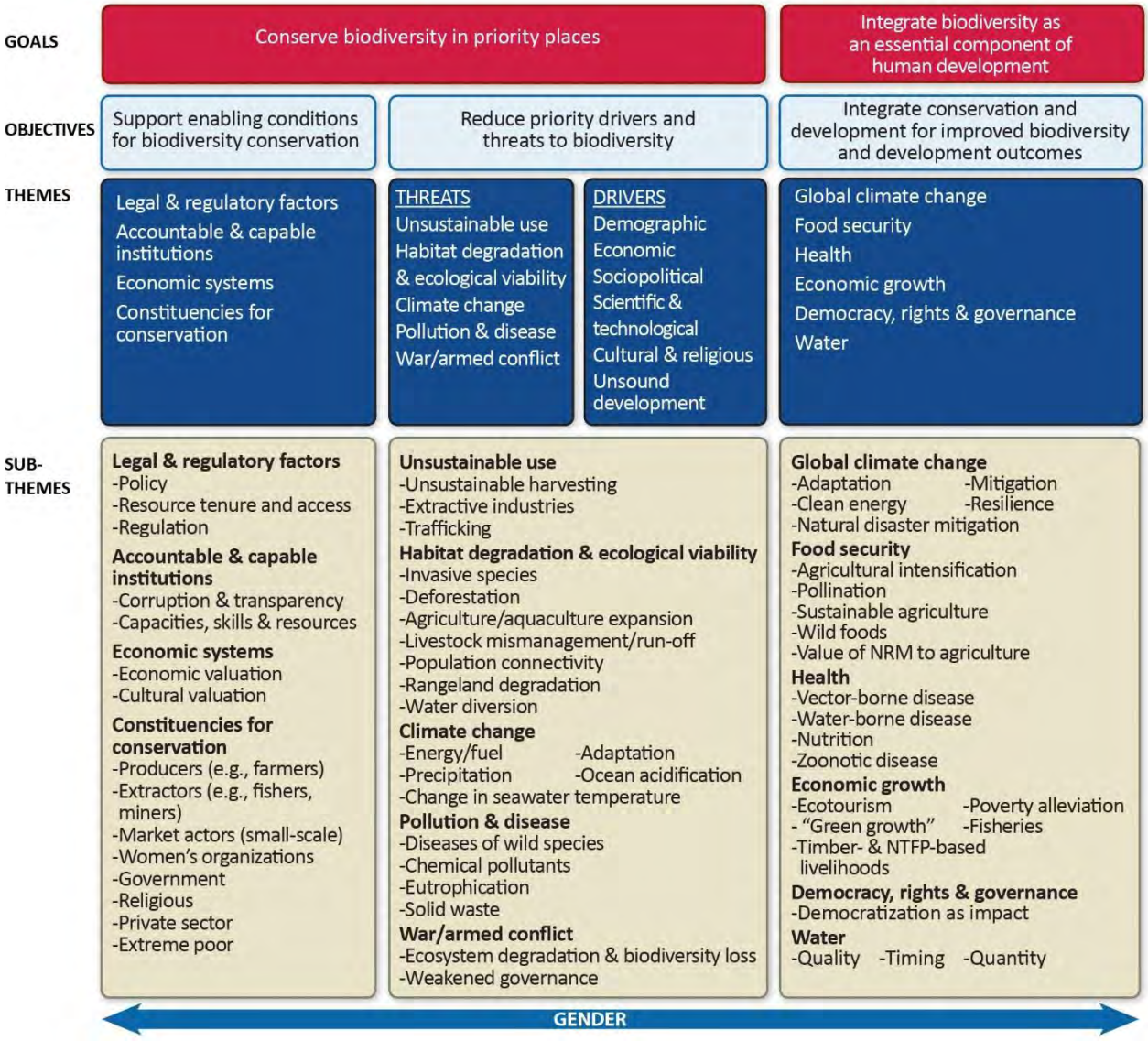
USAID developed this agenda in a systematic, strategic, operations-focused and collaborative manner. The BDRA drew from research priority-setting exercises developed from a comprehensive overview of best practices in health research priority setting. The process prioritized research topics that maximize impact, develop practical solutions for biodiversity and integrated programming or address key knowledge gaps.

Collaboration in the development of the BDRA occurred in three ways: (1) The RAWG comprised staff from the Forestry and Biodiversity (FAB) Office, the Office of Global Climate Change, the Africa Bureau, the Bureau for Policy, Planning and Learning (PPL) and the Global Development Lab. The RAWG met regularly to provide input into the development of the conceptual framework and to help identify research topics and prioritization criteria. (2) FAB Office staff interviewed key informants across sectors and Bureaus to identify research initiatives that potentially intersect with areas relevant to the BDRA. In addition, FAB Office staff also participated in the research agenda working groups of other USAID sectors and initiatives, such as the Global Climate Change Initiative, the Africa Rising Research Initiative that forms part of Feed the Future and work on land tenure and property rights in the Office of Land Tenure and Resource Management. Participating in the development of research agendas across sectors allowed for cross-fertilization of ideas and approaches. (3) USAID Bureaus and Missions, including the E3 Bureau's

leadership, reviewed the BDRA internally to sharpen the focus, identify gaps and provide additional research topics. Agenda drafters in FAB and the Measuring Impact (MI) project incorporated feedback from the internal review process in the final draft of the BDRA.

The BDRA is intended to guide the design and implementation of research in support of the objectives of the Biodiversity Policy, and its conceptual framework aligns with the Policy's vision and goals (Figure 1).

Figure 1. Conceptual Framework for the Biodiversity and Development Research Agenda. NRM: Natural resource management, NTFP: Non-timber forest products.



The RAWG developed key themes and sub-themes corresponding to three of the six objectives of the Biodiversity Policy. Themes under the "support enabling conditions for biodiversity conservation" objective are core conditions to support conservation action and help overcome key barriers to conservation. Themes under the "reduce priority drivers and threats to biodiversity" objective are based on an analysis of taxonomies of threats and drivers, the Convention on Biological Diversity, and the Millennium Ecosystem Assessment taxonomies. Themes under the "integrate conservation and development for improved biodiversity and development outcomes" objective align with the major initiatives of the

Presidential Policy Directive on Global Development: Feed the Future, Global Health, and Global Climate Change. These themes are further broken down into sub-themes that provide the basis for key research topics and questions. The sub-themes align with some of the Agency's primary theories of change and are relevant to major development objectives. The BDRA summarizes key and recent literature on each of these sub-themes.

The peer-reviewed literature and a series of thematic RAWG meetings identified candidate research questions that correspond to sub-themes. A set of criteria were developed and applied to prioritize candidate research questions that support evidence-based programming and are relevant to a range of geographies, geopolitical or cultural contexts, or ecosystems. The team also applied additional criteria for each content area. To maximize transparency, the BDRA includes rigorous documentation of how the research priorities were established, including decision-making criteria and methods, how research topics were generated, and who helped to establish the priorities and generate the research topics.

The BDRA categorizes prioritized research topics and illustrative methodological approaches to address the topic. These methods range from literature reviews, systematic reviews or meta-analyses, to fieldwork using surveys and key informant interviews, and experimental or quasi-experimental evaluations. The methods proposed for the topics are suggestions and more than one option is available to address them, depending on data availability, cost and other constraints. For each sub-theme of the conceptual framework, the agenda rephrased the highest scoring priority research topics into operationalizable research questions. Text boxes indicate research topics recommended by internal reviewers from the Bureaus and Missions. The Agenda identifies over 100 key questions, listed in Annex C. Here are five of the top-rated questions to whet readers' appetites for the full menu:

1. What are the human well-being costs and benefits of protected areas; how are these costs and benefits distributed across various stakeholders, in particular local communities; and how do they vary with governance, resource tenure arrangements and site characteristics?
2. What is the contribution of wild foods to food security for the extreme poor and what is the economic and health value of this contribution?
3. How can freshwater biodiversity and ecosystem service values best be incorporated in the design of water-provisioning schemes for direct human use and food production?
4. What are the benefits that communities perceive from biodiverse areas and how will this understanding help create better policy?
5. What are the impacts on biodiversity and human well-being of differing approaches to devolving different rights (e.g., access, ownership, management, transfer, exclusion, and use) to land and natural resources?

Approaches for implementing research under the BDRA involve engaging current mechanisms and leveraging existing resources in the Agency and building effective partnerships with diverse external institutions in developed and developing countries. USAID has a long tradition of collaborative partnerships to meet development goals while building capacity. Implementation of research under the BDRA may involve strategic partnerships with other U.S. Government agencies, universities and research institutions, conservation NGOs, bilateral and multilateral organizations, and donors. USAID Missions will be integral to the implementation of the BDRA; their knowledge of local and regional issues and relationships with local universities, stakeholder groups and government agencies will ground implementation as well as the communication of findings. The FAB Office, together with internal and external partners, will disseminate findings and results generated from research activities on BDRA priority topics through multiple channels, including publication in peer-reviewed journals, briefs for Agency use, and mass and social media.

To foster the development of evidence-based projects, key research findings can be integrated into all stages of the program cycle. One way to integrate findings and evidence is through a Theory of Change analysis, which is required by the Biodiversity Policy for all USAID biodiversity projects. This type of analysis lays out factors that directly and indirectly affect an objective or target, the hypotheses underlying the approach, and key implementation steps. An evidence-based Theory of Change will show where the approach is grounded in research and knowledge and where key knowledge gaps exist. Thus evidence from the BDRA is closely linked to the need for impact evaluations where gaps exist.

INTRODUCTION

USAID and its partners view biodiversity as a critically important foundation for human welfare, intricately connected to other development sectors and fundamental to meeting the Agency's development goals. USAID programs budget about $200 million in biodiversity funding annually in more than 50 countries, making it one of the largest funders of biodiversity conservation globally.

While biodiversity conservation is a priority in its own right, it is also important for development professionals and decision makers across the Agency and the broader development community to understand the role of biodiversity and healthy ecosystems in providing the crucial services that underpin other development priorities, such as food security, water provision, adaptation to climate change, and mitigation of threats to human health.

A number of threats, including deforestation, habitat loss, and the illegal wildlife trade, are undermining the natural resource base; species are currently being lost at rates estimated to be 100 to 1,000 times higher than natural extinction rates (Pimm et al., 1995). This loss results in declining ecosystem services and threatens the health and well-being of millions of people globally, particularly the world's extreme poor.

Amidst accelerating biodiversity loss and declining ecosystem services, USAID's biodiversity conservation and forestry programs have nevertheless achieved notable results that align with the Agency's wider goals, including supporting sustainable economic growth, ensuring food security, and reducing emissions that contribute to climate change.

In Bangladesh, USAID assistance led the Government to bring the entire Sundarbans, the largest mangrove forest in the world and critical habitat for the Bengal tiger, under co-management of communities and the Government.

Thus, more than 600,000 hectares are now better managed, making communities less vulnerable to climate change impacts while sequestering 266,000 metric tons of carbon dioxide annually (USAID, 2012).

Biodiversity loss results from complex interactions of threats and drivers that shift across spatial and temporal scales and sectors; these shifts have implications for the knowledge required to understand biodiversity loss and support effective action (Van den Hove & Chabason, 2009). To achieve its conservation goals, USAID continues to test, document, and refine best practices to respond to well-known problems, such as weak governance of natural resources and insecure resource rights, emerging threats such as global climate change and age-old problems such as economic and gender inequality.

To help build the evidence base for biodiversity conservation and integrated programming, the Agency sets this research agenda to define and prioritize the most critical research needed in the area of biodiversity conservation in support of USAID's conservation and development objectives. Execution of research under this Biodiversity and Development Research Agenda (BDRA) is a critical step in implementing USAID's Biodiversity Policy and its two main goals: (1) conserving biodiversity in priority places, and (2) integrating biodiversity as an essential component of human development.

Objectives and Rationale

USAID provides global leadership in conservation and development in part by identifying and filling key gaps in the knowledge needed to better design and implement conservation programs. USAID's BDRA provides a framework to generate research that will strengthen the evidence base needed for effective biodiversity conservation and improve the Agency's capability to effectively integrate biodiversity conservation with other development sectors. USAID's Scientific Research Policy underscores the importance of research to design, test, improve, and assess the effectiveness of common approaches and interventions that target key concerns in developing countries. A focused research agenda is central to USAID's Forestry and Biodiversity (FAB) Office's intention to meet the following objectives:

- Conserve global biodiversity and advance human development through evidence-based programming rooted in a robust examination of the critical theories and assumptions in the field of biodiversity and ecosystem conservation.

- Support the reform effort of USAID Forward through conservation programs that are strategic, results-oriented and effective and leverage high-impact partnerships.
- Empirically demonstrate the linkages between biodiversity conservation and development outcomes, particularly in the context of the three major initiatives of the Presidential Policy Directive on Global Development: (1) Feed the Future, (2) Global Health and Global Climate Change and (3) economic development and the Agency's gender equality and female empowerment goals.

The BDRA has wide-ranging applicability to the work of the Agency's Bureaus and Missions and partners in the biodiversity and development community, such as universities and research institutions, NGOs and donors. Stakeholders and partners can use the BDRA to accomplish a number of purposes:

- Identify key research questions on which USAID—a leader in biodiversity conservation practice and finance—would like to encourage researchers and partners to focus.
- Build outreach to the research community, especially key USAID partners in the Consultative Group on International Agricultural Research (CGIAR), AidData, Higher Education Solutions Network (HESN), developing country researchers funded by the Partnerships for Enhanced Engagement in Research (PEER) program and local institutions working with Missions that want to carry out policy-relevant research.
- Encourage critical thinking about key issues and questions in USAID and its wide partnerships.
- Build capacity in identifying research questions and methodologies to carry out research.
- As findings accrue, develop a body of data, evidence, and knowledge to inform USAID and partners' biodiversity and integrated programs. The BDRA provides a wealth of information on key themes and topics that can be tailored to specific approaches, types of programs, and stages in the program cycle.
- Support the Agency's call for leadership in science and technology.

PART ONE: APPROACH, PRINCIPLES, AND METHODS

Four key principles characterize the approach to developing the BDRA: (1) systematic, (2) strategic, (3) operations-focused and (4) collaborative. Adhering to these key principles is expected to produce a research agenda that is rigorous, appropriately targeted and relevant, and broadly supported in both the development and conservation fields. This section describes the rationale for the four key principles and the methods for bringing those principles into operation.

I. Systematic

Research priority-setting processes can help researchers and policymakers identify research topics with the greatest potential benefit for international development outcomes. Setting research priorities is essential to maximize investment effectiveness. For research priority-setting exercises to be effective, they must be high quality; and therefore, the BDRA approach is systematic and based on established best practices. The objective is to generate products that are rigorous, transparent and open to peer review.

The systematic process used in the development of the BDRA drew from a checklist for research priority-setting exercises that was based on a comprehensive overview of good practices in health research and methodological approaches (Viergever et al., 2010).

Annex A discusses the systematic BDRA development approach, which is summarized in these seven steps:

1. Defining the focus
2. Determining the approach to priority setting
3. Determining the level of inclusiveness of actors
4. Identifying information needs and relevant sources
5. Outlining an implementation strategy that leverages existing investments and resources
6. Identifying selection criteria against which proposed topics are vetted
7. Ensuring transparency through rigorous documentation

II. Strategic

The BDRA was developed strategically with an emphasis on making research focused and selective to maximize impact and cost-effectiveness. One prioritization criterion applied to research topics is that results should be applicable across a wide range of geographies, geopolitical or cultural contexts and multiple ecosystems.

III. Operations-focused

To develop practical solutions for Mission-related programming and address key knowledge gaps at the Mission level, the BDRA prioritizes research projects with programmatic implications.

The first step in determining operations-focused research topics was to identify priority research questions that aligned with key programmatic approaches in USAID's biodiversity portfolio. The next step was to assess the effective contribution those research topics would have on building the biodiversity conservation evidence base. Research topics that aligned with these criteria received priority.

IV. Collaborative

Practitioners in the fields of international development and biodiversity conservation face complex, dynamic challenges that require responsiveness across sectors. Collaboration is needed to address these complex program and policy challenges and to generate the evidence as a basis for key programmatic and policy decisions.

The FAB Office undertook a collaborative approach in the BDRA development to access more and better information and ideas, which enhanced the quality of the agenda and applied integrated approaches to the USAID Policy Framework 2011–2015 (USAID, 2011a).

During the BDRA development, three key collaborative mechanisms were used:

1. **The Research Agenda Working Group (RAWG),** which comprises staff from the FAB Office and the Bureau for Africa; Bureau for Policy, Planning and Learning (PPL) and the former Office of Science and Technology (now The Center for Data, Analysis and Research) met regularly to discuss the conceptual framework and identify research topics and prioritization criteria.
2. **Key Informant Interviews** were implemented across sectors and Bureaus to identify ongoing or forthcoming research activities that might overlap with areas relevant to the BDRA. Annex B gives an overview of these research activities.
3. **Other Sectors or Initiatives** also participated in developing research topics. FAB Office staff responsible for leading the BDRA development participated in the research agenda working groups of other USAID sectors and initiatives, including the Global Climate Change Initiative, Feed the Future Food Security Initiative, and Office of Land Tenure and Resource Management in the Bureau for Economic Growth, Education, and Environment. Participating in the development of research agendas across sectors promoted cross-fertilization of ideas and approaches that enriched the thinking.

> Interdisciplinary research works to integrate knowledge and solve problems that individual disciplines cannot solve alone.

PART TWO: CONCEPTUAL FRAMEWORK AND PRIORITIZATION STRATEGY

I. Introduction

Development of the BDRA and execution of research under the agenda are critical steps in implementing USAID's Biodiversity Policy, and this research strategy aligns with the policy vision and goals. The BDRA responds to the Agency's call for leadership in science and technology, and the Scientific Research Policy that underscores the importance of high-quality research in the design, implementation, testing, and improvement of interventions and approaches for target priority issues in developing countries.

This chapter presents the BDRA conceptual framework and describes the approach used to prioritize research implemented under the BDRA at five conceptual levels: (1) goal, (2) objective, (3) theme, (4) sub-theme and (5) topic. The chapter also describes how criteria were prioritized to refine the scope of research implemented under the Agenda and applied to key research topics that emerged during the BDRA development process.

II. Biodiversity and Development Research Agenda Conceptual Framework

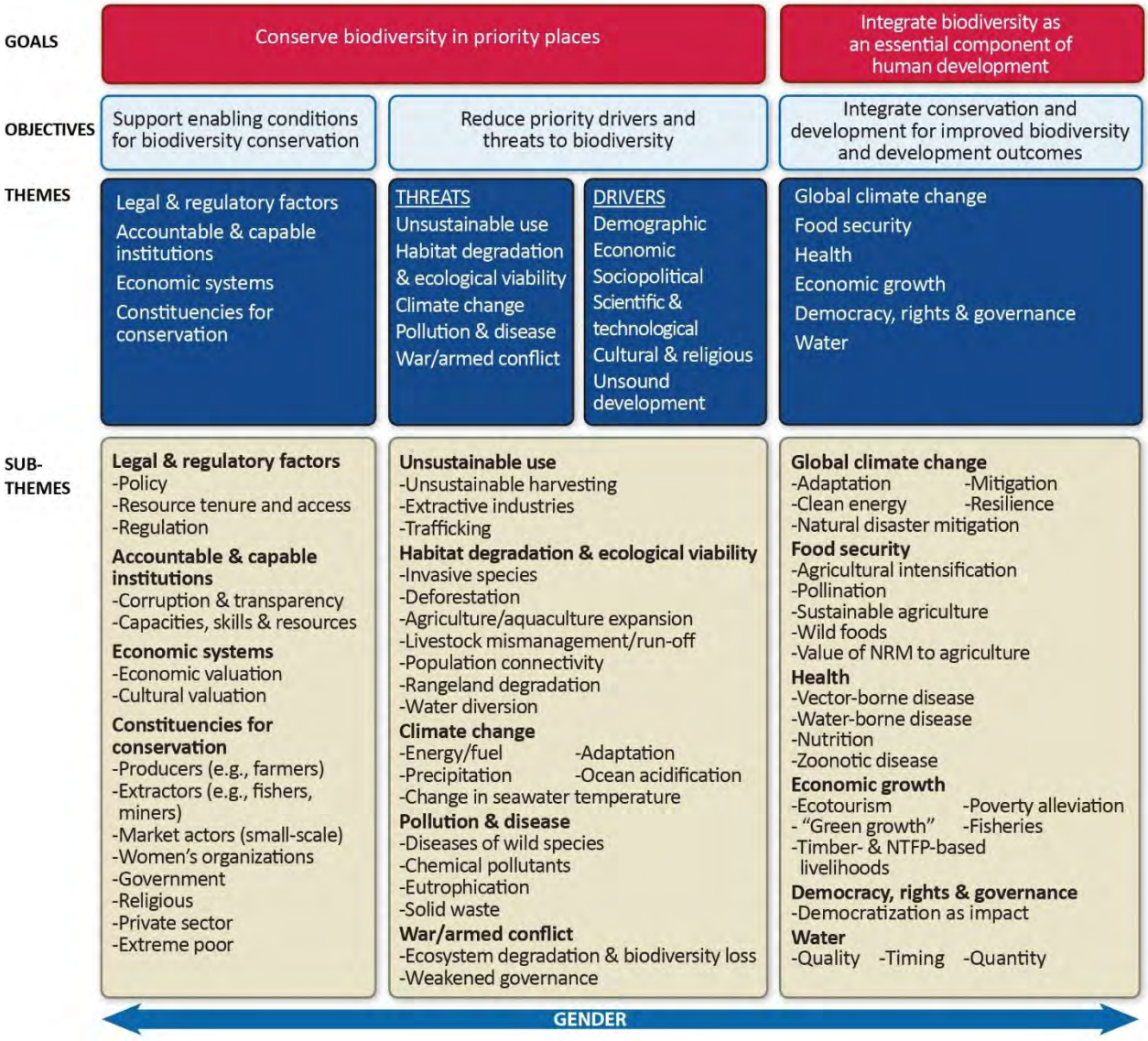
The BDRA conceptual framework's multiple levels reflect the broadest priorities established during the Biodiversity Policy development, listed in Figure 1.

A. Goals

The BDRA guides research implementation that supports the two Biodiversity Policy goals.

> ***Goal 1. Conserve biodiversity in priority places.*** USAID's efforts to conserve biodiversity focus on high priority geographies where the Agency has a comparative advantage and can support host country conservation and development priorities. Research linked to this goal tests critical theories and assumptions in biodiversity and ecosystem conservation because they enable conditions that promote sustained biodiversity conservation and help abate priority threats to biodiversity. For example, research linked to this goal might assess the impact of institutional arrangements and governance (e.g., decentralization and community-based approaches) on achieving sustained biodiversity conservation. Research on threats to biodiversity focuses on the influence of species management, changes in land use, climate change, pollution, and disease. This outcome also captures research that addresses global and regional threats, such as wildlife trafficking and timber trade, agricultural expansion, wildlife diseases and drivers of biodiversity loss such as climate change.
>
> ***Goal 2. Integrate biodiversity as an essential component of human development.*** In recognition of the need to accrue and use evidence showing that integrating biodiversity can improve the impact and sustainability of development outcomes, such as reducing poverty, improving health, and managing the impact of global climate change, research linked to this goal focuses on strengthening the evidence base for biodiversity conservation and development integration. This includes testing, for example, how and the extent to which functioning ecosystems provide ecological goods and services, such as flows of clean water, disease control, pollination, and flood prevention, which are critically important for the long-term well-being of communities and their economic growth. Research questions also tackle key cross-sectoral benefits that may arise from investing in biodiversity conservation, such as economic growth, climate change mitigation, food security, and improved health.

Figure 2. Conceptual Framework for the Biodiversity and Development Research Agenda. NRM: Natural resource management, NTFP: Non-timber forest products.



B. Themes

Several themes appear under each of the objectives (Figure 1). Research in these thematic areas will facilitate achievement of the respective objectives.

The themes under *Support enabling conditions for biodiversity conservation* are (1) legal and regulatory factors, (2) accountable and capable institutions, (3) economic systems and (4) constituencies for conservation. The FAB Office developed the themes as a core group of conditions that can facilitate conservation action (policy, institutional, economic and social) and help overcome key barriers to conservation.

The themes under R*educe priority drivers and threats to biodiversity* are categorized in two groups: (1) threats to biodiversity and (2) drivers of biodiversity loss. The threats to biodiversity are (a) unsustainable use of natural resources, (b) habitat degradation and ecological viability, (c) climate change, and (d) pollution and disease. Biodiversity loss drivers include factors related to (a) demography,

(b) economy, (c) sociopolitical context, (d) science and technology, (e) culture and religion and (f) unsound development.

The themes were developed based on an analysis of taxonomies of threats and drivers to support USAID's technical approach (based on threats and drivers) and institutional needs in light of USAID's Biodiversity Policy. These themes track closely with the Convention on Biological Diversity (CBD, 2010) and the Millennium Ecosystem Assessment (2005) taxonomies.

The themes under *Integrate conservation and development for improved biodiversity and development outcomes* are (1) global climate change; (2) food security; (3) health; (4) economic growth; (5) democracy, rights, and governance; and (6) water. These themes derived from expert consultations with the RAWG.

C. Sub-themes

Under each theme are sub-themes, which emerged from discussions with the RAWG, that are relevant to major development objectives and align with some of the Agency's primary theories of change. Candidate research topics identified by the RAWG align with the sub-themes (Figure 1).

III. Methodology for Identifying and Prioritizing Research Topics

Identification of priority research topics for the BDRA entailed a three-step process:

1. Soliciting candidate research topics through a series of meetings with the FAB Office and the RAWG that focused on each of the Biodiversity Policy's main goals;
2. Compiling research topics from peer-reviewed literature; and
3. Prioritizing the aggregated list of research topics based on standard criteria for inclusion (Sutherland et al., 2011) and a set of criteria consistent with FAB Office programming and management priorities.

Annex A includes a detailed description of each step.

IV. Portfolio Approach to Research Implementation

The BDRA-identified research topics are illustrative and provide guidance for future research plans that would test critical theories and assumptions and generate evidence on the efficacy of USAID approaches to biodiversity conservation and integrated programming.

A portfolio approach to research implementation is recommended to ensure that (1) resources are allocated strategically, (2) research results are disseminated and integrated into the learning cycle and (3) the research agenda continues to reflect and address lessons learned from program implementation and the Agency's changing landscape of priorities and resources. Following are the guiding principles for the proposed portfolio approach to research implementation:

- Distribution of research across goals, objectives, and themes implies that research implemented under the BDRA should generate evidence under each of the objectives in the conceptual framework.
- Distribution of research across methodologies implies that a full range of research and evaluation data and methodologies can be used to address the research topics prioritized in the BDRA.
- Distribution of research across time scales implies that while priority is given to implementing research that can generate evidence in a typical 5-year project cycle, important questions that cannot be addressed in the life of a typical project cycle should not be excluded from consideration under the BDRA.

- Distribution of research that looks at changes in conditions that are likely to affect programming or the ability to do monitoring and evaluation of programming implies the need to refine and rebalance research questions based on learning and the changing landscape of the needs and resources of USAID and its Missions.
- Distribution of research that engages a range of strategic and technical partners in research and evaluation implies that research can be implemented in collaboration with strategic partners to take advantage of rising opportunities and existing partnerships to answer critical research needs in priority Missions.

As part of its evaluation of the BDRA (see Part Six: Sharing and Application of New Knowledge), the FAB Office will update its research priorities and assess the distribution of biodiversity and integrated research across USAID's portfolio according to these principles, and the results will guide the process of updating research priorities.

PART THREE: RESEARCH TOPICS—BUILDING THE EVIDENCE BASE

The BDRA research areas, which align with the goals of the Biodiversity Policy, encompass a wide range of pressing issues. They are essential to achieving the vision of the Biodiversity Policy: *To conserve biodiversity for sustainable, resilient development.*

The objective of this section is to provide a summary background on each of the levels of the BDRA, and then to summarize the prioritized research topics generated for each theme and sub-theme of the Agenda's conceptual framework. In some instances, research topics were not generated for sub-themes; only topics that scored at the median or above on the prioritization criteria and those assessed to be feasible for implementation are listed below by sub-theme. A list of all generated research topics is available in Annex C. Table C1 contains 198 questions and Table C2 contains 302 questions.

The prioritized research topics are categorized by illustrative methodological approaches that could be used to address them. These are given as suggestions because more than one way may be available to address the topic, depending on data availability, cost, and other constraints.

Illustrative operationalizable questions for each sub-theme of the conceptual framework appear in rectangular shaded text boxes. These questions were selected from the highest-scoring priority research topics. Subsequently they were reworded into an operationalizable research question to state the following information:

1. Subject or population to be assessed
2. Outcome of interest
3. Intervention or treatment and other factors of interest
4. Expected correlation or causal pathway

Select USAID Bureaus and Missions reviewed the research topics in the BDRA to ensure they are representative of the critical knowledge gaps needed to inform programmatic work and implementation approaches in biodiversity conservation and integrated programming. During this internal review process, additional research questions were recommended; these questions are highlighted in text boxes with rounded corners, but they are not included in Annex C.

I. Support Enabling Conditions for Biodiversity Conservation

Despite significant investments in conservation programs over the last three decades, biodiversity loss continues at unprecedented rates. Traditional approaches to conservation, such as the establishment of national parks and other protected areas, have been somewhat successful in designating significant areas for conservation and generating substantial revenue. The traditional approaches, however, can have negative repercussions on local communities if they do not share in the revenue generated by these areas. In response, the conservation community has broadened its programmatic approaches to include governance, social, economic, and legal considerations, which are the enabling conditions necessary for sustained biodiversity conservation (Bawa et al., 2011).

These enabling conditions can be critically important in determining the success and long-term sustainability of conservation programs. Conservation programs should address direct threats to biodiversity while providing support and fostering the enabling conditions that are necessary for long-term programmatic success.

Research shows that enabling conditions for sustained biodiversity conservation differ based on the local context and programmatic intervention. For example, a comparative study of the success of forest certification programs in Bolivia and Ecuador found that Bolivia's stronger government enforcement of forestry regulations, forestry laws that are highly compatible with certification requirements and significant tax benefits for certified providers were enabling conditions that supported the success of

these programs (Ebeling & Yasue, 2009). On a different scale, when researchers looked at enabling conditions that contributed to the success of community-based conservation projects, they found that factors such as the capacity of local communities, tenure regimes and cultural beliefs were significant while the national context was less important (Brooks et al., 2012).

Research questions that address enabling conditions for sustained biodiversity conservation cover a range of sub-themes: legal and regulatory factors, accountable and capable institutions, economic factors and constituencies for conservation.

A. Legal and Regulatory Factors

Legal and regulatory factors, such as environmental policies and frameworks, secure land tenure and resource rights, and enforcement of existing regulations are important in determining the success of biodiversity conservation programs. Certain policies, legal frameworks, and regulations can support the sustainable management of natural resources, while others can drive ecosystem degradation and overexploitation of natural resources. The legal and regulatory factors that affect sustainable management of ecosystems are not just those directly related to biodiversity; factors that indirectly impact biodiversity are also related to commodity markets, the extractive industries, and infrastructure development.

A comparative study of the success of forest certification programs in Bolivia and Ecuador found that Bolivia's stronger government enforcement of forestry regulations, forestry laws that are compatible with certification requirements, and tax benefits for certified providers were enabling conditions that supported program success (Ebeling & Yasue, 2009).

1. Policy

Strong, effective policies can play an important role in protecting biodiversity and supporting sustainable management of natural resources. It is important to address issues of accountability, transparency, and participation during the policy development process. Policy impacts can vary based on location, political and economic context, and spillover effects. Policies need to balance development and biodiversity conservation considerations and account for different effects on stakeholder groups (Pfaff & Robaline, 2012).

Illustrative operationalizable research questions on legal and regulatory factors:

1. How do inequalities in access to information on land tenure and property rights impact conservation?
2. What are the impacts of the Lacey Act and similar policies on conservation outcomes?

Experimental or Quasi-experimental Design

What are the impacts of policies related to economic incentives and disincentives on conservation outcomes, including the policies of banking institutions, multilaterals and multinational corporations?

Research question on policy proposed by USAID Bureaus and Missions:

What is the evidence that protocol-type efforts, such as designing and adopting memorandums of understanding, lead to more effective working relationships and thus to better conservation outcomes?

Case Studies (Qualitative)

Is it more effective to do simultaneous policy implementation at both ends of scale (local and national), or is sequential implementation more effective?

2. Resource tenure and access

Resource tenure refers to the rights of individuals or communities to access, own, manage, transfer, and use land and other natural resources (World Resources Institute [WRI] et al., 2005). Resource tenure can be fundamental for sustained biodiversity conservation by fostering a context where local populations can meet their needs for food security and livelihoods in sustainable ways (Food and Agricultural Organization, 2002a). Guaranteeing rights to access and use of land and other natural resources creates incentives to make long-term investments in preserving and improving their productivity. However, what constitutes efficient and equitable resource tenure and administration is contextual and dependent on agro economic, sociocultural and economic factors (Food and Agricultural Organization, 2002a; Ngaido & McCarthy, 2004).

Experimental or Quasi-experimental Design

How do gender differences in legal, informal, traditional, or customary rights around land ownership, inheritance, and access to land, resources and capital impact conservation outcomes?

Systematic Review

What are the human well-being costs and benefits of protected areas? How are these costs and benefits distributed across various stakeholders, in particular local communities, and how do they vary with governance, resource tenure arrangements, and site characteristics?

3. Regulation

Access to and use of natural resources can be regulated and enforced through centralized government-based approaches or decentralized local approaches that depend on community-based participation. A study of shrimp farming in southern Thailand illustrates that regulation through the participation of local communities and governments can be more effective than regulation through certification, which is less likely to facilitate input from affected communities (Vandergeest, 2007). Involving local communities in the management and regulation of marine and terrestrial protected areas may mitigate breaches in enforcement and create conditions that are conducive to sustained biodiversity conservation (Rao et al., 2002; Wiggins et al., 2004). In addition to community-based natural resource management, establishing protected areas is another approach to biodiversity conservation. This approach aims to limit or regulate access to and use of natural resources. While community-based natural resource management and protected areas or parks are leading approaches to combatting biodiversity loss and ensuring the sustainable use of natural resources, a rigorous evaluation of these approaches is required to see if they are effective legal and regulatory tools (Joppa & Pfaff, 2010; Miteva et al., 2012).

Experimental or Quasi-experimental Design

How do alternative ways of managing fisheries affect marine ecosystems and coastal human communities?

Expert Working Group and Key Informant Interviews (Qualitative)

How does the management of protected areas affect conservation beyond the boundaries of the protected area, such as through the displacement of human populations, hunting or fishing?

B. Accountable and Capable Institutions

The structure and characteristics of local institutions, such as transparency, capacity and skills, can shape biodiversity conservation outcomes. For example, a study of institutional arrangements for forest management in Tanzania found that communal and decentralized strategies are associated with less illegal logging and better forest conditions than centralization (Persha & Blomley, 2009). However, a review of 21 local governments involved in forest management in Nicaragua demonstrates that the success of local decentralized approaches to natural resource management depends on capacity, incentive and long-term commitment (Larson, 2002).

1. Corruption and transparency

Corruption in local institutions, such as civilian and military police, is associated with the overexploitation of natural resources, with potentially detrimental effects on biodiversity. For example, between 50 and 70 percent of timber production in Indonesia is estimated to be a result of illegal logging, contributing to the doubling of deforestation rates annually (WRI et al., 2003). A culture of corruption may exist for several reasons, including administrative structures and socioeconomic factors. Strengthening mechanisms for accountability and oversight, instituting independent audits, involving nongovernmental watchdog groups, and nurturing a climate of transparency can foster a governance structure for the routine management and protection of natural resources that contribute to sustainable biodiversity conservation (WRI et al., 2003). However, evidence of the relationship between corruption and biodiversity loss has been confined largely to several case studies and anecdotal evidence (Smith et al., 2007). A transnational statistical study of the association between a decrease in forest cover and elephant populations and patterns of governance illustrates that after confounding socioeconomic and biophysical factors are controlled, national levels of corruption are not significant predictors of the change in biodiversity (Barrett et al., 2006). Further research will highlight the way governance influences the exploitation of natural resources (Smith et al., 2007).

Research question on corruption and transparency proposed by USAID Bureaus and Missions:

What are effective approaches to promote sustainability in challenging governance environments?

Experimental or Quasi-experimental Design

Does co-management of protected areas promote transparency?

Systematic Literature Review

Under what conditions do watchdogs and civil society groups improve conservation outcomes?

What are effective approaches to promote sustainability in challenging governance environments?

Trend Analysis with Case Studies

What is the impact of democratization on biodiversity conservation?

Literature Review That Includes Lessons Learned from Other Fields

How can accountability and transparency be improved at the community level?

Expert Working Group and Key Informant Interviews (Qualitative)

How does corruption influence the effectiveness of conservation, and what are the most effective ways of preventing the negative consequences of corruption?

A transnational statistical study of the association between a decrease in forest cover and elephant populations and patterns of governance illustrates that after confounding socioeconomic and biophysical factors are controlled, national levels of corruption are no longer significant predictors of the change in biodiversity (Barrett et al., 2006).

2. Capacities, skills, and resources

The success of natural resource management and sustainable biodiversity conservation is dependent on capable institutions. At any scale, capable institutions should: (a) raise awareness about the value of natural resources, (b) limit access to and use of natural resources by making and enforcing effective rules, (c) design and implement incentives for the sustainable use of resources, (d) monitor ecological and social trends and (e) modify their suite of regulations and incentives to adjust to changes in natural resources or anthropogenic pressures on it (Barrett et al., 2001; Kremen et al., 1994; Ostrom et al., 1999).

Research question on capacities, skills, and resources proposed by USAID Bureaus and Missions:

What are effective approaches to capacity building and institution building at different levels (central, district, and community), especially in challenging governance environments?

Experimental or Quasi-experimental Design

Are educational programs focused on teaching people about wildlife disease effective or harmful as a conservation strategy?

Literature Review That Includes Lessons Learned from Other Fields

What approaches are most effective for capacity building?

C. Economic Systems

A common approach to achieving sustainable biodiversity conservation is to raise awareness about the economic value of natural resources and ecosystem goods and services. For example, a study in Costa Rica found that the quantity and quality of coffee yields, a valuable export commonly grown in many biodiverse areas, increased by 20 percent due to pollination from nearby forests (Ricketts et al., 2004). Research to understand the contribution of ecosystem services to human development and well-being, and the conditions where valuation of those services is effective in conserving biodiversity could inform more effective programming.

1. Economic valuation

Economic valuation of biodiversity and payment for ecosystem services are common conservation instruments. While the former approach aims to raise public awareness of the importance of biodiversity and ecosystem services in meeting daily needs by fixing a monetary value to them, the latter approach generates motivation among private users to protect the ecology of their terrestrial and marine resources by paying for them directly. Ecological economics is a growing discipline that aims to develop and implement methods for assessing the economic value of wildlife and natural resources (Edwards & Abivardi, 1998). However, comprehensive methodologies for estimating the economic value of biodiversity and ecosystem services and a framework for identifying the conditions where economic valuation of biodiversity is an effective tool are lacking (Jones-Walters & Mulder, 2009). A review of existing evidence on payment for ecosystem services (PES) in developing countries illustrates that most studies find a decrease in deforestation and an increase in reforestation, yet there is little evidence of the impact of PES on the quality of forests (Miteva et al., 2012). In addition, effective PES is contingent on program design factors, such as where the schemes are implemented, who receives the payment, and who makes the payments (Miteva et al., 2012). For example, evaluating the impact of a bird nest protection program in the northern plains of Cambodia indicates that sites where local people were paid to protect nests of selected endangered species experienced population increases for those species compared to control sites (Clements et al., 2013). Despite this success, there were no positive spillover effects for species not covered by the program, and payments to some local beneficiaries created tensions, which lead to intentional disruption of nesting birds (Clements et al., 2013).

Experimental or Quasi-experimental Design

Are the activities being paid for by PES schemes for water funds protecting the water sources?

Expert Working Group and Key Informant Interviews (Qualitative)

How can freshwater biodiversity and ecosystem service values best be incorporated in the design of water-provisioning schemes for direct human use and food production?

Systematic Reviews

Under what conditions do market incentives (e.g., alternative livelihood approaches, certification of green products) improve conservation outcomes?

System Dynamics Modeling

How do shifts in agricultural subsidies, commodity prices, and markets affect the location and rate of conversion of natural ecosystems to agricultural uses?

2. Cultural valuation

Intact ecosystems provide a number of important cultural services, including aesthetic inspiration, settings for recreational activities and tourism, and areas with spiritual significance. Incorporating local people and their needs, beliefs and practices into conservation is vital for preserving biodiversity and natural resources (Sterling et al., 2010; Xu et al., 2005). Maintaining cultural services can be an important incentive for biodiversity conservation. For example, one of the most biodiverse ecosystems in Ghana is a forest that local communities have maintained as habitat for certain sacred primate species (MEA, 2005). However, because it is difficult to quantify the value of cultural services, they are often not recognized or accounted for in environmental decision-making.

In-depth Fieldwork (qualitative)

What is the relationship between individuals learning about environmental problems and their conservation attitudes, knowledge, beliefs and behaviors?

Systems Dynamics Modeling

What factors shape human (in)tolerance of the presence and activities of wild animals, especially where those animals induce human-wildlife conflict?

3. Subsidies

Hundreds of millions of dollars are invested annually in fossil fuel, fishing, and agricultural subsidies, all which can present a significant threat to biodiversity. For example, agricultural subsidies can encourage the use of fertilizer, as opposed to more sustainable methods of increasing soil fertility. Excessive fertilizer use can cause run-off and accumulation of chemical pollutants in coastal areas, presenting a significant threat to marine ecosystems. Likewise, fishing subsidies can cause unsustainable fishing practices, with devastating consequences for marine species. Cumulatively, these perverse incentives can cause the loss of important ecosystem services and encourage unsustainable use of natural resources; however, subsidies also can be beneficial to ecosystems if used to encourage and reward sustainable practices (Sukhdev, 2011).

Illustrative operationalizable research question on economic systems:

Are there effective financial incentives that encourage foreign direct investments to positively impact biodiversity (e.g., Equator Principles)?

D. Constituencies for Conservation

Economic and cultural valuation of biodiversity and ecosystem goods and services is expected to build constituencies for conservation. Participatory approaches that incorporate large and small-scale farmers, women, local and central government bodies and religious and private-sector institutions can support the protection and conservation of species and habitats while garnering inclusive and sustainable development.

Research question on constituencies for conservation proposed by USAID Bureaus and Missions:

What is the evidence of the efficacy of strategic communication approaches in moving key consistencies for conservation from improved knowledge to changed attitudes and to measurable practices?

1. **Producers** (e.g., farmers)

Building constituencies for conservation among large- and small-scale producers can contribute to sustained biodiversity conservation. For example, in Indonesia farmers' production decisions, such as shifting to monoculture or agroforestry, are driven by profitability and global market demands (Feintrenie et al., 2010). Strategies for building constituencies for conservation among producers focus on a number of approaches, including creating financial incentives through certification programs and building producers' capacities to engage in sustainable production practices. There is little evidence, however, to indicate that certification is beneficial to the environment or that it creates financial incentives for producers (Blackman & Rivera, 2011). The lack of standardized methodological approaches contributes to the difficulty of assessing the impact of these approaches (Van den Berg & Jiggins, 2007) and requires further research.

Expert Working Group and Key Informant Interviews (Qualitative)

How can USAID bring farmers into conservation efforts?

2. Extractors

Extractive resources, including fish, minerals, and non-timber forest products, can be managed to promote biodiversity conservation and poverty alleviation. However, decades of research have inadequately captured the multidimensional relationships and trade-offs that exist between extractive resources and environment and development initiatives (Agrawal & Redford, 2006). If mismanaged, extraction can cause overexploitation of resource stocks and the loss of biodiversity, which can cause income declines, governance issues, and conflicts over resource rights (Bebbington et al., 2008; Frost et al., 2006). Case studies in the integration of biodiversity conservation in mining activities in Indonesia, Madagascar, and Brazil reveal practices such as restricted mining in World Heritage Sites and International Union for the Conservation of Nature (IUCN) category I and II protected areas, setting aside biodiversity offsets in endangered areas, rerouting pipelines to avoid sensitive areas, creating forest corridors to support population connectivity, supporting local reforestation activities, conducting independent audits and performing monthly biodiversity reporting (International Council on Mining and Metals, 2010).

Research question on extractors proposed by USAID Bureaus and Missions:

What are best practices in the integration of ecosystem protection in extractive industry development in high value biodiverse areas?

3. **Market actors** (e.g., small-scale traders)

Globally, millions of people rely on the sale of products derived from nature, such as fish, firewood, fruits and vegetables in local markets to sustain their livelihoods. Unsustainable harvesting of these products can cause biodiversity loss and ecosystem degradation, which threatens the livelihoods of these populations. Engaging these local market actors in conservation efforts can result in more sustainable management of natural resources, with long-term ecological and economic benefits. For example, the USAID-supported Global Fish Alliance project worked with local fishers in Cambodia to improve local livelihoods by establishing a local conservation area and providing assistance in combating illegal fishing (Global Fish Alliance, 2013). In the Western Ghats region of India, a group of nonprofit and government organizations worked closely with local indigenous groups to reduce the use of destructive harvesting techniques. This work also expanded into providing support for sustainably increasing agricultural productivity, resulting in less reliance on the sale of non-timber forest products among community members (Shanker et al., 2005).

4. Women

The push for community-based conservation approaches has often ignored how institutions that shape social relations influence the direct and indirect costs and benefits of conservation and development efforts. For example, in Nepal and India, forest conservation practices impose a disproportionate burden

on women both directly, by increasing time and distance to food, water, fodder and fuel wood, and indirectly, by decreasing women's time in income-generating activities. This shift in burdens causes women's time to be consumed in food preparation and livestock management and has implications for the efficiency of forest protection and planning (Agarwal, 2001). Groups in Latin America, Africa and Asia that include women are more likely to show collaboration, solidarity and conflict resolution. In addition, the group's ability to engage in more sustainable management of natural resources increases with the presence of women and is highest in women-only groups (Westermann et al., 2005).

Expert Working Group and Key Informant Interviews (Qualitative)

How can USAID bring women's organizations into conservation efforts?

5. Government

Governments are one of the most important constituencies for conservation. Inadequate national funding for conservation programs is a significant impediment to their success, and many of the countries where conservation efforts are underfunded are relatively rich in biodiversity. One recent analysis found that almost one-third of all threatened mammalian species are in the 40 countries where conservation efforts are most severely underfunded (Waldron et al., 2013). In addition to providing adequate levels of funding for conservation, governments also have a key role in developing and enforcing effective rules and regulations that address global threats to biodiversity including deforestation, wildlife trafficking, and unsustainable natural resource use.

6. Religious organizations

Working with religious groups can help expand constituencies for conservation because of the reach of faith-based groups. For example, faith-based groups are affiliated with and involved in many schools. Faith-based groups can be more influential in shifting cultural attitudes and practices than governments and military leaders where the latter groups are not trusted. Many faith-based groups either own or exert influence over forest areas that are considered sacred. The Alliance of Religions and Conservation (ARC), established by the Duke of Edinburgh in 1995, is a secular nongovernmental organization that works with faith-based groups to develop environmental programs that draw on their core beliefs and practices, and bring secular groups together with faith-based groups to work on environmental issues. ARC is working with faith-based groups in Cameroon, Ethiopia, Ghana, Kenya, Rwanda, South Africa, Tanzania, Uganda and Zimbabwe on sustainable land use and water management (Africa Biodiversity Conservation Group, 2013). A meta-analysis of the role of religion in community-based natural resource management shows religious practices and beliefs in supernatural beings can strongly influence governance factors and positively impact natural resource conditions (Cox et al., 2014). However, additional research is required to document ways religious belief systems and faith-based organizations can be harnessed in community-based natural resource management and approaches to develop constituencies for conservation.

Expert Working Group and Key Informant Interviews (Qualitative)

How can USAID mobilize religious constituencies to support conservation?

7. Private sector

Government efforts to set up and manage protected areas are often outstripped by the pace of biodiversity loss. Privately owned and managed nature reserves have emerged as an approach to address and reverse biodiversity loss. In Sub Saharan Africa and Latin America private sector approaches to conservation, although profitable, are largely motivated by conservation objectives (Langholz, 1996). Increasingly, governments are using public-private partnerships to delegate the management of protected areas. Government officials in at least nine African countries had participated in these partnerships to help manage more than 6 million hectares of protected area (Hatchwell, 2014). Some private corporations are also involved in biodiversity conservation efforts; for example, the Coca Cola Company is partnering with organizations like World Wildlife Fund and USAID to conserve watersheds, promote sustainable agriculture and support local farmers (The Coca Cola Company, 2012).

Expert Working Group and Key Informant Interviews (Qualitative)

To what extent is the financial services sector a driver of biodiversity loss, and has this sector been overlooked as part of a solution to preventing biodiversity loss?

8. Extreme poor

The extreme poor, particularly in rural areas, are most directly dependent on ecosystem services, such as the provision of food, water and firewood. The relationship between the rural poor and biodiversity conservation is complex and highly debated. At times, mutually beneficial outcomes are generated, but at other times, harm is inflicted on poor populations or natural ecosystems, depending on the programs and institutions in place (Adams et al., 2004). Conservation programs that provide incentives or reward rural populations for practicing sustainable resource management can improve stewardship of natural resources (Agrawal & Redford, 2006); however, the rural poor have also been blamed for overexploitation of natural resources and a loss of biodiversity. For example, in some instances, deforestation can be attributed to local demand for agricultural land. Alternatively, biodiversity conservation initiatives can threaten the rural poor by restricting their access to ecosystem goods and services, which can severely compromise their livelihood strategies (Kerr, 2002). Additional research is required to better understand the trade-offs that exist between poverty alleviation and biodiversity conservation objectives and the contextual and programmatic conditions that will lead to mutually beneficial results (Agrawal & Redford, 2006; McShane et al., 2010; Sayer et al., 2007).

Case Studies (Qualitative)

How does public involvement, especially of marginalized groups, in conservation decision-making shape the effectiveness of conservation interventions?

Experimental or Quasi-experimental Design

What will be the biodiversity impacts of Tropical Forest Alliance 2020-supported changes in value chain production?[1]

Cross Sectional Statistical Analyses

What are the benefits that communities perceive from biodiverse areas; how does the valuation of biodiverse areas differ by subgroups in the communities; how will this understanding help create better policy?

9. Indigenous peoples

An estimated 370 million indigenous people live in the world today in approximately 90 countries. Their territories are home to much of the Earth's biological diversity. Their traditional knowledge systems—agricultural, pharmacological and ecological—are a vital and irreplaceable resource for humanity. Indigenous peoples have conventionally been seen as obstacles to development and notions of progress. They continue to be among the most marginalized members of society, and they experience higher rates of poverty, lower levels of education and poorer health than other groups, even in the most developed countries.

In-depth Fieldwork

How do indigenous communities define conservation? How does this definition shape their approach to conservation initiatives?

Participatory Action Research

What are the best ways for indigenous communities to design, monitor and evaluate conservation projects in line with their values and social structures?

[1] The Tropical Forest Alliance 2020 is a public-private partnership to reduce the tropical deforestation associated with key global commodities, such as soy, beef, palm oil and pulp and paper.

Illustrative operationalizable research question on constituencies for conservation:

How does the Agency influence government to support conservation (e.g., government leaders and non-environment ministries)?

II. Reduce Priority Drivers and Threats to Biodiversity

Over the last several decades, human activities have altered ecosystems to a greater degree than at any other comparable period of time, which has caused accelerated biodiversity loss and declining ecosystem services (MEA, 2005). Conservation success requires that the priority threats to biodiversity and the global and transboundary drivers of biodiversity loss be effectively addressed. Currently, top threats to biodiversity include unsustainable use of natural resources, trafficking in species and habitat fragmentation. Climate change poses a direct threat to many species and will also amplify other priority threats through changes in temperature and precipitation.

The convergence of multiple threats to biodiversity that have taken place in the last several decades has resulted in a drastic increase in the number of species that are at risk of extinction. The International Union for the Conservation of Nature assessed more than 60,000 plant and animal species for vulnerability and risk of extinction for its 2012 Red List of Threatened Species, and found that almost one-third of the assessed species are at risk of extinction. Among the most vulnerable groups are amphibians, corals and mammals (IUCN, 2013).

Global and transboundary drivers of biodiversity loss are wide ranging and include agricultural production, the extractive industries and consumption patterns. A recent study found that international trade in products such as coffee, tea, sugar, fish and textiles was responsible for up to 30 percent of threats to global species. Researchers found that the demand for these products in developed countries had significant adverse effects on biodiversity in developing countries (Lenzen et al., 2012).

Research topics listed under this theme address threats to biodiversity and drivers of biodiversity loss.

A. Threats

1. Unsustainable Use

Unsustainable use of species through activities such as consuming bushmeat and trading in wild species is a major threat to biodiversity. Bushmeat hunting has reached unsustainable rates in many areas due to increased local demand due to population growth, expanded national and international markets and other factors. The international wildlife trade, which is estimated to generate billions of dollars annually in revenue, also presents a major threat to thousands of plant and animal species (Broad et al., 2003). As demand for natural resources increases with population growth and changes in consumption patterns, the unsustainable use of species is expected to remain a major threat to biodiversity.

> **Unsustainable harvesting:** The unsustainable harvesting of species has resulted in biodiversity declines in terrestrial, marine and freshwater ecosystems globally. Over the last several decades, unsustainable harvesting of marine species has resulted in the collapse of many coastal and deep ocean fisheries; in a similar situation, freshwater fisheries are also being overexploited globally (CBD, 2010a, 2010b). Terrestrial ecosystems are experiencing defaunation at unprecedented rates due to the overharvesting of species through bushmeat hunting and the wildlife trade (Canale et al., 2012). The species losses that result from unsustainable harvesting can lead to significant reductions in ecosystem productivity and the provision of critically important ecosystem services, including food, natural medicines, and building materials.

Experimental or Quasi-experimental Design

What are the relative ecosystem effects of alternative sources of protein (e.g., bushmeat hunting compared with raising livestock)?

Longitudinal Study

What are the impacts of bushmeat hunting on keystone species, vegetation and predator-prey relationships?

Economic Valuation Analysis

What is the natural capital value of wildlife, particularly with respect to bushmeat and ecotourism?

System Dynamics Modeling

What are the effects on biodiversity on changes in human patterns of food consumption (e.g., shift from bushmeat to domestic meat and from fish to plant-based protein)?

Extractive Industries: Logging, mining, and oil and gas extractions are major drivers of biodiversity loss, with both direct and indirect impacts that lead to habitat fragmentation and species loss. Impacts of oil and gas extraction include deforestation from access roads, drilling platforms and pipeline routes. Spills, leaks and discharges also can lead to soil and aquatic pollution (Finer et al., 2008; World Wildlife Fund, 2014). As the demand for natural resources grows to meet increasing consumption, the extractive industries will continue to expand into even more remote areas. Some sectors, such as the mining industry, are encouraging their members to implement biodiversity management methods (International Council on Mining and Metals, 2010).

Trafficking: Trafficking in plant and animal species generates an estimated $10 billion in revenue annually. Species are harvested for use in traditional medicine, as decorative items and hunting trophies, for the pet trade and for other uses. The Convention on International Trade in Endangered Species of Wild Flora and Fauna, which seeks to regulate trade in species and their derivatives and make this trade more sustainable, lists more than 30,000 species that may be adversely affected by trafficking. The wildlife trade poses a serious threat to highly valued terrestrial species such as elephants, rhinos and tigers (Abensperg-Traun, 2009). Recently, highly organized criminal syndicates and some rebel groups have engaged in wildlife trafficking to fund their activities. Governments are increasingly concerned about the effect of the wildlife trade on national security. The unregulated movement of animal parts can also carry pathogens that pose a significant risk to public health (Dudley et al., 2013).

Experimental or Quasi-experimental Design

What is the efficacy of community scouts, and under what conditions are they most effective for conservation of biodiversity?

Longitudinal Study

What are the development impacts of wildlife trafficking at the source place?

Economic Valuation Analysis

What is the effect of poaching on local economies (e.g., to ecotourism ventures)? Is it possible to put a monetary value on a single rhino poached?

Literature Review with Focus on Lessons Learned from Other Sectors

How can the Agency effectively deal with corruption related to wildlife trafficking? What are the hotspots and choke points?

Review of Programmatic Documents

What are the dominant theories of change for programs that combat wildlife trafficking and under what conditions are they effective (e.g., substitution, alternative livelihoods)?

Expert Working Group and Key Informant Interviews

What are the impacts of wildlife trafficking on different development outcomes, such as health and conflict?

Illustrative operationalizable research question on unsustainable use:

Under what conditions is trade in captive species beneficial to or not beneficial to wild populations?

2. Habitat Degradation and Ecological Viability

Habitat loss is a major threat to biodiversity in marine, terrestrial and freshwater ecosystems. Terrestrial ecosystems such as forests, grasslands and savannas have been degraded at unprecedented rates during the last several decades. For example, it is estimated that only 15 percent of primary forests in Africa are still standing (Food and Agricultural Organization of the United Nations [FAO], 2010). In North America, more than 90 percent of the original grasslands have been lost, while woodland savanna loss in Brazil exceeds deforestation rates elsewhere in the country (CBD, 2010c). In a similar situation, coastal and freshwater habitats are facing degradation from multiples threats, including coastal development and infrastructure, particularly the building of dams (CBD, 2010a; 2010b). The resulting fragmentation of habitat threatens the viability of numerous plant and animal species.

Invasive species: Invasive species can be a major threat to native species in a number of ways: competing with native species for food or habitat, direct predation and through the introduction of diseases for which native species lack immunity. Among terrestrial ecosystems, islands are particularly vulnerable. For example, local bird populations of many Pacific islands decreased drastically due to direct predation after rats were introduced by humans (Pimm et al., 2008). Freshwater ecosystems are also highly vulnerable to invasive species. For example, Lake Victoria in Africa lost many endemic cichlid species after Nile perch and Nile tilapia were introduced to the lake in the 1970s (IUCN, 2012).

Longitudinal Study

Where do invasive species pose threats to human health and livelihoods?

Expert Working Group and Key Informant Interviews

Where are the overlaps and opportunities to work on invasive species across sectors?

Deforestation: Deforestation is a leading cause of biodiversity loss. Forests currently cover more than 30 percent of global land area; of this area, about one-third is primary forest (Aerts & Honnay, 2011). It is estimated that 80 percent of all terrestrial species are found in forests, making them some of the most species-rich habitats on earth. Deforestation is a major threat to forest ecosystems. Globally, more than 100,000 square kilometers of forests were lost annually between 2000 and 2010, with tropical rainforests experiencing some of the highest loss (CBD, 2010c).

Systematic Literature Review

What are the issues of scale with fragmentation, particularly across sectors?

Agricultural and aquacultural expansion: The expansion of cropland for agricultural production is a major threat to biodiversity globally. In recent years, production of crops such as soybeans, maize, rice, sorghum, oil palm, beans, sugar cane, wheat and cassava have increased in many countries, leading to the conversion of natural habitats. Many priority areas for biodiversity have been adversely affected by agricultural expansion, particularly in tropical countries. Analysis of crop area and expansion in 128 tropical countries found that cropland expanded by almost 50,000 square kilometers annually in these countries from 1999 to 2008 (Phalan et al., 2012). Fisheries and aquaculture make important contributions to the nourishment and livelihoods of people globally (FAO, 2012); however, aquaculture expansion is also a major threat to biodiversity globally. For example, a study using remotely sensed species data estimates that about 10 percent of the decline in mangroves along the northern coast of the State of Pernambuco in northeast Brazil is due to shrimp farming (Guimarães et al., 2010).

Experimental or Quasi-experimental Design

Does an ecoagriculture approach work to maintain biodiversity?

Livestock mismanagement and waste run-off: An estimated 200 million pastoralists globally manage herds of about 1 billion livestock, including cattle, camelids, horses, yaks and reindeer. Livestock farming is the primary land use in rangeland ecosystems, which make up about a quarter of the planet's land area and include a broad range of habitats such as grasslands, scrubland, savanna and tundra. Mismanagement of livestock in parts of the world has led to significant biodiversity loss in many of these habitats. Increased demand for food has resulted in the expansion of grazing on rangelands over the last several decades; it is estimated that grazed land area increased by more than 200,000 square kilometers annually from 1987 to 2000 (Alkemade et al., 2012). The shift to factory-based livestock farming can create unmanageable amounts of animal waste, which can be a significant source of pollution. Animal waste spills or leaks into nearby water sources can pose a direct threat to natural ecosystems such as coral reefs and mangroves. Livestock waste run-off can lead to the eutrophication of water surfaces; livestock production was identified as the major source of land-based nutrient pollution that induced a major algae bloom in 1998, which destroyed more than 80 percent of fish in 100 square kilometers along the coast of Hong Kong and southern China (FAO, 2002b).

Population connectivity: Habitat loss and fragmentation can impact the population connectivity of many species. Connectivity is critically important for maintaining healthy populations of these species. Corridors are an important tool implemented by the conservation community to maintain population connectivity across fragmented landscapes. Conservation practitioners also work to restore connectivity by removing barriers such as fences that impede movement (McRae et al., 2012).

Experimental or Quasi-experimental Design

For which species groups are corridors most effective and under what conditions? What scale of corridor is necessary for different groups to maintain ecological viability?

Systematic Literature Reviews

What are the development impacts of corridors (e.g., human-wildlife conflict, agriculture and nutrition, health)?

Water diversion: Fresh water constitutes less than 1 percent of the world's water supply but supports about 6 percent of all species (Dudgeon et al., 2006). Water flow modification is a primary threat to freshwater ecosystems. Water diversion for irrigation and industrial activities and use in urban areas threatens many freshwater species. Infrastructure development, such as dams and levees, also modifies water flows, causing river habitat fragmentation (Strayer & Dudgeon, 2010). For example, in Africa, which is the region with the lowest proportion of access to an improved water source in the world, water diversion due to infrastructure development is a leading threat to freshwater species, such as fish, mollusks, crabs and aquatic plants (IUCN, 2013). A synthesis of 165 studies on water diversion found that changes in flow are positively correlated with ecological change and changes in species diversity and abundance (Poff & Zimmerman, 2010).

3. Climate Change

Climate change presents direct and indirect threats to biodiversity through increased temperatures, more frequent and intense extreme weather events, and ocean acidification. Many terrestrial species are already experiencing the impacts of climate change; scientists have observed shifts in the migration and flowering patterns of some species. Climate change is also a significant threat to marine species. For example, decreased ocean pH caused by ocean acidification can impair the formation of skeletal structures, particularly among coral species (Anthony et al., 2008). Species that are particularly vulnerable to climate change include those that need temperature extremes for survival and those that cannot easily migrate (CBD, 2010b).

Clean energy: Clean energy programs implemented in response to climate change can have adverse effects on biodiversity. The development of renewable energy sources, such as solar and wind power, often involves building infrastructure and installing equipment, such as wind turbines and solar panels, which may have significant ecological footprints (de Lucas et al., 2012). In many developing countries, dams are also being built to meet growing energy needs. There are approximately one million dams worldwide; dams modify water flow and can be particularly harmful to freshwater species, such as fish, mollusks and reptiles (Strayer & Dudgeon, 2010).

Research question on climate change proposed by USAID Bureaus and Missions:

How can climate change data and models help identify habitats and species likely to be at risk in the short- to medium-term and design and implement effective adaptation plans?

Experimental or Quasi-experimental Design

What clean energy approaches are least harmful to biodiversity?

Literature Review

How do different strategies for growing and harvesting biomass or biofuel affect ecosystems and associated social and economic systems?

How can climate change data and models help identify habitats and species likely to be at risk in the short to medium term to design and implement effective adaptation plans?

Systematic Literature Review

How do the type, location and associated mitigation measures of renewable energy technologies affect biodiversity?

Extreme weather: Climate change is predicted to increase the frequency and severity of extreme weather events, such as fires, floods, heat waves and droughts, which can all have adverse effects on biodiversity. Many of the models that predict the impacts of climate change on biodiversity have focused on gradual warming trends; however, evidence suggests that extreme weather events can also be harmful to biodiversity. For example, a 10-week period of extreme warming along the west coast of Australia in 2011 resulted in reduced seaweed, which provides habitat for many marine species; changes were also observed in the composition of fish communities in the area (Wernberg et al., 2013).

Adaptation: Actions to adapt to climate change by human communities can have adverse effects on biodiversity. For example, communities that experience crop failure due to droughts may turn to the natural resource base to supply wild foods to make up for food shortages. Researchers in southern Malawi found that poorer households relied on forests to provide food and sources of cash during times of food shortage (Fisher et al., 2010). Relying on natural resources can lead to biodiversity loss through overharvesting and unsustainable use. Other adaptation actions that can adversely affect biodiversity include migration and infrastructure development, such as sea wall construction (Adger et al., 2003).

Longitudinal Study

How will human responses to climate change (e.g., changes in agriculture, resource conflicts and migration) affect biodiversity?

Trend Analysis with Case Studies

What are the consequences for biodiversity conservation and the delivery of ecosystem services if the goal of crop and livestock management is to reduce greenhouse gas (GHG) emissions?

Experimental or Quasi-experimental Design

Is a focus on small-scale diversification of livelihoods as a climate adaptation approach effective in conserving biodiversity?

Systematic Literature Review

What will the impacts of climate-driven human migration be on high biodiversity areas?

> **Ocean acidification:** Coral reef ecosystems are particularly rich in biodiversity. Corals are among the most threatened species globally, particularly due to ocean acidification. The oceans absorb carbon dioxide, which leads to ocean acidification. As carbon dioxide levels have increased in the last several decades due to human activities, ocean acidification has increased; the decrease in pH harms coral species by inhibiting their ability to absorb minerals that are critical to the formation of their skeletal structures (Anthony et al., 2008).

Literature Review

What ecological and economic changes will result from ocean acidification (in the Coral Triangle region)?

> **Changing seawater temperatures:** Increases in sea surface temperature pose a serious threat to marine biodiversity. The widespread and severe coral bleaching and mortality that occurred in the late 1990s has been linked to record high tropical sea surface temperatures and their steady increase over time (Reaser et al., 2000). It is unlikely that the frequency, geographic spread and intensity of coral bleaching is due to natural variability alone but more likely a result of global increases in temperature and anthropogenic pressures (Reaser et al., 2000). In addition to coral bleaching, sea surface temperature increases are associated with changes in the geographic distribution of fish species (Perry, 2005), the disturbance of plankton populations (Richardson, 2004), massive changes in pelagic biodiversity (Beaugrand, 2002) and the spread of invasive predator species (Zeidberg & Robison, 2007).

Illustrative operationalizable research question on climate change:

What is the role of livelihood diversification as a climate change adaptation strategy?

4. Pollution and Disease

Biodiversity is under threat from pollution (chemical contaminants and solid waste) and disease. Chemicals can leach or be discharged into the environment from fertilizer and pesticides or as a by-product of industrial processes, especially in developing countries where regulations may be less stringent. Once in the environment, these pollutants can persist for years. Diseases affecting wild species are also a concern for biodiversity, especially when they occur in species that face other simultaneous threats.

> **Diseases of wild species:** Infectious and noninfectious diseases are a significant threat to biodiversity and even can drive extinction. For example, chytridiomycosis, an emerging infectious disease, has led to the rapid population decline of many amphibian species globally. Central America has seen some of the most drastic declines in amphibian populations due to the disease (Lips et al., 2006). Other wildlife species that have been significantly affected by disease include the Tasmanian devil (facial tumor disease), bats (white nose disease), and Iberian lynx (feline leukemia). Several factors affect disease transmission, including population size of the host species, social behaviors and the ability of the pathogen to switch hosts (Joseph et al., 2013). Disease is a critical threat to species other than wildlife; chestnut blight, sudden oak death syndrome and Dutch elm disease are examples of wild plant diseases that have led to regional extinction, often with ecosystem-wide repercussions (Anderson et al., 2004).

System Dynamics Modeling

How will changes in land use and climate affect the prevalence and rates of transmission of diseases among wild animals?

Expert Working Group and Key Informant Interviews

How do we manage zoonotic diseases under different development paradigms?

> **Chemical pollutants:** Chemical pollutants, such as lead, mercury, dioxins, and pesticides, can be a significant threat to biodiversity. Health impacts associated with exposure to these pollutants include reproductive failure, depressed immune function leading to increased vulnerability to infectious diseases and cancer. Dichlorodiphenyltrichloroethane is an organochlorine pesticide found to interfere with eggshell formation in certain raptor species such as the American bald eagle and the peregrine falcon. The widespread use of the pesticide was one factor, plus habitat degradation and hunting, that contributed to the near-extinction of these species (Chivian & Bernstein, 2008).

Experimental or Quasi-experimental Design

With regard to the impacts of chemical pollutants on ecosystem degradation, are there tipping points for delivery of ecosystem services?

> **Eutrophication:** The effect of the widespread use of chemical fertilizers can result in eutrophication, which is a significant threat to marine and freshwater ecosystems. The use of agricultural fertilizers can lead to the accumulation of nitrogen and phosphorus in soil; from there, the chemicals migrate into rivers and streams where they concentrate in coastal areas. Algae species that thrive in these polluted waters reproduce rapidly, causing toxic blooms, also known as dead zones, that have harmful impacts on various fish and coral species. The number of dead zones globally has increased significantly over the past several decades (CBD, 2010a; Smith et al., 1999).

Experimental or Quasi-experimental Design

Does intensification of agriculture, particularly with fertilizer use, decrease overall food production for some communities due to its relationship with eutrophication?

> **Solid waste:** Solid waste, particularly in marine ecosystems, is a threat to biodiversity. The vast majority of consumer plastic products are not recycled, and about one million tons of these products end up in oceans annually. Ocean currents lead to the accumulation of debris in certain regions, and this debris harms marine species through entanglement, ingestion of plastic particles that can appear like food and direct toxicity. Ocean debris affects the survival of many marine wildlife species (Baulch & Perry, 2014; Derraik, 2002).

Illustrative operationalizable research question on pollution and disease:

How are patterns of zoonotic disease changing with development and ecosystem degradation?

5. War and Armed Conflict

Understanding the complex and multiscaled impacts of war and armed conflict on biodiversity is a priority research area in conservation biology (Sutherland et al. 2009). Violent conflict is associated with habitat loss and degradation, erosion, pollution and overexploitation of natural resources (McNeely, 2003). The overwhelming majority of contemporary armed conflicts have involved biodiversity hotspots (Hanson et al., 2009), and in some countries, armed strife is a primary driver of forest loss and wildlife exploitation (Velho, et al., 2014). On the other hand, by forcing resettlement, conflict can alleviate demographic pressures over natural resources and abandonment of productive land uses, which can result in reforestation (Dávalos, 2001; Stevens et al., 2011). Conflict can also create de facto buffer zones that prevent further exploitation and ecosystem degradation (Hanson et al., 2009). These benefits, however,

are generally short-lived and the overall effects of conflict on biodiversity are largely detrimental, not directly limited to conflict areas and can persist even after the end of hostilities (Hanson et al., 2009; McNeely, 2003). Further, environmental degradation can exacerbate social tensions and often contribute to future conflict (Hanson et al., 2009).

Ecosystem degradation and biodiversity loss: Conflict can impact biodiversity directly through military activities (e.g., habitat loss and mortality caused by landmines) and efforts to support the combating forces such as poaching or indirectly through the activities of newly displaced persons, such as refugees that are forced to settle in high biodiversity areas (McNeely, 2003), and the social shifts caused by conflict (e.g., weapon proliferation and emerging incentives for wildlife trafficking) (Loucks et al., 2009).

Weakened governance: Beyond direct impacts on ecosystems, conflict can adversely affect biodiversity because it threatens the sustainability of conservation efforts, shifts the focus of international aid away from the environment and weakens local institutions, which can prevent effective management and law enforcement (Hanson et al., 2009; Stevens et al., 2011). This decline of administrative capabilities can hinder post-conflict conservation and restoration efforts.

Research question on war and armed conflict proposed by USAID Bureaus and Missions:

What evidence exists comparing how post-conflict resettlement of areas mitigates or leads to conservation impacts (positive or negative)?

B. Drivers

1. Demographic

Demographic change is an important driver of biodiversity loss globally. In a recent study of 41 tropical countries, researchers found a positive correlation between urban population growth and deforestation. They surmised that urban and international markets for agricultural products resulted in increased industrial-scale agricultural production and higher rates of deforestation (DeFries et al., 2010). In a study using data from more than 100 countries, researchers found a positive association between human population growth and the percentage of threatened species. This study used models that did not account for important factors, such as forest cover, gross domestic product or land tenure issues (McKee et al., 2013). Displacement of human populations can also have major impacts on biodiversity. For example, conflicts and wars can result in large numbers of refugees moving into areas where they must rely on slash-and-burn agriculture and hunting of wildlife species to meet their basic needs (Chivian & Bernstein, 2008).

Research questions on demography proposed by USAID Bureaus and Missions:

1. What are best practices for addressing population pressure in key habitats?
2. Under what circumstances are economic incentives for re-settlement effective in reducing habitat degradation due to population pressure?

Experimental or Quasi-experimental Design

What is the correlation between unmet needs or demand for family planning and reproductive health and conservation impacts?

Longitudinal Study

How does access to health care impact biodiversity, and what are the effects at different spatial and temporal scales (e.g., the impacts of the President's Emergency Plan for AIDS Relief (PEPFAR) on land-use change)?

System Dynamics Modeling

What are the conservation impacts of improved access to education, employment, and reproductive choice?

Literature Review

What are best practices for addressing population pressure in key habitats?

2. Economic

Economic growth can result in the unsustainable use of natural resources and biodiversity loss. The increasingly globalized economy also significantly impacts biodiversity and natural habitats. International trade and demand for common products, such as coffee, tea, meat and fish, can drive species loss in developing countries. One recent analysis found that international trade was responsible for 30 percent of global threats to animal species (Lenzen et al., 2012).

Trend Analysis

Does broad-based economic growth focused on equitable distribution yield better outcomes for biodiversity than free-market approaches?

3. Sociopolitical Conditions

The sociopolitical conditions in a given context are inextricably linked to the way natural resources are used. For example, formal policies and regulations related to economic development and land use have significant impacts on the environment and can be major drivers of deforestation, resource extraction and infrastructure development. Property rights, particularly related to land tenure arrangements, also have a major influence on how natural resources are used. The climate in which policies and laws are enacted also significantly impacts the environment. For example, corruption and mismanagement can result in ecosystem degradation and biodiversity loss, even with a strong regulatory framework (Geist & Lambin, 2002).

4. Technological Change

Technological advances in recent years, while having made significant contributions to global development, can also lead to ecosystem degradation and biodiversity loss. For example, advances in the agricultural sector have led to expansion and intensification of agricultural lands, which can cause adverse effects on ecosystems resulting from conversion of natural habitats and eutrophication (Geist & Lambin, 2002). Natural resource extraction also has been aided by technology. For example, modern fishing methods, such as bottom trawling, can lead to unsustainable fish harvesting and are a significant threat to marine ecosystems (CBD, 2010a).

Research question on science and technology proposed by USAID Bureaus and Missions:

What are the impacts of hydropower proliferation and activities related to extractive industries on species viability and land cover fragmentation?

Literature Review

How can the shift to biochar as a strategy for carbon sequestration affect land cover and species richness?

Experimental or Quasi-experimental Design

What is the impact of the proliferation of hydropower in the Andean Amazon on species viability and land cover fragmentation?

Expert Working Group and Key Informant Interviews

How can mobile-sensing technologies contribute to biodiversity monitoring (e.g., camera traps to sense wildlife, ground-truthing of remotely sensed data or sound recognition of bird calls)?

5. Cultural and Religious

Culture and religion can be influential in shaping public attitudes toward the natural environment. The cultural services that intact ecosystems provide, including areas for recreational activities, places of spiritual significance and aesthetically pleasing landscapes and seascapes, play an important role in human well-being. The value of these services, however, is not well understood and is difficult to quantify and appreciate. The conservation community is recognizing that religious leaders could play an important role in shaping the public's perceptions of the natural environment. Researchers investigating the spatial overlap between the world's religions and biodiversity priority areas have concluded that while these areas overlap among the world's major religions, the Roman Catholic and Christian Orthodox churches have the best opportunity per capita to influence attitudes toward biodiversity (Mikusinski et al., 2013).

Research questions on culture and religion proposed by USAID Bureaus and Missions:

1. How does post-conflict resettlement of areas mitigate or lead to positive or negative conservation impacts?
2. To what degree does the protection of sacred sites generate conflict as indigenous, traditional and other users seek access to or control over these sites?
3. How effective are the available designations of protection (e.g., UNESCO World Heritage Sites) at conserving and avoiding conflict over religiously important areas when they coincide with high biodiversity value?

Expert Working Group and Key Informant Interviews

How effective are the available designations of protection (e.g., UNESCO World Heritage Sites) at conserving and avoiding conflict over religiously important areas when they coincide with high biodiversity value?

6. Unsound Development

Unsound economic growth and development can affect the rate of biodiversity loss due to the unsustainable use and exploitation of natural resources. The lack of development also has the potential to increase pressure on natural resources to meet basic needs (Jha & Bawa, 2006). Proponents of the environmental Kuznets curve hypothesis have argued that economic growth will reduce environmental impacts due to the development of more environmentally friendly modes of production. Time series analyses of fish catch and trends in marine biodiversity from 102 nations spanning the period 1960 to 2003 illustrate that marine biodiversity decreased with economic growth, urbanization and population size, a decline that is partially associated with the ability to make bigger catches (Blackman & Rivera, 2011). Time series analyses of average population growth rates; human development measured by income, health, and education; and deforestation rates for countries with biodiversity hotspots illustrate diverse contexts where development can be correlated with biodiversity loss. Thus, regardless of the level of human development, policies that fail to account for conservation can become drivers of biodiversity loss (Jha & Bawa, 2006).

Research questions proposed by USAID Bureaus and Missions on unsound development:

1. Does rigorous application of the Extractive Industries Transparency Initiative standards mitigates or avoids negative social and environmental impacts?
2. As areas move from coca and narcotics economies to green-based economies and civil war or conflict scenarios, do different governance approaches or conservation approaches lead to greater conservation achievements (or, at least, less destruction of biodiverse habitats)?

Experimental or Quasi-experimental Design

What are the impacts of Feed the Future on biodiversity?

Case Studies (Qualitative)

Does rigorous application of the Extractive Industries Transparency Initiative standards mitigates or avoids negative social and environmental impacts?

Literature Review

Which lessons learned from studies of agrarian change can lead to improved conservation practices?

Illustrative operationalizable research question on drivers of biodiversity loss:

How can advancements in remote sensing technology be harnessed to combat wildlife trafficking?

III. Integrate Conservation and Development for Improved Biodiversity and Development Outcomes

Biodiversity underpins the ecosystem goods and services that constitute the foundation for sustainable development. Functioning ecosystems provide basic necessities for human communities and include food, clean water, natural medicines, and fuel. They also provide services, such as pollination, protection from natural disasters, and disease regulation that are critical to maintain human health and well-being. One recent study found that conserving just 25 percent of the highest biodiversity areas globally could provide about half of the ecosystem services on which the world's poor depend (Turner et al., 2012).

Investments in conservation also can yield co-benefits for development that extend beyond the provision of basic goods and services. These co-benefits of biodiversity programming include the diversification of livelihoods, empowerment of local communities, promotion of gender equality and increased government transparency and accountability. For example, investment in Namibia's community-based conservancies increased wildlife populations, which led to increased revenue from tourism and sustainable use for more than 250,000 people. This revenue, in turn, has been invested to meet community development needs (Weaver & Peterson, 2008).

Biodiversity loss and ecosystem degradation can also threaten and even reverse development gains. For example, a 4 percent change in forest cover in the Brazilian Amazon caused by deforestation resulted in a 48 percent increase in the incidence of malaria locally (Olson et al., 2010). Malaria is one of the leading causes of death among children in developing countries, especially in Sub Saharan Africa. Thus, deforestation may threaten the gains that the global health community has made in combating this deadly disease.

Research questions that focus on strengthening the evidence base for biodiversity conservation and development integration cover a range of sub-themes, such as health, nutrition, food security, sustainable agriculture, natural disasters, climate change adaptation, livelihoods and poverty alleviation.

A. Global Climate Change

Biodiversity and climate change are interconnected: changes in the climate can impact biodiversity and the state of biodiversity can also affect the climate. For example, climate change is threatening species, such as the polar bear in the Arctic, and whole ecosystems, such as Southeast Asia's coral reefs. A recent study confirmed that anthropogenic climate change is a key threat to global biodiversity (Maclean & Wilson, 2011). Conversely, biodiversity can play a role in climate change mitigation and adaptation; forests and mangroves can alleviate the impact of extreme weather events on affected communities, and intact ecosystems can contribute to permanent carbon sinks (Secretariat of the Convention on Biological Diversity, 2009).

Adaptation: Adaptation policies aim to enhance the resilience of people and ecosystems to withstand and recover from climate change impacts (Murdiyarso et al., 2005). Ecosystem-based approaches to climate change adaptation are often expected to promote the sustainable use of ecosystem goods and services and the conservation of biodiversity while producing socioeconomic and cultural benefits. Maintenance and restoration of mangroves and other coastal wetlands can decrease the impact of coastal flooding and erosion on local communities and contribute to the conservation of habitats and species. In a similar situation, investing in diverse agroforestry systems can contribute to carbon sequestration while decreasing carbon emissions from best management practices and complementing the sustainable management of forests. Climate change adaptation activities, however, can have adverse effects on biodiversity conservation. For example, sea walls potentially can disturb tidal and sediment flows (Secretariat of the Convention on Biological Diversity, 2009).

Experimental or Quasi-experimental Design

Regarding adaptation approaches to climate change, what are the benefits of an ecosystem-based approach compared with a traditional approach?

Economic Valuation Analysis with Impact Analysis

If there are benefits to an ecosystem-based adaptation approach, what is the economic value of these benefits?

Review of Programmatic Documents and Key Informant Interviews

Does diversification of livelihoods for climate change adaptation address degradation and leakage?

Cross-sectional Statistical Analysis

How is climate migration impacted by the integrity of the ecosystems in the areas from which people migrate?

Mitigation: More than two-thirds of the increase in global GHGs since pre-industrial times has occurred in the last four decades. To protect against expected future increases in GHG emissions, mitigation policies and measures are required to reduce GHG emissions and increase carbon sinks. The sustainable management of forests and reduction in deforestation and forest degradation can help achieve the objectives of global climate change mitigation and biodiversity conservation (Reid & Huq, 2005; United Nations Framework Convention on Climate Change, 2013).

Systematic Literature Review

How do the benefits of intact ecosystems, such as biodiversity and genetic variability, help mitigate the effects of climate change on food security, water quality and quantity and fisheries?

Clean energy: Wind, solar, tidal, biomass and hydropower are some clean energy alternatives to fossil fuel energy. While clean energy alternatives can reduce GHG emissions, they also may cause negative consequences for biodiversity. For example, first generation biofuels, which require the use of food crops for liquid fuels, can increase the rate of changes in land use, including deforestation (Secretariat of the Convention on Biological Diversity, 2009).

Resilience: The resilience of ecosystems is intertwined with that of human communities. For example, chronic overfishing of coral reefs degrades their regenerative structure, thus reducing their resilience to withstand natural disturbances; this increases the vulnerability of coastal communities to the impacts of natural disasters. Coral mining and mangrove deforestation have reduced the resilience of local communities to rebound from economic impacts of extreme climate events, such as tsunamis, because of the loss of traditional livelihoods. Understanding the key intersections of human and ecological resilience is essential for developing integrated programs that build resilience and enhance adaptive capacities (Adger et al., 2005).

Systems Dynamics Modeling

To what extent does climate change variability impact the resilience of a resource (e.g., a biodiverse system can help provide resilience to climate change and also be impacted by it)?

Case Studies (Qualitative)

Is an area with greater biodiversity more resilient to climate change?

> **Natural disaster mitigation:** Healthy coastal wetlands, including mangroves and coral reefs, can protect coastal communities from extreme weather events, such as storm surges and high winds associated with cyclones (Das & Vincent, 2009). Coral bleaching damages the structure of coral reefs, thus reducing their ability to physically protect coastal communities from waves and provide essential habitat for the fish that are crucial to local livelihoods. Reducing the risks of such natural hazards and decreasing vulnerability of poor, coastal populations requires balancing short-term needs, such as food security and water provision, with longer-term needs, such as protection from natural disasters (Ingram et al., 2006). For example, intact forests are important in preventing landslides and soil erosion from heavy rainfall; in southern India, researchers found increased frequency and intensity of landslides in areas that had undergone deforestation for the development of tea estates (Kumar & Bhagavanulu, 2008). Investing in the protection of green infrastructure is a cost-effective strategy for natural disaster mitigation that can potentially generate socioeconomic benefits for local communities, such as providing food and livelihoods (Secretariat of the Convention on Biological Diversity, 2009).

Cross-sectional Statistical Analysis

What are the key intersections of human and natural vulnerability and resilience in the context of climate change adaptation in biodiverse areas?

Experimental or Quasi-experimental Design

Does enhancing the resilience of people to adapt to climate change impact the resilience of other systems?

Systematic Literature Review

How do forests, coastal vegetation, native grasses, and wetlands help to mitigate (floods, fire, etc.)?

Illustrative operationalizable research question on climate change:

What are good practices for the integration of climate change into corridor planning?

B. Food Security

Ecosystem goods and services provided by intact habitats can contribute to the food security of local communities, especially poor and rural households, which are more likely to be dependent on ecosystem services for livelihoods and as a source of nourishment. Fish is a significant source of protein for more than 2.5 billion people globally (Brunner et al., 2009). Literature has documented the benefits of biodiversity conservation for food security. For example, in Malawi, a net loss of forest cover was associated with a lower likelihood of a child having a diverse diet (Johnson et al., 2013). A study of marine protected areas in the Philippines illustrates the importance of such areas for food security among fishing communities (Mascia et al., 2010).

> **Agricultural intensification:** Demographic growth and developments in modern agriculture, among other factors, have contributed to the degradation and loss of species and key habitats. It is believed that agricultural intensification—harnessing technology to produce more on less land—can achieve desired development outcomes in an environmentally sustainable fashion, namely food security and social equity, with less harmful impacts on biodiversity (USAID, 2011b); however, the effectiveness of agricultural intensification as a biodiversity conservation strategy is under debate (Edwards et al., 2014; Mendenhall et al., 2013; Phalan et al., 2011).

Experimental or Quasi-experimental Design

Does agricultural intensification reduce deforestation and land conversion?

Wild foods: Wild foods may contribute to food security, particularly among the rural poor and other vulnerable populations. In two rural areas in South Africa, households affected by AIDS through recent morbidity, mortality or orphan fostering are more likely to depend on wild foods (Kaschula, 2008). In these areas, households with access to wild foods are more likely to be economically resilient (Kaschula, 2008). In rural and landless populations in Asia, Africa and Latin America, wild meats are an important source of protein (Rao & McGowan, 2002) and also an important source of income. The economic value of wild meat harvesting in the Amazon Basin alone is greater than $175 million per year. The demand for wild meat, however, could increase local and global rates of extinction through legal and illegal harvesting (Rao & McGowan, 2002).

Pollination: Wild pollinators play an important role in the food supply system, but pesticide and herbicide use and habitat fragmentation contribute to their decline. In the early 1990s, honeybee colonies in North America dropped to their lowest levels in 50 years. Increased education and training of the general public, farmers, and resource managers can raise awareness of the critical ecological services provided by pollinators and build capacities for more responsible management that protects habitats and populations of pollen-vectoring animals and nectar-producing plants (Gordon et al., 1998).

Value of natural resources management to agriculture: The success of farming systems depends on the availability of natural resources, such as fertile soil and adequate quantities of water; however, gains in agricultural productivity sometimes contribute to the unsustainable use of these resources. More sustainable management of natural resources can improve the productivity of agro-economic systems while conserving habitats and species by reducing land degradation and improving soil and water management (World Bank, 2013).

Experimental or Quasi-experimental Design

How can increasing crop and non-crop biodiversity help in pest and disease management?

Sustainable agriculture: Sustainable agriculture is an effective strategy for lowering deforestation, one of the key drivers of biodiversity loss in tropical areas; however, a comparison of sustainable agriculture users and nonusers in Guatemala and Mexico found that under some conditions, sustainable agriculture might be associated with greater agricultural expansion and, accordingly, more deforestation (Margoluis et al., 2001). Although sustainable agriculture and with other land-use management activities may contribute to biodiversity conservation and climate change adaptation and mitigation (Secretariat of the Convention on Biological Diversity, 2009), additional research is needed to determine how this approach may be effective.

Experimental or Quasi-experimental Design

What is the contribution of wild foods to food security generally, and for rural and extreme poor populations specifically? What is the value (economic, health) of this contribution?

Economic Valuation Analysis

How can the value of inputs from natural resources management that impact agricultural productivity, such as water quality and quantity and soil fertility be captured?

Illustrative operationalizable research questions on food security:

1. [Where] is food diversity as or more important than bio-fortification?
2. How can we develop incentives for the sustainable management of biodiverse areas to mitigate against food scarcity?

C. Health

Research shows important linkages between the state of ecosystems and public health issues, such as malnutrition and communicable diseases. Intact ecosystems are critically important in providing food, clean water and natural medicines that human communities rely on for their well-being; they also provide protection from natural disasters, regulate disease and support agriculture (Dobson et al., 2006). Ecosystem degradation threatens the continued supply of these services. This decline in ecosystem services has a disproportionate impact on the world's poor, who rely most on natural resources to meet basic needs (MEA, 2005).

Vector-borne disease: Factors that influence the transmission of vector-borne diseases, such as Lyme disease, malaria and West Nile virus, include direct human contact with previously unknown pathogens through interactions with wildlife, changes in microclimate that are more favorable to vectors and alternations in species composition in an ecosystem (Ostfeld, 2009). For example, the risk of Lyme disease transmission decreases in areas of high biodiversity due to the presence of species that serve as incompetent hosts to the tick vector that transmits the disease; this is referred to as the dilution effect (Ostfeld & Keesing, 2001). The positive association between deforestation and increased risk of malaria transmission in the Brazilian Amazon is thought to be related to changes in land cover from deforestation that create conditions more favorable for the mosquito vector that transmits the disease (Olson et al., 2010).

Nutrition: Intact ecosystems provide essential services to support agriculture, such as pollination, soil formation and nutrient cycling. Furthermore, natural systems also provide a variety of wild foods such as fish, animals, fruits and vegetables that more than 1 billion people worldwide rely on as part of their daily diets. Ecosystem degradation can cause malnutrition by compromising food production and decreasing the availability of wild foods. The world's poor, who are heavily dependent on the natural resource base to meet their basic nutritional needs, are particularly vulnerable to the impacts of ecosystem degradation (Richardson, 2010).

Case Studies (Qualitative)

How do aquatic conservation policies directly or indirectly affect human health?

Experimental or Quasi-experimental Design

Does ecosystem degradation result in reversals of global health gains?

Literature Review with Statistical Modeling

What is the role of medicinal plants in determining human health outcomes?

Water-borne disease: Intact ecosystems, particularly forests, play an important role in maintaining water availability and quality for human communities by decreasing soil erosion, regulating local climate, storing rainfall and reducing storm-flow. Ecosystem degradation can compromise both water availability and quality, leading to increased risk of water-borne diseases, such as infectious diarrhea. For example, researchers found that the risk of diarrhea in young children in Malawi decreased as forest cover increased (Johnson et al., 2013). In Indonesia, researchers found a positive correlation between watershed protection and increased availability of water to downstream communities (Pattanayak & Wendland, 2007).

Zoonotic disease: Zoonoses are infectious diseases that are shared by wildlife, livestock and humans. Research links ecosystem degradation and biodiversity loss with the emergence of zoonotic diseases (Ostfeld, 2009). Degradation of natural systems can lead to new contact between species that may result in the transmission of a pathogen between species. For example, the Nipah virus, which causes encephalitis in humans, was transmitted from fruit bats to pigs to humans. The degradation of their native forests prompted the bats to seek out food in fruit orchards, which were adjacent to pig farms; the virus was transmitted from bats to pigs and from pigs to humans. Hantavirus, which causes a severe pulmonary infection in adults, is transmitted to humans from rodents, and the risk of transmission increases in areas with decreased mammalian biodiversity (Suzan et al., 2009). Ebola virus infection, which has caused devastating effects on human

populations throughout West Africa, is believed to have a bat species as its natural reservoir (Biek et al., 2006) and to spill over to humans through contact with wildlife through bushmeat processing and trade (Monath, 1999).

System Dynamics Modeling

What is the role of deforestation on patterns of zoonotic disease transmission?

Illustrative operationalizable research question on health:

How does poor health impact biodiversity at the individual level (e.g., liquidation of natural capital to meet health care expenses) and community level?

D. Economic Growth

Intact ecosystems provide services that serve as the foundation for sustained economic growth. Depletion of ecosystems can cause the loss of natural capital, which can impede economic development. The sustainable management of natural resources can ensure provision of ecosystem services that are critically important to economic development.

Ecotourism: Ecotourism focuses on working with local communities to conserve biodiversity and promote economic growth through the development of sustainable tourism projects. When these projects are well implemented, ecotourism offers an opportunity to safeguard biodiversity and support economic development. For example, members of the Maasai community in Kenya participated in an ecotourism project to establish the Il'Ngwesi Ecolodge, which has resulted in decreased poaching in the area and increased wildlife populations and economic benefits, including funding for the local school. Poorly planned, implemented or managed ecotourism projects, however, can result in worsening ecosystem degradation and no tangible benefits for local communities (Tallis et al., 2008).

Systematic Literature Review

Under what conditions do enterprise approaches to conservation such as ecotourism benefit biodiversity?

Poverty alleviation: More than 1 billion people worldwide are estimated to live on less than $1.25 a day (World Bank, 2012). The world's poorest people, particularly the rural poor, are disproportionately impacted by biodiversity loss and the decline in ecosystem services. Biodiversity and functioning ecosystems are critical to underpinning the ecosystem goods and services that the poor depend on, such as wild foods, clean water, pollination and soil fertility. Researchers found that the benefits of ecosystem services provided by priority habitats exceeded $1 per day for more than 300 million of the world's poorest people. Furthermore, they concluded that the benefits of conserving these priority habitats are three-fold greater than the costs of protecting them (Turner et al., 2012).

Literature Review

Is minor forest production (e.g., beekeeping) or community forestry a poverty trap?

Green growth: Green growth focuses on fostering economic development in a sustainable manner that ensures that natural resources are protected and preserved. The conservation of biodiversity is critical to green growth. Balancing economic development with the protection of ecosystems can be difficult. For example, the growth of the agricultural sector and the biofuels industry in Brazil has caused increased deforestation. Recent trends, such as commodity markets that are demanding less environmentally destructive products, and emerging carbon markets can provide incentives for countries to implement economic development plans that are more compatible with green growth (Nepstad et al., 2008).

Fisheries: Fish is a significant source of protein for more than 2.5 billion people globally; tens of millions of people are also dependent on fisheries for their livelihoods (Brunner et al., 2009). Coral reef fisheries generate an estimated $30 billion in benefits annually by providing fish, serving as settings for tourism and providing protection from extreme weather. Fisheries all over the world are being degraded due to threats such as overfishing, pollution and habitat degradation. Marine protected areas are being implemented by conservation practitioners as a tool for dealing with fisheries decline. Their effectiveness, however, has not been consistent and depends on enabling conditions in the local context (Nagelkerken et al., 2012).

Timber and non-timber forest product (NTFP)-based livelihoods: Millions of people build their livelihoods around the natural resources forests provide; however, timber and NTFP harvesting has reached unsustainable rates in many regions. For example, harvesting wood for pulp and paper production has tripled over the last several decades, leading to higher deforestation rates in some regions (MEA, 2005). Fuelwood and charcoal provide household energy for more than 2 billion people worldwide, and the sale of these products is an important source of income. In Africa, unsustainable wood harvesting has resulted in local shortages, with rural populations having to spend more time to travel farther to collect wood (MEA, 2005; Yadama et al., 2012). The unsustainable use of timber and NTFPs threatens the livelihoods and economic stability of millions of people, particularly the world's poor who most directly depend on natural resources.

Illustrative operationalizable research question on economic growth:

There are many programs that assume that changing livelihoods (e.g., ecotourism, beekeeping, and timber products) will have a positive impact on biodiversity conservation. Does the economic incentive approach work? How do different categories of people react to different incentives?

E. Democracy, Rights and Governance

Biodiversity conservation programs can have development co-benefits that result in better governance, improved resource rights and democratization. Biodiversity conservation actions and interventions can empower local communities, promote gender equality, increase government transparency and accountability and contribute to peace and security. For example, creating enabling conditions for conservation might require working with civil society groups to bring about institutional change and address poor governance, resulting in strengthened civil society (Rands et al., 2010).

Democratization as a co-benefit: Conservation practitioners are increasingly implementing participatory, community-based natural resource management in a variety of settings. Successful decentralization requires that local communities and institutions are adequately empowered and fully participate in all aspects of decision-making and management, including rule making, implementation and enforcement. Effective decentralization may create more democratic local institutions and empower civil society; however, it also may be poorly coordinated for local management of natural resources (WRI, 2002). Analysis from western Uganda found that although national legislation supports decentralization, confusion exists among local communities about access to and use of forests and wetlands in the region due to the inadequate dissemination of pertinent information, which has resulted in continued degradation of these resources (Hartter & Ryan, 2010).

Experimental or Quasi-experimental Design

To what extent does community-based natural resource management result in improved civil society building at the grass-roots level and better governance, as well as advocacy for the rights of indigenous people and women?

Cross-sectional Statistical Analysis

Are women who participate in community-based natural resource management (CBNRM) groups more empowered within their households, for example, their decision-making power, compared with women who do not participate? How does CBNRM enhance women's rights?

Case Studies (Qualitative)

Do degraded ecosystems result in increased human demand for more sustainable natural resources management?

Illustrative operationalizable research question on democracy, rights and governance:

Do increased rule of law and anti-corruption initiatives contribute to biodiversity conservation? Are there spillover effects from enforcement into other sectors?

F. Water

As an essential resource that sustains all living organisms, water underpins every facet of human development and biodiversity. The quantity, quality and timing of water availability affect human health and well-being, the productivity of natural and cultured systems, food security and the viability of economic ventures. Despite the vital importance of water, much of the globe has inadequate access to sufficient water quality and quantity at the appropriate times, and thus suffers from water-related diseases, droughts and floods. Ecosystems, such as wetlands, mangrove forests and coral reefs, can help mitigate floods and droughts and reduce impacts from extreme weather events and storm surges. Extreme water stress conditions will increase over the next decade in some regions of the world (FAO, 2012; Watkins, 2006). Lack of water in natural ecosystems can reduce the availability of food and water for consumption, but it also can undermine the functionality of other ecosystem services, such as protection from natural disasters, regulation of climate and provision of non-timber forest products. The U.S. Government, including USAID's Water Strategy, recognizes water insecurity as a threat to human health in the next decade and as a driver of conflict that increases the risk of regional instability and state failure and jeopardizes peace and security (Intelligence Community Assessment, 2012). Transboundary water resource management is an effective approach to enhancing cooperation and regional peace, thus reducing potential conflicts.

Water quality: Water quality is adversely impacted by industrial and municipal effluent, agricultural pollution, untreated human waste, poor watershed management, saltwater intrusion and mineral leaching (United Nations Environment Programme, 2012). Poor water quality can pose risks to human health and industry and require costly advanced treatment technology. Contaminated water supplies also harm natural ecosystems and reduce ecosystem functionality and productivity. For example, industrial and agricultural wastewaters can increase eutrophication and dead zones in oceans and freshwater sources, which harms fisheries (United Nations Environment Programme, 2012). The services of natural ecosystems, such as forests and wetlands, can, however, be leveraged to improve water quality and reduce water treatment technology needs (United Nations Environment Programme, 2012).

Water quantity: Given the importance of water to human survival, limited water supplies contribute to competition throughout the world and could create political instability for countries in the future (USAID, 2013). Fresh water access has major implications for food security because agriculture consumes 70 percent of global freshwater resources, and food demands are expected to increase by 70 percent by 2050 (World Water Assessment Programme, 2012). Demands for industrial use are growing and will compete with water use for agricultural purposes. Natural ecosystems can impact water quantities and storage capacity, and should, therefore, be considered in any development planning that involves water resources management. For example, forests regulate humidity and precipitation, while wetlands and soils can regulate the extremes of droughts and floods (United Nations Environment Programme, 2012).

Timing of water availability: The timing of water available to ecosystems and people is traditionally determined by seasonal fluctuations and weather patterns. The development of reservoirs and dams has altered many natural flows, thus impacting natural processes. Climate change is expected to alter the timing of water in many regions of the world, impacting nature and people. Now, more agricultural losses occur from floods (when quantity is too high) than droughts (when quantity is too low). Many small-holder farmers around the world depend on rain-fed agriculture for sustenance and income. Global climate change is causing changes to weather patterns and an increase in severe weather events. Farmers are, subsequently, more often faced with drought, flooding and unpredictable rainfall, which compromise their crop yields. Many small-scale fishers depend on the natural life-cycles of fish and their migratory patterns, which can be disrupted by the timing of flows from dams or climate change. Furthermore, rapid glacier melt and decreased snowpack are increasing the variability and dynamics of stream flows, which affect the timing and ultimate amount of water supplies available (USAID, 2013). The trend toward changes in the timing of environmental flows, flooding and drought also adversely impacts ecosystems by altering spawning times, lifecycles and habitats. Extreme weather events can also increase erosion, chemical and sedimentary runoff and the desiccation of soils, which harms human livelihoods and natural ecosystems (USAID, 2013).

System Dynamics Modeling

How has disruption of environmental flows (such as through unsound development and operation of dams and water withdrawals) threatened downstream ecosystems and vital ecosystem goods and services to humans?

Cross-sectional Statistical Analysis

How can natural infrastructure, such as mangrove forests along coasts and wetlands and forests in upper watersheds, mitigate the impacts of floods, droughts, cyclones and storm surge?

Illustrative operationalizable research questions on water:

1. How can freshwater biodiversity and ecosystem service values best be incorporated in the design of water-provisioning schemes for direct human use and food production?
2. How do different agricultural practices and technologies affect water availability and quality?

PART FOUR: IMPLEMENTATION APPROACHES

Research under the BDRA is essential to meet the Agency's biodiversity conservation goals. Implementing research under the BDRA may involve engaging current mechanisms and leveraging existing resources in the Agency and forging effective partnerships with a variety of external institutions in developed and developing countries. USAID Missions will be integral in addressing priority research questions in the field.

I. Participation in Collaborative Partnerships

USAID has successfully participated in collaborative partnerships to meet its development goals while building capacity in developing countries. Research under the BDRA may involve strategic partnerships with different types of institutions, including universities, other U.S. Government agencies, conservation NGOs and multilateral organizations. This will allow the Agency to tap into a range of resources, knowledge and innovations across sectors. Engaging in results-driven collaborative partnerships that leverage the relative strengths of each institution will be a prime modality for implementing research under the Agenda.

A. Universities and Research Institutions

USAID works with universities and research institutions to harness their intellectual and capacity building expertise. These institutions bring a wealth of technical knowledge, regional expertise and unique perspectives. Working with local and regional universities and research institutions to enhance their capacities to receive external funding and meet USAID standard provisions can foster improved partnerships. These partnerships contribute significantly to USAID's capacity building mandate while advancing the scientific and technical knowledge base that is crucial to social, economic and political development.

USAID's E3/Forestry and Biodiversity Office and Missions have successfully partnered with universities and research institutions that help to meet the Agency's biodiversity goals while building capacity in partner countries. For example, the Indonesia Mission supported the Smithsonian Institution, Udayana University, Diponegoro University, the State University of Papua and the University of California, Los Angeles, to create the Indonesian Biodiversity Research Center[2] in 2010. The goal of the collaboration is to promote biodiversity research and build scientific capacity in the country.

The Agency also works with the Center for International Forestry Research (CIFOR)[3] on sustainable use of forests, best practices for forest restoration and the trade-offs of REDD+ in Asia.

B. Interagency Collaboration

USAID has successful collaborations with interagency partners, including the National Aeronautics and Space Administration (NASA), National Science Foundation (NSF), National Institutes of Health (NIH), Smithsonian Institution, United States Department of Agriculture (USDA), United States Geological Survey (USGS) and the Centers for Disease Control and Prevention to implement priority initiatives, such as Feed the Future, PEPFAR and the Global Climate Change Initiative.

These partnerships bring to USAID a whole-of-government approach that capitalizes on areas of expertise in other agencies to increase the overall effectiveness of programs. For example, the Partnerships for Enhanced Engagement in Research (PEER) science program is a joint research initiative between USAID and six other U.S. Government research and technical agencies, explicitly designed to address development challenges such as biodiversity loss, climate change and forest and watershed resource management. PEER leverages investments that other agencies are making in scientific

[2] http://www.ibrcbali.org
[3] http://www.cifor.org/donors-and-partners/featured-donor.html

research, technological applications and training that broaden USAID's reach and capacity to use science and technology to address global development challenges.

C. Bilateral and Multilateral Organizations

Bilateral and multilateral organizations, such as the United Kingdom's Department for International Development, Japan's International Cooperation Agency and the United Nations Development Programme have knowledge and experience in addressing development challenges. USAID works with these organizations in regions where the Agency is active. For example, the Agency has partnered with Japan's International Cooperation Agency in the Philippines on a program that supports water and sanitation programs. At a global level, USAID worked with the Group of Eight to establish a new global partnership among donors, the private sector and developing country governments. This partnership, the New Alliance for Food Security and Nutrition, seeks to bring 50 million people out of poverty in the next decade. The Agency's response to natural disasters and humanitarian crises often involves close coordination with a number of bilateral and multilateral organizations, particularly in countries or regions where these organizations may have a comparative advantage.

The BDRA may draw on these relationships with bilateral and multilateral organizations to identify synergies in research interests and goals. Through these partnerships, USAID can leverage the resources, expertise and comparative advantages provided by these organizations to optimize implementation of research under the Agenda. For example, in countries where one of these organizations might have a stronger relationship with partner-country institutions like universities, working in partnership could allow USAID to leverage knowledge, expertise and resources that might have been unavailable otherwise.

D. Nongovernmental Organizations

USAID has long relied on partnerships with NGOs to accomplish its development goals by capitalizing on their experience, knowledge and capacity. Biodiversity conservation NGOs are important partners in implementing programs supported by the FAB Office and Missions in the countries and regions that receive biodiversity funding. They bring a range of expertise that the Agency has relied on to meet its biodiversity and development goals, including working with communities to promote educational and training programs, provide training and capacity building to their local partners, strengthening civil society and increasing participation of women in biodiversity programs.

Partnering with NGOs may be a critical element in implementing the BDRA. These organizations often have strong science programs that take on research on key topics. In many situations, conservation NGOs have worked in a landscape or seascape or region for decades and have collected data and other information that may be useful for research efforts.

The Biodiversity Support Program (BSP), which was a consortium of the World Wildlife Fund, the Nature Conservancy and World Resources Institute in the 1990s, served in an intermediary grant-making capacity and provided technical support and capacity building for biodiversity conservation efforts in the tropics. BSP also undertook research efforts, such as the Biodiversity Conservation Network, a 10-year program that investigated the conditions governing enterprise-based approaches to conservation, such as ecotourism or NTFP harvesting, and what they can contribute to biodiversity and human development.

For the last seven years the Bureau for Africa has built on that experience and supported the Africa Biodiversity Collaborative Group (ABCG), a coalition of the major U.S. international conservation NGOs with field activities in Africa. The ABCG includes African Wildlife Foundation, Conservation International, the Jane Goodall Institute, the Nature Conservancy, Wildlife Conservation Society, World Resources Institute and the World Wildlife Fund. The ABCG provides program planning, implementation, evaluation and knowledge management and outreach support to biodiversity conservation programs in Africa.

Finally, NGOs often forge strong relationships with local communities, government institutions, universities and research institutions that can be valuable when implementing research projects.

E. Other Donors

Private foundations, such as the Rockefeller Foundation, the Bill and Melinda Gates Foundation and the Gordon and Betty Moore Foundation, have played an increasingly important role in funding development initiatives, collectively contributing billions of dollars annually toward these initiatives. Foundations have certain advantages and flexibility in their programming compared with traditional government agencies because they do not have to contend with issues such as public budgeting rules and political cycles; this may allow them to be more innovative and have a longer-term view with their programs.

USAID collaborates with many of these private foundations on a full range of development projects that capitalize on these comparative advantages. Implementing the BDRA may involve collaborations with traditional biodiversity conservation funders, such as the Rockefeller Foundation and the Gordon and Betty Moore Foundation in the appropriate settings, and working with the Consultative Group on Biological Diversity (CGBD). USAID was a founding member of this group, which is a member-lead organization that focuses on strategic grant-making on environmental issues. USAID should also explore opportunities to work on cross-sectoral research projects with funders like the Gates Foundation that focus on other sectors like health and food security.

F. The Private Sector

Biodiversity is essential to many industries. Kerry ten Kate and Sarah A. Laird's book, The Commercial Use of Biodiversity, is an invaluable resource on regulations, markets, benefit-sharing and research related to private-sector investment in biodiversity sectors such as botanicals, pharmaceuticals and seeds.

The private sector represents a tremendous resource for research partnerships and the dissemination and use of research findings. USAID has numerous private-sector partnerships; a few sectors of interest to the biodiversity community include ecotourism, extractive industry, tree crops, geospatial information systems and data management.

Private-sector research is largely driven by competitive forces, the need to constantly improve products and consumer experience. As such, a key consideration for working with the private sector is clarity about what is and is not proprietary information. Proprietary information is anything that a company would not want to share with competitors. An example of research that would likely not be proprietary is data from biodiversity surveys supported by a mining company as part of its due diligence or corporate social responsibility program. An example of proprietary information would be data on pharmaceutical properties of samples legally derived from bioprospecting. As the U.S. Government increasingly commits to open data, it is crucial to have legal experts scrutinize agreements to determine how data collected in USAID private-sector partnerships can be shared. USAID Global Development Alliances tools and resources are available to help.

The private sector is critical to dissemination of research through industry networks, such as sustainability roundtables. In addition a huge industry is devoted to communications and knowledge management, representing the best global thinking about how to identify, synthesize, curate, archive and repurpose data and information for optimal user experience. Drawing on that expertise through partnerships with the knowledge industry could significantly improve conservation outcomes.

> The top 10 private-sector companies that USAID did business with, according to a 2012 Devex report, include companies with significant research focus and expertise. In addition, many of the smaller and national-level companies that USAID contracts with provide targeted research services, such as data and knowledge management and gender or culturally specific research expertise.

Ultimately the aim of USAID biodiversity research, in line with the Policy, is to help shift the conversation about biodiversity conservation from being something esoteric to something widely and well understood, embraced by the private sector and consumers as an essential component of doing business.

II. Engaging Agency Mechanisms

A. Working with Missions

Working with Mission staff is key to implementing the BDRA. Their knowledge of local and regional issues will be particularly valuable when formulating priority research questions in the field, and the relationships that Missions have built up with local universities and research institutions will be useful when implementing research projects. Their relationships with local stakeholder groups and government agencies will be important when sharing and applying new knowledge generated by research projects. A survey circulated to Agency Bureaus and Missions asked respondents to identify ways they expect their Office or Mission to use or participate in the BDRA. The range of responses underscores the diversity of approaches to engage with the BDRA, depending on programmatic priorities, capacities and available resources.

Answers to question posted to Missions: What do you think is the best way for your Bureau or Mission to participate in and use the BDRA?

- Receive technical assistance to design and implement the research topics identified in the BDRA
- Receive results of the research in short briefs
- Receive guidance on how to integrate research results into program planning and implementation
- Receive guidance on how to disseminate research results in peer-reviewed journals and communities of practice

B. Working with Existing Research Mechanisms

USAID conducts and promotes research through existing mechanisms, such as PEER, HESN and Biodiversity Analysis and Technical Support. The Agency also works with CGIAR on research projects. These mechanisms and partnerships work in different ways, including partnering with other government agencies, such as NSF, and working with leading American and international academic institutions. These existing mechanisms and partnerships offer certain advantages when implementing the BDRA, including the opportunity to leverage expertise in other government agencies and universities and the chance to capitalize on or add to ongoing research efforts. More information on each of these mechanisms and partnerships follows:

- **PEER:** Provides grants to developing country scientists who collaborate with governments and government-supported scientists to tackle local development issues like agriculture, biodiversity conservation, disaster mitigation and water resource management. PEER's funding model permits USAID missions and bureaus to buy in to the program to fund specific research agendas that will support evidence-based programming.
- **HESN:** A group of eight development labs that harness the intellectual power of great American and international academic institutions and catalyze the development and application of new science, technology and engineering approaches and tools to solve some of the world's most challenging development problems.
- **Biodiversity Analysis and Technical Support:** A program that provides technical support and shares lessons learned to help USAID's Africa Bureau Office of Sustainable Development, Africa Missions and local and national organizations in Africa tackle major existing and emerging threats to Africa's biodiversity. The program also contributes to sound development based on wise use of natural resources and maintenance of ecosystem services. It is implemented through consulting firms, USDA, Forest Service and ABCG.
- **CGIAR:** Works closely with USAID's Feed the Future initiative to help developing countries transform their own agriculture sectors to sustainably grow enough food to feed their people. CIFOR and the Forest Trees and Agroforestry Research Program work with USAID's Forestry and Biodiversity and Global Climate Change Offices on research issues, such as the sustainable use of forests, best practices for forest restoration, forests and food security and the impacts of climate change on the Agency's programs in the forest sector.

C. Working across the Agency

This research agenda was developed in part through coordination with other Offices' and Bureaus' research strategy initiatives, including the Office of Global Climate Change, the Global Development Lab, the Bureau for Africa and the Bureau for Food Security, among others. Annex B includes an example of cross-Agency engagement on biodiversity-related research that fed into this research agenda. The BDRA can help coordinate and integrate the implementation of research related to biodiversity conservation across USAID and allow USAID to enhance the efficiency of biodiversity-focused research while maximizing the impact of research findings across the Agency.

III. Leveraging Significant Existing Data Sources

Leveraging existing high-quality data resources to support the investigation of priority research topics is a key element of the BDRA implementation strategy. Rigorous examination of integrated databases will enhance the ability to describe and understand the interactions between biodiverse environments and human development outcomes.

USAID has made considerable investments in remote sensing, mapping, geographic information systems and related technologies, notably through the GeoCenter and in the SERVIR hubs. The data derived from these investments can be used to build baselines and measure the impact of USAID's forestry and biodiversity conservation programs and analyze the relationships between biophysical processes such as deforestation and socioeconomic variables like food security or infrastructure expansion. Further investments in land-use maps, inventories and imagery analysis are found in bilateral USAID and other donor climate change programs, such as UN-REDD and the World Bank Forest Carbon Partnership Facility. Where these investments overlap with USAID biodiversity and forestry programming, opportunities exist to analyze trends, such as rates of deforestation, forest fragmentation and increases in forest cover, which can contribute to a more thorough understanding of project impacts.

USAID's Bureau of Global Health's MEASURE Demographic and Health Surveys project has worked with governments in developing countries for more than 30 years to generate the internationally recognized gold standard in population and health data collection. These and other government investments in high-quality data can be leveraged to improve understanding of the relationship between biodiversity conservation and development outcomes.

Where existing biophysical and socioeconomic population data are unavailable or inappropriate, BDRA implementation can occur through targeted primary data collection. A range of primary data collection methods are available—household surveys, forest inventory plots, water quality monitoring, species monitoring, participatory and non-participatory observation, key informant interviews and focus groups. Targeted primary data collection also can occur by leveraging existing or ongoing data collection efforts by including topic-specific modules in large-scale surveys or oversampling certain clusters. While some modes of primary data collection require outside, professional expertise, which can be costly, certain primary data such as observation and monitoring of species can be collected by trained community volunteers (Danielsen et al., 2009).

IV. Practicing Open Science Through Harnessing Information Technology

The practice of open science in cross-disciplinary and multilateral organization collaboration, and in the transparent sharing of raw data and results, drives scientific discovery and progress (Royal Society Science Policy Centre, 2012). Open science is essential to the strategic implementation of the BDRA and will be practiced in part through the harnessing of information technology to access and link existing open access datasets and to communicate research results and contribute to the global dialog on biodiversity conservation and sustainable development.

PART FIVE: SHARING AND APPLICATION OF NEW KNOWLEDGE

Sharing and applying new knowledge is essential to ensure that USAID's policy, program, and activity decision-making is grounded in evidence. USAID's Scientific Research Policy highlights the importance of high-quality research in identifying, testing, improving and adapting solutions to key concerns in developing countries. When effectively communicated and applied, research can be used to inform, adapt and improve projects and programs from the earliest phases of the development of the Country Development Cooperation Strategy to the project design and implementation phase to evaluation and sharing.

This section describes approaches to communicate research results and the adaptive integration of findings into activity cycles to maximize the value of the knowledge generated through research on BDRA priority topics.

I. Multiple Channel Distribution of Key Findings

Key findings and results generated from research activities on BDRA priority topics will be disseminated through multiple channels, including publications in peer-reviewed journals, briefs for Agency use and mass and social media. Disseminating results through multiple channels allows diverse audiences to access new knowledge, both in the Agency and externally. In addition, sharing knowledge through different channels allows for tailoring communication materials to audiences. For example, Mission staff may be more responsive to the application of new knowledge if it is incorporated in an internal Agency brief rather than an article in a peer-reviewed journal that can be difficult to access.

A. Peer-Reviewed Journal Articles

Peer-reviewed journals are an important channel for dissemination of research findings. Peer-reviewed journals are a primary mode of communicating with the scientific community, and publication of an article in a highly regarded journal often indicates the quality of the research. Articles in peer-reviewed journals also can be tracked with readily available metrics on how often they are cited, which allows researchers to better understand the impact of their work. Factors that discourage publication in peer-reviewed journals include the time involved to prepare and revise manuscripts and associated costs such as publication fees. Access to articles in many peer-reviewed journals also is limited to those who can pay a subscription fee, although with increasing frequency open access peer-reviewed journals are being published to make scientific information more accessible.

B. Mass and Social Media

Both traditional mass media and new forms of social media are effective ways to communicate key research findings, particularly because they can reach large audiences. While the readership of peer-reviewed journals tends to be mostly limited to the scientific community, mass and social media can reach broad audiences from diverse groups. Information can be tailored to make it accessible to audiences with different levels of scientific literacy. Effective use of mass and social media can increase public awareness of biodiversity conservation issues and generate support for interventions.

C. Internal Briefs

Communicating research findings through internal briefs can be an effective way to share new information with key USAID staff. Internal briefs communicate efficiently in a large organization like USAID and can be tailored to audiences based on Agency needs. These briefs can convey important findings in standard, coordinated and strategic ways in the Agency.

D. Conference Presentations

Presenting research findings at conferences and other meetings is an important way to communicate with fellow researchers and other key audiences that include the media and policymakers. USAID staff attendance at conferences helps staff get a better understanding of related cutting-edge research and provides opportunities to meet researchers from the same field and forge relationships that can lead to future collaborations.

E. Emphasis on Open Access Data and Peer-Reviewed Journal Publications

Effective dissemination of key research findings can be limited because access to scientific journals and other sources of data among key audiences is limited, especially in countries where USAID works. When possible, new knowledge on BDRA priority topics should be disseminated through open access journals, and efforts should be made to ensure that research data will be in the public domain. Advantages of open access include greater visibility and use of research findings and increased access among key audiences, such as other researchers, the media, policymakers and the public. USAID should make special effort to assure findings are available in French, Spanish, Arabic, Portuguese and local languages to reach target audiences.

II. Adaptively Integrating Findings into the Program Cycle

Effective integration of key research findings in the programmatic cycle is critical to ensure that USAID's programs are grounded in evidence. Research findings should inform all stages of the programmatic cycle, from design to implementation and evaluation. The identification, rigorous evaluation, and refinement of critical theories and assumptions contribute to improved biodiversity conservation programming. Several research topics in the BDRA can be approached by using a Theory of Change analysis; however, for research findings and the results of theories of change analyses to be effectively integrated into the programmatic cycle, a systematic learning mechanism that includes strategic communication with Missions and implementing partners is required.

A. Leveraging Principles of Adaptive Management

The practice of adaptive management (AM) centers on the use of evidence throughout the program cycle, including conceptualization, project design, implementation, monitoring and evaluation, learning and adapting (Figure 2). The AM core principles include (a) an explicit theory of change, (b) robust monitoring and evaluation and (c) systematic mechanisms to adopt lessons learned. AM is most effective when research and new knowledge continually inform the process. A strategic approach to communicate research results that are aligned with the BDRA to Missions and implementing partners includes explicit leveraging of AM principles.

B. Engaging Missions and Partners

Missions may face a number of challenges and limitations in using research throughout the program cycle:

- Limited access to scientific research
- Limited awareness of or access to available research specific to a region
- Limited time and capacity to analyze, interpret and communicate relevant data
- Limited understanding of what qualifies as research
- Limited expectations for Missions to demonstrate viability of a strategy or activity
- Limited expectations for implementing partners to collect, organize and share data in a structured, easily accessible fashion

To mitigate these challenges, research findings should be aligned with the BDRA to (1) be responsive to the needs of Missions and implementing partners throughout the project cycle and (2) be disseminated strategically. This approach will improve Missions' access to research, enhance the usability of research findings and supplement an understanding of the conditions under which conservation strategies are viable.

Figure 3. Graphic representation of USAID's program cycle.

Source: USAID. (2011). *Program Cycle Overview*. Washington, DC: USAID.

PART SIX: ONGOING EVALUATION OF THE BIODIVERSITY AND DEVELOPMENT RESEARCH AGENDA

Setting research priorities is required to maximize the impact of invested funds and ensure the greatest benefit to policy-making and program design, planning and management; however, this is not a one-time activity. Periodic evaluation of research priorities and the process of priority setting is crucial to ensure that the research agenda continues to reflect contextual factors that shape the priority-setting process; that is, designating intended beneficiaries and audience and identifying existing capacities to do the research, including budgetary and time constraints (Viergever et al., 2010).

Reviewing the priority-setting process and the research agenda entails the following tasks (Sibbald et al., 2009; Viergever et al., 2010):

1. ***Evaluate the priority-setting process to improve the quality of the results and achieve greater consensus***. This entails assessing stakeholder satisfaction with involvement and the modality of engagement. Another aspect, beyond assessing stakeholders' satisfaction with the degree of inclusiveness, is gauging stakeholders' sense of the transparency of the priority setting exercise; for example, understanding what decisions were made by whom and why. Improving inclusiveness and transparency can contribute to greater consensus on priorities and improve the quality of results.
2. ***Convene periodic meetings with stakeholders to review research priorities***. The success of the priority-setting process is partially reflected by the extent to which it is institutionalized. Convening periodic meetings to identify top research topics that would enhance conservation and development policy and programming would ensure that the research agenda remains a relevant roadmap. Incorporating learning from the field, such as the results of program monitoring and evaluation, can also contribute to institutional learning and maintain an up-to-date research agenda.
3. **Conduct impact analysis to assess improvement in institutional learning and decision-making quality and changes in resource reallocation.** This entails identifying knowledge gaps, which are addressed by the research, and evaluating the extent to which results have been incorporated in the program design, implementation and evaluation, and thus contributing to institutional learning. Another measure of the success of the research agenda is the extent to which it has mobilized a shift in resource allocation that reflects the priorities identified, and consequently, that captures stakeholder buy-in.
4. **Assess when and how use of evidence from research and evaluation improves conservation outcomes.** This task is not one that the FAB office or even USAID can take on alone. The U.S. Government has been promoting evidence-based programming since 2012 with the aim of fiscal responsibility and efficiency. The health sector has taken the lead overall; however, the rigorous methodologies used in health research are typically not appropriate for complex field-based programs. Assessing the impact of research to better pinpoint threats may be a good starting point to promote measurement of knowledge before and after use. Studying the impact of more complex research, such as that concerning constituencies for conservation, will require longer-term multipronged inquiry.

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Annex A: Systematic Approach to Developing the Biodiversity and Development Research Agenda

I. Approach

The process used to develop the Biodiversity and Development Research Agenda (BDRA) drew from a checklist for research priority-setting exercises developed based on a comprehensive overview of common views on good practices in health research priority setting (Viergever et al., 2010). The checklist allows informed choices on different approaches and outlines nine common themes of good practice.

The approach to developing the BDRA proceeded systematically according the steps the following steps.

1 The first step set the context for the exercise by identifying the resources available for the process and defining its focus. During meetings with the USAID Forestry and Biodiversity Office (FAB), it was decided that the research agenda would align with the Agency's Biodiversity Policy and focus on research that supports the following outcomes:

- Enabling conditions for sustained biodiversity conservation are in place
- Reducing priority threats to biodiversity
- Strengthening the evidence base for biodiversity conservation and development integration

A timeframe for implementation also helped set the context for the research agenda. During meetings with the FAB Office, it was determined that the BDRA should embrace a portfolio approach that uses a 5-year project cycle, but not exclude key questions that require a longer timescale to generate evidence.

Setting the context also entailed defining the underlying values or principles that should guide the selection and prioritization of research questions, listed below.

2 The second step involved determining whether to use a comprehensive, step-by-step approach to set research priorities. Several established approaches provide structured guidance for research priority-setting processes from beginning to end. The process of developing the research agenda drew on a combination of structured approaches and provided an opportunity for more ad hoc contributions to the process.

3 Determining the level of inclusiveness—the degree to which individuals inside and outside of the FAB Office and USAID would be involved in developing the research agenda—was a key decision point. It was determined that the Agency should be the primary driver of the agenda development. To this end, the FAB Office established a Research Agenda Working Group (RAWG), which comprised primarily FAB Office staff and participants from the Bureau for Africa; the Policy, Planning and Learning Bureau; and the Office of Science and Technology. Later perspectives from implementing partners and other experts in the field of conservation and development will be included and opportunities will be made for experts in the field external to USAID to participate.

4 The following sources and types of information are essential in the development of the BDRA:

(a) Research questions and issues under development in non-FAB USAID units that might overlap with the BDRA (see Annex B).

(b) Research questions articulated in the conservation literature as priorities for the field.

(c) Research questions developed through a consultative process with experts at USAID through the RAWG.

5 A research agenda is useful only to the extent that the research it advocates for is implemented. While it was outside the scope of the development of the BDRA to identify implementers of research activities a priori, the agenda describes an implementation approach (Part Four of this document), which advocates participation in collaborative partnerships, engagement with Agency mechanisms, leveraging significant existing data sources and harnessing information technology to facilitate implementation of research.

6 In a context of limited financial and temporal resources, it was required to select criteria against which proposed research topics could be vetted. To accomplish this task, standard criteria for inclusion (Sutherland et al., 2011) and a participatory process for identifying FAB Office programming and management priorities were used to identify relevant criteria to help prioritize selected research topics. After finalization through a consensus process, three expert reviewers independently assessed the priority research topics from the literature against the BDRA conceptual framework. Topics that aligned with the BDRA were compiled with topics generated by the RAWG and scored on the criteria. The resulting set of questions appears in Annex D (149 questions) in order of allocated score; the scoring criteria and weights appear in Table A1.

7 Because of the strategic importance of a research agenda for generating new knowledge and informing policy and programs, the process of developing the BDRA should be subject to evaluation: Was the work that went into developing the research agenda useful? What was learned from the process? What aspects of the process should be continued? What aspects should not be repeated in the future?

The BDRA itself should be evaluated periodically when USAID's biodiversity and development research priorities are updated.

8 Transparency in the process, methods, and actors involved in the development of the BDRA is central to assure its legitimacy inside and outside of USAID. To maximize transparency, the agenda incorporates a rigorous documentation of how the research priorities were established, including decision-making criteria and methods, how research topics were generated, and who helped establish the priorities and generate the research topics.

II. Methodology for Identifying and Prioritizing Research Topics

A. Soliciting Candidate Research Topics

The methodology adopted to identify and prioritize research topics and questions for the BDRA parallels a well-established process used to set science and policy research agendas in fields such as global conservation (Sutherland et al., 2011), global agriculture (Pretty et al., 2010) and ocean science (Council of Canadian Academies, 2012).

The FAB Office-led RAWG and peer-reviewed literature identified candidate research topics.

FAB Office-led RAWG

Research topics that corresponded to each of the sub-themes of the BDRA conceptual framework were identified based on a systematic, strategic, open, collaborative, and iterative process that engaged experts from USAID's FAB Office and the RAWG. During an annual retreat June 2013, the FAB Office conducted a half-day workshop to generate research topics to help strengthen the evidence base for biodiversity conservation and development integration. Thematic RAWG meetings in July and August 2013 identified candidate research topics for the following content areas: (1) enabling conditions for sustained biodiversity conservation; (2) reducing priority threats to biodiversity; and (3) strengthening the evidence base for biodiversity conservation and development integration.

Research topics generated during the FAB Office retreat and the RAWG meetings were refined to 190 priority topics for inclusion in the final list. Duplicate topics were discarded, compound topics were sometimes split into sequential topics and candidate topics were reworded to be clearer and more focused (Table C1).

Peer-reviewed Literature

Research topics were culled from the peer-reviewed literature, specifically from articles that described important questions in the field of biodiversity conservation. The survey of literature generated approximately 300 topics that were deemed to be high priority research areas in the field of biodiversity conservation (Table C2).

These topics were independently assessed by three expert reviewers for alignment with the BDRA conceptual framework. Using a consensus-based process, reviewers compared their assessments and identified areas of agreement and disagreement. If consensus could not be achieved, the question was included or excluded based on majority vote.

Experts maintained a list of potential research topics that were found to be in alignment with the BDRA and the conceptual framework and ones generated by the RAWG (see Annex D), which were then prioritized according to the strategy below.

B. Prioritizing Research Topics

To adhere to the principles of selectivity and focus, the research topics in this list were subjected to two rounds of prioritization. First, research topics were reviewed against two sets of criteria: (1) criteria applied to all questions on the list and (2) criteria specific to content area. The prioritization criteria were derived from the peer-reviewed literature and discussions with the RAWG. Select members of the FAB Office then reviewed and refined the resulting criteria.

Two expert reviewers independently assessed each candidate research topic against the criteria described below. They applied scores to each criterion that the topic met. Then they calculated a final score for each topic by taking the average of their scores. Table A1 illustrates the scoring criteria, definitions and values applied.

In the second round of prioritization, reviewers assessed the feasibility of implementing the research of a list of topics selected from the first round based on their scores. Figure A1 shows a schematic of the prioritization procedure.

1. **First round of prioritization scoring**
    a. Overarching prioritization criteria:
        i. *Support to USAID evidence-based programming.* The literature identified research topics that the FAB Office assessed on the likelihood to produce results that support evidence-based programming. Research topics that fulfilled this criterion received a score of 1; if not, they received a score of 0.
        ii. *Strategic value.* Research topics generated by the RAWG and those identified from the literature were assessed on their strategic value—namely, their likelihood to be relevant across a wide range of geographies, geopolitical or cultural contexts or ecosystems. A research topic received a score of 0.33 for each of the three sub-criteria it fulfilled in the strategic value criterion. The maximum score on this criterion is one, making it equal in weight to the “supports USAID evidence-based programming” criterion.
    b. Specific prioritization criteria (designed to be equal weight or value as overarching criteria):
        i. Criteria for topics related to enabling conditions in place for sustained biodiversity conservation:
            (a) Research topic is oriented to the intersection of biodiversity and human well-being.
            (b) Addressing the research topic will produce evidence of high value to other sectors.

            A research topic received a score of 0.50 for each of the above two sub-criteria. The maximum score on these criteria is one. If the topic did not fulfil any of the sub-criteria, it received a score of zero.

ii. Criteria for topics related to strengthening the evidence base for biodiversity conservation and development integration:

(a) Question intersects with the major initiatives of the Presidential Policy Directive: Feed the Future, Global Health, and Global Climate Change and the Agency's economic growth goals.

(b) Question explicitly addresses gender equality or female empowerment.

(c) Question is oriented to the intersection of biodiversity and human well-being.

(d) Addressing the question will produce evidence of high value to other sectors.

A research topic received a score of 0.25 for each of the above four sub-criteria. The maximum score on these criteria is one. If the topic did not fulfil any of the sub-criteria, it received a score of zero.

Because no criteria were identified for reducing priority drivers and threats to biodiversity, all questions related to this objective earned by default a score of 0.5.

2. Second round of prioritization scoring

Following the first round of prioritization, median scores by content area were calculated based on the average scores and candidate topics that scored at or above the median; these topics advanced to a second stage of prioritization. Feasibility of implementing the research was assessed by the following factors, which were adapted from the selection criteria in Sutherland et al. (2011):

i. Answerable through a realistic research design.

ii. Has a spatial and temporal scope that can be realistically addressed by a research team.

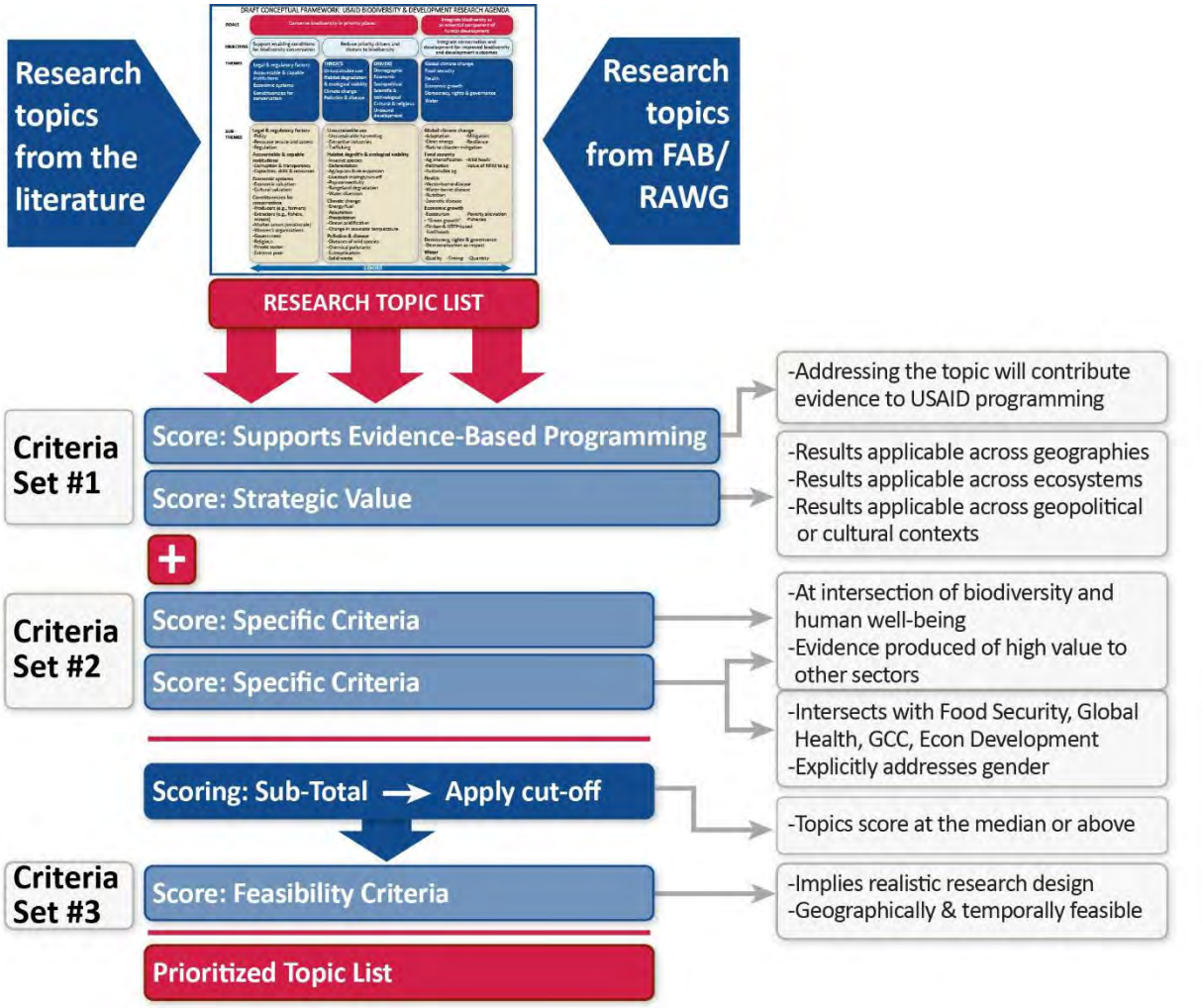
Only research topics that satisfied the above two criteria were considered feasible and subsequently shortlisted as a "priority research topic." Annex D lists priority research topics in order of their prioritization scores. Additional feasibility criteria may be used during the stage of proposal consideration. Additional criteria might include factors such as whether the research activity could be conducted in a project's allocated budget or if there is potential to use a pre-existing USAID mechanism for implementation.

Table A1. Criteria and scoring approach to prioritization of research topics under the BDRA: over-arching and specific criteria.

Criteria	Sub-criteria	Value per sub-criterion
Supports Evidence-based Programming**	Addressing the topic will produce evidence that can contribute to USAID programming	**1.00**
Strategic Value	Results potentially applicable across a wide range of geographies	**0.33**
	Results potentially applicable across a wide range of geopolitical or cultural contexts	**0.33**
	Results potentially applicable across multiple ecosystems	**0.33**
Specific Criteria: Enabling Conditions in Place	Topic oriented to intersection of biodiversity and human well-being	**0.50**
	Addressing the topic will produce evidence of high value to other sectors	
Specific Criteria: Reduce Priority Drivers and Threats	No specific criteria; add 0.50 point by default to standardize	**0.50**
Specific Criteria: Integrate Conservation and Development	Topic intersects with food security, global health, global climate change and economic development	**0.25 per intersect**
	Topic explicitly addresses gender	**0.25**
	Topic oriented to intersection of biodiversity and human well-being	**0.25**
	Addressing the topic will produce evidence of high value to other sectors	**0.25**

** Applied only to research topics identified from the peer-reviewed literature.

Figure A1. Procedure for prioritization of candidate research topics for the BDRA.



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Annex B: Summary of Key Informant Interviews on Research Activities at USAID

Table B1. Cross-sectoral Research Activities at USAID that are Relevant to FAB Office Objectives (AAAS: American Association for the Advancement of Science; BFS: Bureau for Food Security; CIFOR: Center for International Forestry Research; DCHA: Bureau for Democracy, Conflict, and Humanitarian Assistance; GCC: Office of Global Climate Change; GH: Bureau for Global Health; ICAA: Initiative for Conservation in the Andean Amazon; LTRM: Office of Land Tenure and Resource Management; HIND: Office of Health, Infectious Diseases and Nutrition; MPAG: Marine Protected Area Governance Project; RDMA: Regional Development Mission for Asia; the Global Development Lab).

Group/Individual	Sector	Topic	Sites where Applicable	Tie to Biodiversity Policy
Tim Resch (Bureau for Africa)	Bureau for Africa	High conservation value forest assessments: elephant density/abundance maps; great apes; plant conservation zones; forest habitat classification; aquatic biodiversity sampling and mapping; biodiversity offsets	Gabon (biodiversity offsets); other Africa	
Jerry Glover (BFS)	BFS	Sustainable intensification: technology trials have up to 100 sites geo-referenced; potential to add ecosystem and landscape layer	Tanzania, Malawi, North Ghana, South Mali	Priority Places, Integration
Julie Howard, Jerry Glover (BFS)	BFS	Sustainable intensification		
Sieglinde Snapp (Michigan State University; collaborator on BFS/Africa Rising project)	BFS	Participatory agriculture research in Africa	Malawi	Integration, Partner Missions
Tracy Powell (AAAS Fellow at BFS)	BFS	Africa Rising; ground truth map of soils across Africa	Africa	Priority Places, Integration
DCHA	Democracy and governance	Human rights, civil society strengthening, transparency		

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Group/Individual	Sector	Topic	Sites where Applicable	Tie to Biodiversity Policy
Robert Nasi (CIFOR)	FAB	Certification, multiple uses of forests, bushmeat		
Celly Catharina (USAID/Indonesia), Pahala Nainggolan (MPAG), Handoko Adi Susanto (MPAG)	FAB, EG	Impacts on fishery (economic growth and health) and ecotourism of marine protected areas (MPAs)	Indonesia, Wakatobi MPA, Gili Matra MPA	Priority Places, Integration
Kathryn Stratos, Jenny Frankel-Reed (GCC)	GCC	Mangrove valuation to feed into resiliency policy	Vietnam (mangroves); integration pilot countries/sites	Remote Sensing, Kenya Biodiversity Mapping
Jonathan Cook (GCC)	GCC adaptation	Best practices for GCC adaptation and biodiversity co-funding	Global	Integration
Marion Adeney (AAAS Fellow at the Lab)	GCC, FAB	Geographic Information Systems for ICAA	Andean Amazon	Priority Places, Sustainable Landscapes
SilvaCarbon	GCC	Remote sensing for REDD+	Likely focused on SilvaCarbon countries (e.g., Gabon, Peru); Panama (Smithsonian Tropical Research Institute).	

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Group/Individual	Sector	Topic	Sites where Applicable	Tie to Biodiversity Policy
Dan Schar (RDMA), August Pabst (GH/HIND), Lexine Hansen (GCC)	GCC, Global Health	GCC has funded a research project at RDMA linking deforestation and land-use change with emerging pathogens; the goal is to take data on human-wildlife interactions from PREDICT and PREVENT in Malaysia and create a model for predicting disease emergence and spread	Malaysia	Integration, Priority Places
Alex Deghan, Michele Schimpp, Brandon Sitzmann (the Lab)	General	Biodiversity in Burma, targeted support to NSF		
Kiersten Johnson (ICF International)	Global Health	Forest cover, dietary diversity, and diarrhea	Malawi, Uganda, Tanzania, Bolivia, Cambodia, Madagascar	
Matt Erdman, Nonie Hamilton, Hannah Marquesee (Population and Reproductive Health)	Global Health	Family planning in biodiverse areas	Philippines, Tanzania, Uganda, Papua New Guinea, Ghana, Democratic Republic of Congo, Nepal; also discussion of planned project in Malawi	Integration, Partner Missions
LTRM Productive Landscapes	Land Tenure and Resource Management	Metrics for NWP; land tenure and property rights intersections with biodiversity		

Table B1. Cross-sectoral Research Activities at USAID that are Relevant to FAB Office Objectives (AAAS: American Association for the Advancement of Science; BFS: Bureau for Food Security; CIFOR: Center for International Forestry Research; DCHA: Bureau for Democracy, Conflict, and Humanitarian Assistance; GCC: Office of Global Climate Change; GH: Bureau for Global Health; ICAA: Initiative for Conservation in the Andean Amazon; LTRM: Office of Land Tenure and Resource Management; HIND: Office of Health, Infectious Diseases and Nutrition; MPAG: Marine Protected Area Governance Project; RDMA: Regional Development Mission for Asia; the Global Development Lab).

Group/Individual	Sector	Topic	Sites where Applicable	Tie to Biodiversity Policy
Peter Giampoli (LTRM)	Land Tenure and Resource Management	Property rights for artisanal logging with case study of People, Rules and Organizations Supporting the Protection of Ecosystem Resources (PROSPER) in Liberia		
West Africa Regional	Land Tenure and Resource Management	Satellite analyses to map land use and degradation to improve land management	West Africa	
Ku McMahan (AAAS Fellow at the Global Development Lab); Brandon Sitzman (the Lab)	Water	Partnerships for Enhanced Engagement in Research Water—water for agriculture, a partnership with NASA to use its data and satellites to understand water use and availability for agriculture		Integration

Annex C: Unfiltered Lists of Priority Research Topics

This annex contains the original, comprehensive set of questions from both the literature and the RAWG and FAB Office meetings. They are presented before any filtering, refinement, or reorganization. The questions included in the main body of the BDRA may appear in slightly modified form or placement relative to the questions in this annex. The themes and sub-themes in the main body of the BDRA may appear slightly modified compared with this annex of original data because the RAWG refined some terminology in later stages.

I. Research Topics Generated by the RAWG and at the FAB Office Retreat

Table C1. Unfiltered List of Priority Research Topics Generated by the RAWG and at the FAB Office Retreat.

#	Research Topic	Theme and Sub-theme	Source
1	Under what conditions does investing in policy improve conservation outcomes?	Legal & regulatory framework\Policy	RAWG
2	Is it more effective to do simultaneous policy implementation at both ends of scale (local & national), or is sequential implementation more effective?	Legal & regulatory framework\Policy	RAWG
3	At what scale is policy engagement most effective for conservation (e.g., local, national, regional, or international level)?	Legal & regulatory framework\Policy	RAWG
4	In what situations and for which biodiversity threats does the Agency also need to work on policy at the regional level (e.g., wildlife trafficking)?	Legal & regulatory framework\Policy	RAWG
5	How does the Agency get policies to nest in an aligned and effective manner, given decentralization in many of the settings where we work?	Legal & regulatory framework\Policy	RAWG
6	What are more effective ways of influencing outcomes: policies focused on conservation compared with policies around free trade agreements with the United States (e.g., timber trade)?	Legal & regulatory framework\Policy	RAWG

Table C1. Unfiltered List of Priority Research Topics Generated by the RAWG and at the FAB Office Retreat.

#	Research Topic	Theme and Sub-theme	Source
7	What are the impacts of policies related to economic incentives/disincentives on conservation outcomes, including the policies of banking institutions, multilaterals, and multinational corporations?	Legal & regulatory framework\Policy	RAWG
8	What are the impacts of the Lacey Act and similar policies on conservation outcomes?	Legal & regulatory framework\Policy	RAWG
9	Is decentralization effective, and if so, what are the critical components of decentralization that make it effective?	Legal & regulatory framework\Policy	RAWG
10	What are the barriers to creating effective property rights regimes that incentivize conservation?	Legal & regulatory framework\Resource tenure and access	RAWG
11	How many different types of rights (e.g., land tenure, resource tenure, equality of rights) should be bundled together to get the best incentives for local communities to sustainably manage resources?	Legal & regulatory framework\Resource tenure and access	RAWG
12	What incentives are required for governments to relinquish resource rights, especially when they might lose revenue as a result?	Legal & regulatory framework\Resource tenure and access	RAWG
13	How do inequalities in access to information on land tenure and property rights impact conservation?	Legal & regulatory framework\Resource tenure and access	RAWG
14	How do gender differences in (legal, informal, traditional or customary) rights around land ownership, inheritance, and access to land, resources, and capital impact conservation outcomes?	Legal & regulatory framework\Resource tenure and access	RAWG

Table C1. Unfiltered List of Priority Research Topics Generated by the RAWG and at the FAB Office Retreat.

#	Research Topic	Theme and Sub-theme	Source
15	What is the impact on conservation outcomes when the linkages between different components of the bundle of rights (e.g., access, ownership, management, transfer, exclusion, and use) are not well defined or not implemented?	Legal & regulatory framework\Resource tenure and access	RAWG
16	What approaches are most effective for securing resource tenure in ways that incentivize conservation?	Legal & regulatory framework\Resource tenure and access	RAWG
17	How do gender differentiated roles in access to and use of natural resources impact conservation outcomes?	Legal & regulatory framework\Resource tenure and access	RAWG
18	To what extent does strengthening local rights improve conservation outcomes?	Legal & regulatory framework\Resource tenure and access	RAWG
19	What are barriers that prevent legal engagement in forestry activities?	Legal & regulatory framework\Resource tenure and access	RAWG
20	What is the relationship between decentralization and corruption?	Accountable & capable institutions\Corruption & transparency	RAWG
21	Does co-management of protected areas promote transparency?	Accountable & capable institutions\Corruption & transparency	RAWG
22	Under what conditions do watchdogs and civil society groups improve conservation outcomes?	Accountable & capable institutions\Corruption & transparency	RAWG
23	What is the impact of social media on real-time biodiversity monitoring and advocacy for biodiversity conservation?	Accountable & capable institutions\Corruption & transparency	RAWG
24	How can accountability and transparency be improved at the community level?	Accountable & capable institutions\Corruption & transparency	RAWG
25	What is the impact of democratization on biodiversity conservation?	Accountable & capable institutions\Corruption & transparency	RAWG

Table C1. Unfiltered List of Priority Research Topics Generated by the RAWG and at the FAB Office Retreat.

#	Research Topic	Theme and Sub-theme	Source
26	Where should the Agency invest funds to improve capacities for enforcement?	Accountable & capable institutions\Capacities, skills, and resources	RAWG
27	What is the role of universities in providing training for biodiversity conservation?	Accountable & capable institutions\Capacities, skills, and resources	RAWG
28	What approaches are most effective for capacity building? How can brain-drain be prevented?	Accountable & capable institutions\Capacities, skills, and resources	RAWG
29	Are different types of valuations more effective than others? How do we communicate value to different audiences (e.g., civil society organizations compared with government ministries)?	Economic systems\Economic valuation	RAWG
30	How can undervaluation of resources and the lack of recognition of the full value of biodiversity be addressed?	Economic systems\Economic valuation	RAWG
31	How does the valuation of ecosystem services impact conservation outcomes?	Economic systems\Economic valuation	RAWG
32	How can biodiversity conservation be successfully integrated into economic planning?	Economic systems\Economic valuation	RAWG
33	How do payment for ecosystem services programs impact conservation outcomes?	Economic systems\Economic valuation	RAWG
34	Are different types of valuations more effective than others? How can the Agency communicate value to different audiences (e.g., civil society organizations compared with government ministries)?	Economic systems\Economic valuation	RAWG
35	How does the Agency get people to recognize the value of ecosystem goods and services in the long-run?	Economic systems\Economic valuation	RAWG

Table C1. Unfiltered List of Priority Research Topics Generated by the RAWG and at the FAB Office Retreat.

#	Research Topic	Theme and Sub-theme	Source
36	Do market incentives (e.g., alternative livelihood approaches and certification of green products) improve conservation outcomes?	Economic systems\Economic valuation	RAWG
37	Do alternative sources of incentives, like those provided by the banking and manufacturing industries, have positive impacts on conservation?	Economic systems\Economic valuation	RAWG
38	What are the best ways to harmonize public and private incentives for resource management?	Economic systems\Economic valuation	RAWG
39	Are the activities being paid for by PES schemes/water funds protecting the water sources?	Economic systems\Economic valuation	RAWG
40	What are the barriers to implementing more forward thinking conservation policies (e.g., tax incentives, land use incentives, and offsets)?	Economic systems\Economic valuation	RAWG
41	How can the Agency bring women's organizations into conservation efforts (e.g., women's framers groups)?	Constituencies for conservation	RAWG
42	How does the Agency bring farmers into the fold to support conservation programs?	Constituencies for conservation	RAWG
43	How does the Agency mobilize religious constituencies to support conservation?	Constituencies for conservation	RAWG
44	How does the Agency engage and encourage big corporations that have an interest in good management of a natural resource (e.g., water company and public-private partnership) to support conservation?	Constituencies for conservation	RAWG
45	How does culture impact the uptake of conservation practices?	Constituencies for conservation	RAWG

Table C1. Unfiltered List of Priority Research Topics Generated by the RAWG and at the FAB Office Retreat.

#	Research Topic	Theme and Sub-theme	Source
46	What can the Agency learn from Global Health and the Bureau for Food Security programs about how to influence cultural practices and encourage first adopters?	Constituencies for conservation	RAWG
47	How does the Agency influence government to support conservation (e.g., government leaders and non-environment ministries)?	Constituencies for conservation	RAWG
48	How important is intrinsic valuation for conservation outcomes?	Constituencies for conservation	RAWG
49	How do you harness diasporas for conservation (e.g., remittances)?	Constituencies for conservation	RAWG
50	To what extent is subsistence bushmeat harvesting contributing to biodiversity loss, particularly in different geographic subsets?	Threats\Unsustainable use\Unsustainable harvesting	RAWG
51	What are the impacts of bushmeat hunting on keystone species, vegetation, and predator-prey relationships?	Threats\Unsustainable use\Unsustainable harvesting	RAWG
52	What is the natural capital of wildlife, particularly with respect to bushmeat, ecotourism, and others?	Threats\Unsustainable use\Unsustainable harvesting	RAWG
53	What are the relative ecosystem impacts of alternative sources of protein (e.g., bushmeat hunting compared with raising livestock)?	Threats\Unsustainable use\Unsustainable harvesting	RAWG
54	How does the devolution of rights to access wildlife affect sustainability of the harvest?	Threats\Unsustainable use\Unsustainable harvesting	RAWG
55	Under what conditions is devolution of rights effective and how can it be made more effective?	Threats\Unsustainable use\Unsustainable harvesting	RAWG

Table C1. Unfiltered List of Priority Research Topics Generated by the RAWG and at the FAB Office Retreat.

#	Research Topic	Theme and Sub-theme	Source
56	What are the economic incentives (e.g., property rights) necessary for sustainable use and are these enough?	Threats\Unsustainable use\Unsustainable harvesting	RAWG
57	Where are investments in conservation most cost effective (e.g., law enforcement, management, and building public constituencies for conservation)?	Threats\Unsustainable use\Unsustainable harvesting	RAWG
58	To what extent is illegal harvesting contributing to biodiversity loss?	Threats\Unsustainable use\Trafficking	RAWG
59	What are the development impacts of wildlife trafficking at the source place?	Threats\Unsustainable use\Trafficking	RAWG
60	What are the impacts of trafficking on natural capital, local livelihoods, and ecology?	Threats\Unsustainable use\Trafficking	RAWG
61	Under what circumstances does legality of wildlife trafficking matter?	Threats\Unsustainable use\Trafficking	RAWG
62	Some countries have wildlife trafficking laws that only apply certain months of the year. What is the impact of the seasonality of certain wildlife trafficking laws?	Threats\Unsustainable use\Trafficking	RAWG
63	How strong are the cultural roots of the demand for illegal wildlife products?	Threats\Unsustainable use\Trafficking	RAWG
64	How do the impacts of illegal compared with legal wildlife trafficking differ?	Threats\Unsustainable use\Trafficking	RAWG
65	Are there alternatives to the use of ivory (e.g., palm nut) and to rhino horn?	Threats\Unsustainable use\Trafficking	RAWG
66	Under what conditions is trade in captive species beneficial to or not beneficial to wild populations?	Threats\Unsustainable use\Trafficking	RAWG

Table C1. Unfiltered List of Priority Research Topics Generated by the RAWG and at the FAB Office Retreat.

#	Research Topic	Theme and Sub-theme	Source
67	What are the dominant theories of change for programs that combat wildlife trafficking and under what conditions are they effective (e.g., substitution and alternative livelihoods)?	Threats\Unsustainable use\Trafficking	RAWG
68	Where do invasive species pose threats to human health and livelihoods?	Threats\Unsustainable use\Trafficking	RAWG
69	Where are the overlaps and opportunities to work on invasive species across sectors?	Threats\Habitat fragmentation & ecological viability\Invasive species	RAWG
70	Can invasiveness of a species be predicted and can this be planned for and mitigated?	Threats\Habitat fragmentation & ecological viability\Invasive species	RAWG
71	What are the issues of scale with fragmentation, particularly across sectors?	Threats\Habitat fragmentation & ecological viability\Deforestation	RAWG
72	What are the development impacts of corridors (e.g., increases in human wildlife conflict and impacts on agriculture)?	Threats\Habitat fragmentation & ecological viability\Population connectivity	RAWG
73	Under what conditions do corridors work?	Threats\Habitat fragmentation & ecological viability\Population connectivity	RAWG
74	What are the human health impacts of wildlife corridors (e.g., on nutrition and malaria)? If there are positive impacts, can they be used to build support for conservation?	Threats\Habitat fragmentation & ecological viability\Population connectivity	RAWG
75	For which species groups are corridors most effective, and what scale is necessary for different groups to maintain ecological viability?	Threats\Habitat fragmentation & ecological viability\Population connectivity	RAWG
76	Does an ecoagriculture approach work to maintain biodiversity?	Threats\Habitat fragmentation & ecological viability\Agricultural expansion	RAWG

Table C1. Unfiltered List of Priority Research Topics Generated by the RAWG and at the FAB Office Retreat.

#	Research Topic	Theme and Sub-theme	Source
77	For which types of species is an ecoagriculture approach most effective (e.g., generalists compared with endemics)?	Threats\Habitat fragmentation & ecological viability\Agricultural expansion	RAWG
78	What is the smallest area of habitat needed in an agricultural landscape to have positive impacts on biodiversity?	Threats\Habitat fragmentation & ecological viability\Agricultural expansion	RAWG
79	Under what conditions are biodiversity offsets effective?	Threats\Habitat fragmentation & ecological viability\Other	RAWG
80	How much biodiversity needs to be conserved to maintain natural capital and delivery of ecosystem services?	Threats\Habitat fragmentation & ecological viability\Other	RAWG
81	How can looking at historical patterns of wide-scale development inform future planning in less fragmented areas?	Threats\Habitat fragmentation & ecological viability\Other	RAWG
82	Which ecosystem goods and services are critical for development and at what levels do they need to be sustained in high and low biodiversity areas?	Threats\Habitat fragmentation & ecological viability\Other	RAWG
83	To what degree can biodiversity be managed in nonprotected areas to benefit protected areas and biodiversity in general?	Threats\Habitat fragmentation & ecological viability\Other	RAWG
84	What clean energy approaches are least harmful to biodiversity?	Threats\Climate change\Energy & fuel	RAWG
85	When building dams, under what conditions do fish passages/ladders work?	Threats\Climate change\Energy & fuel	RAWG
86	To what extent are clean energy approaches and programs such as hydropower and wind farms sufficient to meet projected energy needs, particularly in the context of their possible impacts on biodiversity and food security?	Threats\Climate change\Energy & fuel	RAWG

Table C1. Unfiltered List of Priority Research Topics Generated by the RAWG and at the FAB Office Retreat.

#	Research Topic	Theme and Sub-theme	Source
87	What is the role of healthy ecosystems and biodiversity in mitigating climate change-related natural disasters?	Threats\Climate change\Adaptation	RAWG
88	How is climate migration impacted by the integrity of the ecosystems in the areas from which people migrate?	Threats\Climate change\Adaptation	RAWG
89	Is a focus on small-scale diversification of livelihoods as a climate adaptation approach effective in conserving biodiversity?	Threats\Climate change\Adaptation	RAWG
90	How are policy responses to climate change impacting biodiversity?	Threats\Climate change\Other	RAWG
91	What is the interaction between human adaptation and biological adaptation to climate change?	Threats\Climate change\Other	RAWG
92	What are good practices for the integration of climate change into corridor planning?	Threats\Climate change\Other	RAWG
93	Which plant and animal species and groups are most vulnerable to climate change?	Threats\Climate change\Other	RAWG
94	What characteristics of plant and animal species result in higher vulnerability to climate change impacts, and what are the impacts of these vulnerabilities on ecosystem services?	Threats\Climate change\Other	RAWG
95	What will the impacts of climate-driven human migration be on high biodiversity areas?	Threats\Climate change\Other	RAWG
96	How are patterns of zoonotic disease changing with development and ecosystem degradation?	Threats\Pollution & disease\Wildlife diseases	RAWG

Table C1. Unfiltered List of Priority Research Topics Generated by the RAWG and at the FAB Office Retreat.

#	Research Topic	Theme and Sub-theme	Source
97	How do we manage zoonotic diseases under different development paradigms?	Threats\Pollution & disease\Wildlife diseases	RAWG
98	Does intensification of agriculture, particularly with fertilizer use, decrease overall food production for some communities, for example by creating dead zones?	Threats\Pollution & disease\Eutrophication	RAWG
99	With regards to the impacts of chemical pollutants on ecosystem degradation, are there tipping points for delivery of ecosystem services?	Threats\Pollution & disease\Chemical pollutants	RAWG
100	What are the cumulative impacts of pollution, degradation, and climate changes on ecosystems and their ability to deliver services?	Threats\Pollution & disease\Chemical pollutants	RAWG
101	How does exposure to endocrine disruptors impact threatened species, particularly reproduction rates?	Threats\Pollution & disease\Chemical pollutants	RAWG
102	To what extent are small-scale extractive activities and artisanal mining contributing to biodiversity loss?	Threats\Pollution & disease\Chemical pollutants	RAWG
103	It is estimated that a 50% to 60% increase in agricultural production is needed to meet population growth in the coming decades. Would educational campaigns prompt changes in consumption patterns and thereby reduce agricultural pressure on ecosystems?	Drivers\Agriculture	RAWG
104	How does USAID's infrastructure portfolio under the Development Credit Authority impact biodiversity?	Drivers\Development	RAWG

Table C1. Unfiltered List of Priority Research Topics Generated by the RAWG and at the FAB Office Retreat.

#	Research Topic	Theme and Sub-theme	Source
105	What are the impacts of Feed the Future initiative on biodiversity?	Drivers\Development	RAWG
106	Which lessons learned from studies of agrarian change can lead to improved conservation practices?	Drivers\Development	RAWG
107	What does good development look like in relation to biodiversity?	Drivers\Development	RAWG
108	How can advancements in remote sensing technology be harnessed to combat wildlife trafficking?	Drivers\Development	RAWG
109	How can a development agency with a robust conservation program look at tradeoffs on timeframes, geographic scale, and access to decision--making?	Drivers\Development	RAWG
110	Are there effective financial incentives that encourage foreign direct investments to positively impact biodiversity (e.g., Equator Principles)?	Drivers\Economic & political systems	RAWG
111	The Tropical Forest Alliance 2020 is a public-private partnership aimed at reducing the tropical deforestation associated with key global commodities, such as soy, beef, palm oil, and pulp and paper. What will be the biodiversity impacts of the Tropical Forest Alliance 2020-supported changes in value chain production?	Drivers\Private sector	RAWG
112	What are the social and ecological impacts of certification schemes?	Drivers\Private sector	RAWG
113	To what extent is the financial services sector a driver of biodiversity loss, and have they been overlooked as part of a solution to preventing biodiversity loss?	Drivers\Private sector	RAWG

Table C1. Unfiltered List of Priority Research Topics Generated by the RAWG and at the FAB Office Retreat.

#	Research Topic	Theme and Sub-theme	Source
114	How can the power of the private sector be harnessed to do good for biodiversity?	Drivers\Private sector	RAWG
115	What are the best lessons learned regarding motivating the private sector to do good for biodiversity?	Drivers\Private sector	RAWG
116	Do family planning programs, like Population, Health and Environment, have long-term positive effects on biodiversity?	Drivers\Population	RAWG
117	How does access to health care impact biodiversity and what are the effects at different spatial and temporal scales (e.g., the impacts of the President's Emergency Plan for AIDS Relief on land-use change)?	Drivers\Population	RAWG
118	How can consumers be motivated to buy more biodiversity-friendly products?	Drivers\Consumption patterns and culture	RAWG
119	How can technology and innovation be harnessed to support biodiversity conservation?	Drivers\Other	RAWG
120	What is the role of biotechnology in biodiversity conservation?	Drivers\Other	RAWG
121	What are the impacts of climate change policy and action responses on biodiversity (e.g., clean energy, exotic fuel wood for carbon sequestration, and ecosystem-based adaptation)?	Climate change and natural disaster mitigation	RAWG
122	How do institutional responses to climate change in the energy and landscaping sector impact biodiversity outcomes?	Climate change and natural disaster mitigation	RAWG

Table C1. Unfiltered List of Priority Research Topics Generated by the RAWG and at the FAB Office Retreat.

#	Research Topic	Theme and Sub-theme	Source
123	In the context of sustainable landscapes programs, are our current methods and tools for monitoring biodiversity valid and reliable given the climate change perspective? What additional steps need to be taken to supplement the use of remote sensing in this context?	Climate change and natural disaster mitigation	RAWG
124	What are the key intersections of human and natural vulnerability and resilience in the context of climate change adaptation in biodiverse areas?	Climate change and natural disaster mitigation	RAWG
125	(How) does enhancing the resilience of people to adapt to climate change impact the resilience of other systems?	Climate change and natural disaster mitigation	RAWG
126	How could we sustainably manage crop wild relatives outside of protected areas?	Food security and sustainable agriculture	RAWG
127	How can estate crops, such as coffee, cocoa, oil palm, and other commercial agricultural commodities be managed to mitigate biodiversity loss or enhance biodiversity protection?	Food security and sustainable agriculture	RAWG
128	What are the benefits that communities perceive from biodiverse areas, and how will this understanding help create better policy?	Food security and sustainable agriculture	RAWG
129	How does the valuation of biodiverse areas differ by sub-groups (e.g., women, elderly, and children) that have varying degrees of dependence on ecosystems?	Food security and sustainable agriculture	RAWG
130	How do ecosystem services, including providing water and wild foods, contribute to food security?	Food security and sustainable agriculture	RAWG
131	What are the impacts of genetically modified organisms on biodiversity conservation?	Food security and sustainable agriculture	RAWG

Table C1. Unfiltered List of Priority Research Topics Generated by the RAWG and at the FAB Office Retreat.

#	Research Topic	Theme and Sub-theme	Source
132	How can we develop incentives for the sustainable management of biodiverse areas to mitigate against food scarcity?	Food security and sustainable agriculture	RAWG
133	Is minor forest production (e.g., beekeeping) or community forestry a poverty trap? To what degree does it provide a stepping stone to other more lucrative livelihoods (from a biodiversity and livelihoods perspective)?	Economic growth, poverty alleviation, and livelihoods	RAWG
134	Many programs assume that changing livelihoods (e.g., ecotourism, beekeeping, and timber products) will have a positive impact on biodiversity conservation. Does the economic incentive approach work? How do different categories of people react to different incentives?	Economic growth, poverty alleviation, and livelihoods	RAWG
135	Does economic growth stimulate increased consumption of resources, to the detriment of the impoverished dependent on those resources?	Economic growth, poverty alleviation, and livelihoods	RAWG
136	Does broad-based economic growth focused on equitable distribution yield better outcomes for biodiversity than free-market approaches?	Economic growth, poverty alleviation, and livelihoods	RAWG
137	What is the relationship between access to natural resources and extreme poverty?	Economic growth, poverty alleviation, and livelihoods	RAWG
138	What are the benefits of leapfrogging into a services-based economy, and what impacts does this have on biodiversity? For example, what is the degree of deforestation that can be allowed that would foster economic growth without threatening biodiversity?	Economic growth, poverty alleviation, and livelihoods	RAWG
139	What is the role of natural capital in the economic success or failure of states?	Economic growth, poverty alleviation, and livelihoods	RAWG

Table C1. Unfiltered List of Priority Research Topics Generated by the RAWG and at the FAB Office Retreat.

#	Research Topic	Theme and Sub-theme	Source
140	Regarding wildlife trafficking, how effective is it to work on the supply side compared with the demand side?	Economic growth, poverty alleviation, and livelihoods	RAWG
141	Which approaches are most effective in combatting the different types of wildlife trafficking (e.g., bushmeat compared with rhino compared with saiga)?	Economic growth, poverty alleviation, and livelihoods	RAWG
142	Many developing populations are experiencing a population dividend or youth bulge. What is the impact of the more productive “middle” on biodiversity?	Health and nutrition	RAWG
143	Does ecosystem degradation result in reversals of global health gains (e.g., does deforestation in areas that had eradicated malaria result in a resurgence of malaria, and hence a loss of progress)?	Health and nutrition	RAWG
144	What trade-offs are people willing to make between health and biodiversity conservation? Where does biodiversity fit into people’s cost-benefit analysis when they are assessing options/actions to meet their immediate needs?	Health and nutrition	RAWG
145	What is the impact of water pollution on ecosystems and, in turn, on health?	Health and nutrition	RAWG
146	To what extent does community-based natural resource management result in improved civil society building at the grass-roots level, better governance, and advocacy for the rights of indigenous people and women?	Democracy, rights, and governance	RAWG
147	How does community-based natural resource management (CBNRM) enhance women’s rights?	Democracy, rights, and governance	RAWG

Table C1. Unfiltered List of Priority Research Topics Generated by the RAWG and at the FAB Office Retreat.

#	Research Topic	Theme and Sub-theme	Source
148	Are women who participate in CBNRM groups more empowered in their households, for example in terms of their decision-making power, compared to women who do not participate in CBNRM groups?	Democracy, rights, and governance	RAWG
149	The loss of local knowledge of biodiversity (e.g., through migration) is a huge driver of biodiversity loss. How do we measure this impact?	Democracy, rights, and governance	RAWG
150	A significant amount of programming is invested in improving tenure rights. Is this approach working and under what conditions?	Democracy, rights, and governance	RAWG
151	Does supporting indigenous communities to attain land tenure result in improved biodiversity outcomes? Does providing land tenure to those communities strengthen their position to attain improved development outcomes?	Democracy, rights, and governance	RAWG
152	Do increased rule of law and anti-corruption initiatives contribute to biodiversity conservation? Are there spillover effects from enforcement into other sectors?	Democracy, rights, and governance	RAWG
153	How does corruption influence the effectiveness of conservation, and what are the most effective ways of preventing the negative consequences of corruption?	Democracy, rights, and governance	FAB Office Retreat
154	How has disruption of environmental flows (such as through unsound development and operation of dams and water withdrawals) threatened downstream ecosystems and vital ecosystem goods and services to humans?	Water	RAWG

Table C1. Unfiltered List of Priority Research Topics Generated by the RAWG and at the FAB Office Retreat.

#	Research Topic	Theme and Sub-theme	Source
155	How can natural infrastructure, such as mangrove forests along coasts and wetlands and forests in upper watersheds, mitigate the impacts of floods, droughts, cyclones, and storm surge?	Water	RAWG
156	To what extent does climate change variability impact the resilience of a resource (e.g., a biodiverse system can help provide resilience to climate change and also be impacted by it)?	Climate change	FAB Office Retreat
157	Is an area with greater biodiversity more resilient to climate change?	Climate change	FAB Office Retreat
158	To what extent does integration of climate change adaptation into the planning of 'eco-towns' have a positive impact?	Climate change	FAB Office Retreat
159	Regarding adaptation approaches to climate change, what are the benefits of an ecosystem-based approach compared with a traditional approach?	Climate change	FAB Office Retreat
160	Among the different approaches to climate change adaptation, which ones are working and which ones are not?	Climate change	FAB Office Retreat
161	If there are benefits to an ecosystem-based adaptation approach, what is the economic value of these benefits?	Climate change	FAB Office Retreat
162	What is a positive climate change externality attributable to biodiversity?	Climate change	FAB Office Retreat

Table C1. Unfiltered List of Priority Research Topics Generated by the RAWG and at the FAB Office Retreat.

#	Research Topic	Theme and Sub-theme	Source
163	What incentivizes people to adopt climate change adaptation practices?	Climate change	FAB Office Retreat
164	What is the role of livelihood diversification as a climate change adaptation strategy?	Climate change	FAB Office Retreat
165	How do the benefits of intact ecosystems, such as biodiversity and genetic variability, help to mitigate climate change impacts on food security, fire resistance, water quality and quantity, corals, and fisheries?	Climate change	FAB Office Retreat
166	How do forests, coastal vegetation, native grasses, and wetlands help to mitigate natural disasters such as floods, fire, etc.)?	Natural disaster mitigation	FAB Office Retreat
167	When the ecosystem impacts of agricultural intensification, such as creating dead zones, are accounted for, does agricultural intensification increase food production and security?	Sustainable agriculture	FAB Office Retreat
168	Does agricultural intensification reduce deforestation or land conversion?	Sustainable agriculture	FAB Office Retreat
169	What are the impacts of agrochemicals on downstream ecosystems?	Sustainable agriculture	FAB Office Retreat
170	What is the role of crop genetic diversity in climate change resilience?	Sustainable agriculture	FAB Office Retreat
171	What is the interaction between different elements in multiuse landscapes?	Sustainable agriculture	FAB Office Retreat

Table C1. Unfiltered List of Priority Research Topics Generated by the RAWG and at the FAB Office Retreat.

#	Research Topic	Theme and Sub-theme	Source
172	How can the value of inputs from natural resources management, such as water quality and quantity and soil fertility that impact agricultural productivity, be captured?	Sustainable agriculture	FAB Office Retreat
173	When is shifting cultivation worse or better for biodiversity?	Sustainable agriculture	FAB Office Retreat
174	Is food diversity as or more important than biofortification, and if so, where?	Food security	FAB Office Retreat
175	How important are wild relatives of crops to food security?	Food security	FAB Office Retreat
176	What is the contribution of wild foods to food security for the extreme poor and what is the value (e.g., economic and health) of this contribution?	Food security	FAB Office Retreat
177	What is the correlation between unmet needs or demand for family planning and reproductive health and conservation impacts?	Health	FAB Office Retreat
178	What is the role of intact ecosystems in mitigating the impacts of pollution on human health?	Health	FAB Office Retreat
179	How does the impact of pollution on ecosystems translate into human health effects?	Health	FAB Office Retreat
180	How do invasive species impact human health and nutrition through their effects on the survival of native plants or animals and domestic livestock?	Health	FAB Office Retreat
181	What is the role of deforestation on patterns of zoonotic disease transmission?	Health	FAB Office Retreat

Table C1. Unfiltered List of Priority Research Topics Generated by the RAWG and at the FAB Office Retreat.

#	Research Topic	Theme and Sub-theme	Source
182	What is the role of wildlife trafficking or trade on zoonotic disease transmission patterns?	Health	FAB Office Retreat
183	Among zoonotic disease agents, which ones are most likely to jump species boundaries in the context of deforestation?	Health	FAB Office Retreat
184	Are educational programs focused on teaching people about wildlife disease effective or harmful as a conservation strategy, and how could these educational programs be more effective?	Health	FAB Office Retreat
185	What is the role of medicinal plants in determining human health outcomes?	Health	FAB Office Retreat
186	How does interacting with nature impact mental health outcomes, and do degraded ecosystems result in increased human demand for more sustainable natural resources management?	Health	FAB Office Retreat
187	How does poor health impact biodiversity at the individual level (e.g., liquidation of natural capital to meet health care expenses) and community level?	Health	FAB Office Retreat
188	What is the contribution of wild foods (wild plants and animal sources) to human nutritional outcomes?	Nutrition	FAB Office Retreat
189	What are the theories of change underlying biodiversity programs that promote alternative livelihoods (a dominant activity supported by USAID), and do they address barriers or threats?	Livelihoods	FAB Office Retreat
190	Does diversification of livelihoods for climate change adaptation address degradation and leakage?	Livelihoods	FAB Office Retreat

Table C1. Unfiltered List of Priority Research Topics Generated by the RAWG and at the FAB Office Retreat.

#	Research Topic	Theme and Sub-theme	Source
191	What are the benefits of cost-benefit analysis compared with cultural approaches to valuation, particularly with respect to the valuation of biodiversity investments and economic co-benefits?	Livelihoods	FAB Office Retreat
192	How can the Agency contribute to the green growth agenda, the natural capital approach, and the blue growth approach?	Livelihoods	FAB Office Retreat
193	Under what conditions do enterprise approaches to conservation, such as ecotourism, benefit biodiversity?	Livelihoods	FAB Office Retreat
194	What are the tipping points that result in unsustainable enterprise approaches to conservation?	Livelihoods	FAB Office Retreat
195	What are the state of the art practices and systemic constraints in integrating conservation into economic growth?	Livelihoods	FAB Office Retreat
196	What are the impacts of urban investments in rural areas, such as coffee farms, on biodiversity?	Livelihoods	FAB Office Retreat
197	Is 'empowerment' the most strategic approach to poverty alleviation?	Poverty alleviation	FAB Office Retreat
198	Under what conditions does biodiversity provide a safety net for marginalized people?	Poverty alleviation	FAB Office Retreat

II. Research Topics Selected from the Literature on Conservation and Development

Table C2. Unfiltered List of Research Topics Selected from the Literature on Conservation and Development.

#	Leading research topics from the literature on conservation and development
1	How do policy, legal, or institutional arrangements shape the effectiveness of integrated management for terrestrial watersheds and adjacent coastal environments?
2	How will ocean acidification affect marine biodiversity and ecosystem functions, and what measures could mitigate these effects?
3	How will coastal aquifers and groundwater resources respond to sea-level rise through effects such as saltwater intrusion, and how can freshwater quality be maintained under these conditions?
4	How will coastal human communities be affected by sea-level rise and increasing levels of erosion?
5	Which management actions are most effective for ensuring the long-term survival of coral reefs in response to the combined impacts of climate change and other existing stressors?
6	What management approaches will be required to maintain or increase the abundance of fish and shellfish populations when harvesting is one of multiple stressors acting on those populations?
7	To what extent can coastal habitat restoration or rehabilitation compensate for loss of quantity or quality of existing species' habitat?
8	Which management approaches to fisheries are most effective at mitigating the impacts of fish extraction and fishing gear on non-target species and their habitats?
9	How can aquaculture and open water farming be developed to minimize impacts on coastal and aquatic habitats?
10	How will northern coastal ecosystems respond to changes in climate and industrial activity as reduced ice cover increases human access to those ecosystems?
11	What are the effects of changes in human patterns of seafood consumption on biodiversity?
12	How are human patterns of seafood consumption shaped by education programs, financial incentives, and other policy instruments?
13	What are the comparative impacts of newly emerging types of renewable energy, such as wave energy, on coastal ecosystems and species?
14	How will key fishery species be affected by changes to nursery grounds as coastal ecosystems undergo reorganization?
15	How far should we go with managed realignment of coasts in order to adapt to sea-level rise?
16	How do aquatic conservation policies directly or indirectly affect human health?
17	In and outside of marine protected areas, how do the abundances and distributions of species with different life histories respond to establishment of those areas?
18	What are the impacts of alternative configurations of, and management strategies for, aquatic reserves on human well-being?
19	What are the cumulative demographic and genetic effects of harvest on target and non-target aquatic populations and species?

Table C2. Unfiltered List of Research Topics Selected from the Literature on Conservation and Development.

#	Leading research topics from the literature on conservation and development
20	How important are caged fishes as reservoirs of parasites and pathogens that have detrimental effects on wild populations?
21	How do transboundary migrations of aquatic animals affect efforts to manage populations of those species?
22	What quantity and quality of surface and groundwater will be necessary to sustain human populations and ecosystem resilience during the next 100 years?
23	How do different strategies for ecosystem management across the gradient of development intensities affect human health in urban areas?
24	How do different strategies for growing and harvesting biomass or biofuel affect ecosystems and associated social and economic systems?
25	How do different strategies for managing forests, grass-lands, and agricultural systems affect carbon storage, ecosystem resilience, and other desired benefits?
26	What are the relative ecological effects of increasing the intensity compared with spatial extent of agricultural and timber production?
27	How do different agricultural practices and technologies affect water availability and quality?
28	What are the ecological and economic effects of different methods of restoring forests, wetlands, and streams?
29	What are the potential effects on ecosystems of developing new sources of renewable and nonrenewable energy?
30	How do population dynamics respond to the independent and interactive effects of multiple stressors?
31	How is the productivity of soil in a given region affected by different policies and stressors?
32	What are the aggregate effects on ecosystems of current-use and emerging toxicants?
33	How do demographic and cultural shifts in the human populations shape conservation values, attitudes, and behaviors?
34	How do the social and economic impacts of conservation policies vary spatially, temporally, and among social groups?
35	In and outside the United States, what are the ecological and economic effects of programs implemented under the Conservation Title of the Farm Bill?
36	How do shifts in agricultural subsidies, commodity prices, and markets affect the location and rate of conversion of natural ecosystems to agricultural uses?
37	What are the ecological, social, and economic costs and benefits of different mechanisms of conservation financing?
38	How do different systems of natural resource governance affect capacity for adaptive management?
39	How do different systems of natural resource governance affect the maintenance of ecosystem resilience?
40	How do different types of cross-jurisdictional governance systems affect ecosystems?

Table C2. Unfiltered List of Research Topics Selected from the Literature on Conservation and Development.

#	Leading research topics from the literature on conservation and development
41	What are reliable and scientifically defensible metrics for quantifying the benefits that humans receive from ecosystems and trade-offs among those benefits?
42	What are reliable scientific metrics for detecting chronic, long-term changes in ecosystems?
43	How does the configuration of land cover and land use affect the response of ecosystems to climate change?
44	How will changes in land use and climate affect the severity of infrequent, spatially extensive disturbance events?
45	What attributes of ecosystems facilitate prediction of impending transitions among alternative states?
46	At what threshold values of abiotic or biotic attributes do ecosystems change abruptly in response to species extirpations or species introductions?
47	How will changes in land use affect species composition and how will those changes impact ecosystems?
48	How will changes in climate affect species composition and how will those changes affect ecosystems?
49	What are the ecological characteristics of populations and species most likely to persist in the face of changes in land use and climate?
50	What factors affect the ability of native species to move through and persist in human-dominated landscapes?
51	How will changes in land use and climate affect ecologically and economically important mutualistic relationships among species?
52	How will changes in land use and climate affect the prevalence and rates of transmission of diseases among non-domesticated animals?
53	How will changes in land use and climate affect the prevalence and rates of transmission of diseases among humans?
54	How will changes in land use and climate affect factors that facilitate the spread of nonnative species?
55	What are the attributes of species that will require ongoing human intervention to persist outside captivity?
56	How does domestic propagation of species affect the supply of, demand for, and persistence of these species in the wild?
57	How will changes in the Arctic's climate affect ecosystems in the Arctic and elsewhere?
58	What ecological and economic changes will result from ocean acidification (in the Coral Triangle region)?
59	How will coastal ecosystems and human communities be affected by sea-level rise, storm surge, erosion, the intrusion of saltwater, and changes in the amount and variability of precipitation?
60	How do alternative ways of managing fisheries affect marine ecosystems and coastal human communities?
61	In and outside of marine protected areas, how do the abundances and distributions of species with different life histories respond to establishment of those areas?

Table C2. Unfiltered List of Research Topics Selected from the Literature on Conservation and Development.

#	Leading research topics from the literature on conservation and development
62	How will changes in land use and climate affect the effectiveness of terrestrial and marine protected areas?
63	Do critical thresholds exist at which loss of species diversity, or the loss of species, disrupts ecosystem functions and services, and how can we predict when these thresholds might be exceeded?
64	What is the effectiveness of different methods for the assessment of ecosystem services?
65	How can biodiversity considerations be integrated into economic policies to reflect the monetary and nonmonetary value of biodiversity, ecosystem processes, goods, and services?
66	How can ecosystems be managed to increase protection to humans and biodiversity from extreme events?
67	How, where, and when has biodiversity loss affected human welfare?
68	What strategies for distributing the material benefits derived from biodiversity most effectively foster environmental stewardship and biodiversity conservation?
69	How can we design protected area networks to increase carbon storage benefits and mitigate climate impacts, and use these benefits as incentives to support conservation actions?
70	How does soil biodiversity contribute to the amount and persistence of ecosystem services, including agricultural productivity?
71	What impact will the melting of polar ice and a reduction in permafrost have on the human use of high-latitude ecosystems, and how will these changes in human use affect biodiversity?
72	Which elements of biodiversity in which locations are most vulnerable to climate change, including extreme events?
73	How is the resilience of ecosystems to climate change affected by human activities and interventions?
74	What factors determine the rates at which coastal ecosystems can respond to sea-level rise, and which of these are amenable to management?
75	How will climate change, together with other environmental stressors, alter the distribution and prevalence of diseases of wild species?
76	How will human responses to climate change (e.g., changes in agriculture, resource conflicts, and migration) affect biodiversity?
77	How might biodiversity policies and management practices be modified and implemented to accommodate climate change?
78	How might emerging carbon markets affect biodiversity through their impacts on the protection, management, and creation of habitats?
79	What are the potential effects of feedbacks between climate change and ecosystem dynamics (e.g., drought, forest dieback, and coral bleaching) on the effectiveness of policy measures to sequester carbon and protect biodiversity?
80	How much carbon is sequestered by different ecosystems, including their soils, and how can these ecosystems be managed to contribute most effectively to the mitigation of climate change?
81	How, where, and to what extent can natural and semi natural ecosystems contribute to climate change adaptation and mitigation?

Table C2. Unfiltered List of Research Topics Selected from the Literature on Conservation and Development.

#	Leading research topics from the literature on conservation and development
82	How will climate change affect the distribution and impacts of climate-dependent disturbance regimes, such as fire?
83	How will climate change affect global food production, and what are the resulting consequences for ecosystems and agro biodiversity?
84	How does biodiversity shape social resilience to the effects of climate change?
85	How might nanotechnology have positive or negative impacts on biodiversity conservation?
86	How do the type, location, and associated mitigation measures of renewable energy technologies affect biodiversity?
87	What are the direct and indirect impacts of genetically modified organisms on biodiversity?
88	What are the implications for land use and biodiversity of the new and emerging bioeconomy markets (e.g., crops for pharmaceuticals, plastics, and adhesives)?
89	How effective are different types of protected areas (e.g., strict nature reserves, hunting reserves, and national parks) at conserving biodiversity and providing ecosystem services?
90	What is the management cost per hectare required to manage protected areas effectively, and how does this vary with management category, geography, and threat?
91	What are the human well-being costs and benefits of protected areas; how are these costs and benefits distributed to stakeholders and in local communities; and how do they vary with governance, resource tenure arrangements, and site characteristics?
92	How does the management of protected areas affect conservation beyond the boundaries of the protected area, such as through the displacement of human populations, hunting, or fishing?
93	What is the trade-off for biodiversity between balancing production of natural resources from intensive management systems, such as plantation forestry and aquaculture, compared with harvesting those resources from more natural ecosystems?
94	What was the condition of ecosystems before significant human disruption, and how can this knowledge be used to improve current and future management?
95	What and where are the significant opportunities for large-scale ecosystem restoration that benefits biodiversity and human well-being?
96	How can ecosystem management systems be designed to better emulate natural processes, notably natural disturbance regimes, and to what extent does this improve conservation effectiveness?
97	To what extent, and under what conditions, does the integration of marine, terrestrial, and freshwater ecosystems in conservation plans yield better outcomes than plans based on single realms?
98	What spatial pattern of human settlement (e.g., clustered compared with dispersed) has the least impact on biodiversity?
99	What is the contribution of areas that are intensively managed for production of commodities (such as food, timber, or biofuels) to conservation of biodiversity at the landscape scale?

Table C2. Unfiltered List of Research Topics Selected from the Literature on Conservation and Development.

#	Leading research topics from the literature on conservation and development
100	How can an understanding of factors affecting household decisions to invest in different natural resource-based productive activities (e.g., agriculture, fishing, or hunting) be used to predict the biodiversity impacts of household responses to environmental change?
101	How will ocean acidification affect marine biodiversity and ecosystem function, and what measures could mitigate these effects?
102	What are the ecological, social, and economic impacts resulting from the expansion of freshwater and marine aquaculture?
103	Which management actions are most effective for ensuring the long-term survival of coral reefs in response to the combined impacts of climate change and other existing stressors?
104	Which management approaches to fisheries are most effective at mitigating the impacts of fish extraction and fishing gear on non-target species and their habitats?
105	How does the effectiveness of marine protected areas vary with biological, physical, and social factors?
106	How does the effectiveness of marine protected areas vary with connectivity to other protected areas?
107	What will be the impacts of climate change on phytoplankton and oceanic productivity, and what will be the feedbacks of these impacts on the climate?
108	How will multiple stressors, especially fishing, pollution, sea temperature fluctuations, acidification, and diseases, interact to affect marine ecosystems?
109	Which mechanisms are most effective at conserving biodiversity in ocean areas occurring outside the legal jurisdiction of any single country?
110	How can freshwater biodiversity and ecosystem service values best be incorporated in the design of water-provisioning schemes for direct human use and food production?
111	Which aquatic species and communities are most vulnerable to human impacts?
112	How does degradation of aquatic species and communities affect the provision of ecosystem services?
113	Where will the impacts of global climate change on hydrology be most extreme, and how might they affect freshwater species and the ability of wetlands and inland waters to deliver ecosystem services?
114	Which multinational governance, cross-sector cooperation arrangements, and finance mechanisms will make freshwater ecosystem management more effective and reduce international conflicts over water?
115	How does investment in restoration of wetlands and riparian areas compare with construction of dams and flood defenses in providing cost-effective improvements in flood management and the storage and retention of water for domestic, industrial, and agricultural use?
116	Under what conditions is trade in captive or wild-harvested species beneficial for wild populations of the traded species?
117	What information is required to enable responsible authorities to decide when and how to manage nonnative species?

Table C2. Unfiltered List of Research Topics Selected from the Literature on Conservation and Development.

#	Leading research topics from the literature on conservation and development
118	What is the relative effectiveness of different methods for facilitating movement of a species among distinct patches of its habitat?
119	What is the cost-effectiveness of different contributions to species conservation programs such as education, captive breeding, and habitat management?
120	What are the ecosystem impacts of efforts to conserve charismatic, flagship, or umbrella species?
121	What are the likely risks, costs, and benefits of reintroducing and translocating species as a response to climate change?
122	What are the most effective approaches for reversing range and population collapse in top predators, large herbivores, and other species that exert disproportionate effects on ecosystem structure and function?
123	How can we best manage diseases that have the potential to move among wild species, domestic species, and people?
124	How do the characteristics of the organizations (e.g., government compared with nongovernment) and their funding (e.g., amount and duration of funds) shape the effectiveness of conservation interventions?
125	What factors affect the extent to which practitioners integrate consideration of human needs and preferences into policy and practice?
126	What is the cost-effectiveness of different approaches for rapidly expanding professional conservation capacity, and how does this vary with circumstances and among countries?
127	What is the effectiveness of the different mechanisms used to foster the evaluation and dissemination of conservation interventions?
128	How effective are the different strategies devised to integrate scientific knowledge into conservation policy and practice?
129	How effective are the different mechanisms used to promote data sharing and collaboration among individuals, conservationists, and conservation organizations?
130	What are the impacts on biodiversity of shifting patterns and trends in human demography, economic activity, consumption, and technology?
131	How does the relationship between economic growth and biodiversity vary across scales, among different ecosystems, and with economic activity?
132	What are the direct and indirect impacts of armed conflict on biodiversity?
133	What are the biodiversity impacts of changes in energy prices?
134	How do resource tenure systems shape conservation outcomes in different social and ecological contexts?
135	What are the impacts of international trade agreements and related policy instruments on biodiversity?
136	How do economic subsidies affect biodiversity in the recipient country and elsewhere?
137	How does corruption influence the effectiveness of conservation, and what are the most effective ways of preventing negative consequences?

Table C2. Unfiltered List of Research Topics Selected from the Literature on Conservation and Development.

#	Leading research topics from the literature on conservation and development
138	What are the conservation impacts of improved access to education, employment, and reproductive choice?
139	What is the relationship between individuals learning about environmental problems and their conservation attitudes, knowledge, beliefs, and behaviors?
140	What are the impacts of increasing human dissociation from nature on the conservation of biodiversity?
141	What are the effects of changes in human patterns of food consumption on biodiversity (e.g., shift from bushmeat to domestic meat and from fish to plant-based protein)?
142	How are changes in food consumption (e.g., shift from bushmeat to domestic meat and from fish to plant-based protein) shaped by education programs, financial incentives, and other policy instruments?
143	What factors shape human (in)tolerance of the presence and activities of wild animals, especially where those animals induce human–wildlife conflict?
144	What have been the impacts on biodiversity of the Convention on Biological Diversity 2010 targets, and what objectives, mechanism, time frame, and means of measurement would be most effective for future targets?
145	How do different values (e.g., use compared with preservation) and the framing of these values (e.g., ecosystem services compared with species) motivate policy makers to assign public resources to conservation programs and policies?
146	What factors shape individual and state compliance with local, national, and international conservation regimes?
147	What are the consequences of investment in improving knowledge (e.g., status, nature of threat, and effectiveness of interventions) compared with expenditure on conservation action, and how does this differ among conservation issues?
148	What are the impacts on biodiversity and human well-being of differing approaches to devolving different rights (e.g., access, ownership, management, transfer, exclusion, and use) to land and natural resources?
149	What are the impacts of different conservation incentive programs on biodiversity and human well-being?
150	How does public involvement, especially of marginalized groups, in conservation decision-making shape the effectiveness of conservation interventions?
151	What are the impacts of free, prior, and informed consent policies on the emergence, evolution, and performance of conservation interventions?
152	How does providing information to resource users affect behavior and support for collective restrictions, and how does the effect vary with different means of providing the information?
153	What are the conservation impacts of corporate social responsibility regimes that are biodiversity-oriented?
154	What are the social impacts of conservation interventions, and how and why do these impacts vary among social groups (e.g., elites, poor, women, and indigenous)?

Table C2. Unfiltered List of Research Topics Selected from the Literature on Conservation and Development.

#	Leading research topics from the literature on conservation and development
155	What factors shape the likelihood and extent of formal recognition of informal (potentially including traditional or customary) rights to land, wildlife, and other natural resources and traditional institutions for managing or administering these rights as the basis for conservation policy and practices? What are the impacts of formal recognition of informal (potentially including traditional and customary) rights to land, wildlife, and other natural resources and traditional institutions for managing or administering these rights as the basis for conservation policy and practices on conservation outcomes?
156	What are the most cost-effective means of encouraging broad, long-lasting, and active societal support and action for conservation in different contexts and among different actors?
157	What has been the effect of environmental impact assessments on biodiversity conservation?
158	What mechanisms best promote the use of local ideas and knowledge in conservation programs in ways that enhance biodiversity outcomes?
159	What are the predicted critical impacts of climate change (e.g., changes in temperature, wind speed, humidity and water availability, storm intensity, crop water requirements, snowmelt and seasonal runoff, pests, waterlogging, agroecosystem shifts, human migration) on agricultural yields, cropping practices, crop disease spread, disease resistance, and irrigation development?
160	What would be the global cost of capping agricultural water withdrawals if environmental reserves were to be maintained?
161	What is the effect of increased rain water harvesting on local hydrological fluxes, and how do local changes combine and alter water resource availability at larger geographic scales?
162	How can aquaculture and open water farming be developed so that impacts on wild fish stocks and coastal and aquatic habitats are minimized?
163	What approaches (operational, agronomic, genetic, supplemental irrigation schemes, fertility management, winter rainfall storage) can be developed to increase water use efficiency in agriculture, and what is the cost-effectiveness of these approaches?
164	What combinations of forestry, agroforestry, grass cover, water-collecting systems and storage facilities, drought-resistant crops, and water-saving technology are needed in arid and semi-arid areas to increase food production, and to what extent can they become cost-effective?
165	How can the allocation of water be optimized between irrigated agriculture and environmental functions, and what innovative policies and technologies can minimize trade-offs between irrigation and healthy functions of natural ecosystems?
166	What benefits can sustainable soil management deliver for both agricultural production and delivery of other ecosystem services?
167	What are the best uses of organic amendments by subsistence farmers in cropping systems to improve soil nutrients and water-holding capacities and thereby assist in restoring agroecosystems?
168	What are the most practical and economic methods for managing soil fertility in paddy soils and upland production systems in the tropics?

Table C2. Unfiltered List of Research Topics Selected from the Literature on Conservation and Development.

#	Leading research topics from the literature on conservation and development
169	What guidelines can be established for poor small-scale farmers to ensure that nitrogen fertilization is managed in a way that results in net accretion of soil organic carbon rather than net mineralization?
170	How can salinization be prevented and remedied?
171	How can native soil organisms be exploited to maximize food productivity and minimize environmental impacts?
172	Which stocks and reserves of phosphate in the world are mobile, and are they sufficient to support adequate levels of food production globally for the next century?
173	What is the relationship between productivity and biodiversity (and other ecosystem services), and how does this vary between agricultural systems and as a function of the spatial scale at which land is devoted mostly to food production?
174	How should the options of intensification, extensification, habitat restoration, or the status quo be chosen, and how can we best combine measures of economic, environmental, and social benefit to make the choice?
175	What are the environmental consequences of drought-resistant crops in different locations?
176	What are the consequences for biodiversity conservation and delivery of other ecosystem services if crop and livestock management is driven by the objectives of greenhouse gas (GHG) emission reduction?
177	In intensive production systems, are agri-environment measures best deployed to buffer protected areas and areas of pristine or semi natural habitat, or to 'soften the matrix' between patches of these habitats?
178	Where would natural habitat restoration provide the greatest food and environmental benefits to society?
179	What combinations of improved technologies, farming practices, institutions, and policies will result in the maintenance of ecosystem services, including soil fertility, in agricultural systems undergoing intensification in developing countries, such as Sub Saharan Africa?
180	Can payments for ecosystem services (e.g., carbon sequestration, green water credits, and biodiversity enrichment) lead to adoption of recommended land-use and management practices by resource-poor farmers in developing countries?
181	What are the best options for agriculture increasing food production while simultaneously reducing its contribution to GHG emissions?
182	What will be the risk of mass migration arising from adverse climate change, and how will this impact agricultural systems?
183	Given the high current direct and indirect energy inputs into agriculture, how can food production be made carbon neutral to allow emission targets to be met over the next 40 years?
184	How would different market mechanisms of payment for GHG reduction and carbon storage in agriculture affect farming and how could these best be implemented?
185	How can competing demands on land for production of food and energy be balanced to ensure the provision of ecosystem services while maintaining adequate yields and prices?

Table C2. Unfiltered List of Research Topics Selected from the Literature on Conservation and Development.

#	Leading research topics from the literature on conservation and development
186	How can the resilience of agricultural systems be improved to gradual climate change and increased climatic variability and extremes?
187	What is the appropriate mix of intensification and extensification required to deliver increased production, GHG reduction, and increased ecosystem services?
188	How can crop breeding, new technologies, the use of traditional crops, and improved agronomic practice be balanced to increase food production and enhance resilience to future climate change?
189	How can the transition from a hydrocarbon-based economy to a carbohydrate-based economy best be made using biorefineries to process agricultural products to provide high-value products, biomaterials, energy and soil improvers, and the food products currently produced?
190	How can long-term carbon sinks be created on farms (e.g., by soil management practices, perennial crops, trees, ponds, and biochar)?
191	How can the inclusion of agriculture in carbon markets provide significant benefits for farmers?
192	What are the benefits and risks of embracing the different types of agricultural biotechnology (environmental impacts; sensitivity or resistance to environmental stressors such as heat, drought, salinity; dependence on or independence from inputs; risks of accelerated resistance; food safety, human health, and nutrition; economic, social, and cultural impacts)?
193	What are the advantages and disadvantages of organic production systems in terms of biodiversity, ecosystem services, yield, and human health, particularly in resource-poor developing countries?
194	What practical measures are needed to lower the ideological barriers between organic and genetically modified, and thus fully exploit the combined potential of genetically modified crops and organic modes of production to achieve agroecological management practices compatible with the sustainable intensification of food production?
195	What is the long-term capacity of fossil fuels and nitrogen, phosphorus, and potassium fertilizer stocks to support intensive production systems globally?
196	How can food production systems that reduce dependence on externally derived nitrogen, phosphorus, and potassium resources be designed?
197	How can we develop agreed metrics to monitor progress toward sustainability in different agricultural systems that are appropriate for, and acceptable to, different agroecological, social, economic, and political contexts?
198	What part can reclamation, restoration, and rehabilitation of degraded land play in increasing global food production?
199	What are the best integrated cropping and mixed system options (including fallow rotations and other indigenous cropping systems for cereals, tubers and other staples, agroforestry, crop-livestock, and crop-aquaculture systems) for different agroecological and socioeconomic situations, taking account climate and market risk, farm household assets, and farmers' circumstances?

Table C2. Unfiltered List of Research Topics Selected from the Literature on Conservation and Development.

#	Leading research topics from the literature on conservation and development
200	What are the gains in resource use efficiency that could be achieved by crop genetic improvement for resistance to abiotic and biotic stresses?
201	What improvements to crop varieties can be made to ensure that emissions of GHGs from agriculture and horticulture are significantly reduced?
202	What is the comparative effectiveness of different genetic approaches to the development of crops with tolerance of abiotic stresses such as frost, heat, drought, waterlogging, acid infertility, and salinity?
203	What is the efficiency of different ways to genetically improve the nutrient-use efficiency of crops and simultaneously increase yield?
204	What impact can crop genetic improvement have on levels of micronutrients available to humans, livestock, and fish?
205	What evidence exists to indicate that climate change will change pest and disease incidence?
206	How can insecticide application in agriculture be modified to lessen the evolution of pesticide resistance in mosquitoes and other major vectors of human disease?
207	How can landscape-level interventions help pest management, and which approaches are the most economically and socially sustainable?
208	How can perennial-based farming systems include cover crops as a pest management method and what are the economic and non-economic costs and benefits?
209	How can intensive livestock systems be designed to minimize the spread of infectious diseases among animals and the risk of the emergence of new diseases infecting humans?
210	How can increasing both crop and non-crop biodiversity help in pest and disease management?
211	How can middle and small-scale animal production be made suitable for developing countries in terms of environmental impact, economic return, and human food supply, and what should be the key government policies to ensure balance between the two?
212	What are the priority efficiency targets for livestock production systems (e.g., the appropriate mix of activities in different systems and the optimal numbers and types of animals) that would enable these systems to meet the demand for livestock products in an environmentally sound, economically sustainable, and socially responsible way?
213	What are the effective and efficient policies and other interventions to reduce the demand for animal products in societies with high consumption levels, and how will they affect global trade in livestock products and the competitiveness of smallholder livestock production systems in poor countries?
214	In addition to livestock production, how can inland and coastal fish farming contribute to a more sustainable mode of animal protein production in developing countries?
215	What are the best means to encourage the economic growth of regional livestock markets, while limiting the effects of global climate change, and what can industrialized countries do to improve the carbon footprint of its livestock sector?

Table C2. Unfiltered List of Research Topics Selected from the Literature on Conservation and Development.

#	Leading research topics from the literature on conservation and development
216	What are the environmental impacts of different kinds of livestock rearing and aquaculture systems?
217	As agriculture is highly knowledge intensive and institutionally determined, what is the effectiveness of different novel extension strategies, and how best can they be set up to facilitate institutional change and technical innovation with the aim of ensuring that the widest number of farmers are reached and engaged?
218	How much can agricultural education, extension, farmer mobilization, and empowerment be achieved by the new opportunities afforded by mobile phone and web-based technologies?
219	Which models and mechanisms for private-sector funding or co-financing of extension advisory systems have most successfully reached farmers otherwise excluded from public sector extension services?
220	What are the most effective approaches for retaining women in research and extension systems and ensuring that they are fully involved in the design of research and extension systems to meet both gender-specific and wider needs?
221	What are the best social learning and multi-stakeholder models (e.g., farmers field schools) to bring together farmers, researchers, advisors, commercial enterprises, policy makers, and other key actors to develop better technologies and institutions, for a more equitable, sustainable, and innovative agriculture?
222	What is the impact of agricultural subsidies in Organization for Economic Cooperation and Development countries on the welfare of farmers in developing countries?
223	What systematic approaches can be used to identify and adapt technical options for increasing land and water productivity of rain fed crop and livestock systems so that they contribute to poverty reduction in different agroecological and socioeconomic situations?
224	What are the society-wide trade-offs among efficiency, social equity, and environmental outcomes for agricultural development in societies with large rural and smallholder populations?
225	What are the best options to improve the sustainable intensification of agriculture?
226	How can the transition from today's smallholder-based agriculture to sustainable agricultural intensification occur in ways that maintain livelihoods for smallholder farmers?
227	What are the long-term impacts of international donors and aid enterprises on target beneficiaries in terms of food security, environmental sustainability, local economies, and social inclusion?
228	How can interdisciplinary frameworks integrating scientific innovation and multi-stakeholder perspectives be designed and effectively applied to farming systems in developing countries?
229	Under what environmental and institutional conditions will increasing agrobiodiversity at farm and landscape scales result in increased livelihood opportunities and income?
230	Who will be farming in 2050, and what will be their land relationships (farm ownership, rental, or management)?

Table C2. Unfiltered List of Research Topics Selected from the Literature on Conservation and Development.

#	Leading research topics from the literature on conservation and development
231	What will be the consequences to low-income countries of the increased political roles of countries with growing economic and purchasing power (e.g., Brazil, China, India, and Indonesia) in global food systems?
232	What is the effectiveness of aid delivery models for multilateral and bilateral donors for increasing the well-being and productivity of smallholder farmers in poorer developing countries?
233	Under what circumstances do investments in smallholder agriculture compared with larger and more mechanized farms achieve the greatest societal and environmental good?
234	What are the consequences of different mixes of public to private investment in irrigation infrastructure?
235	What are the consequences of different choices of investments in the resilience of agricultural systems to address the multifaceted adverse effects of climate change?
236	What steps need to be taken to encourage young people to study agricultural science?
237	How might a unified sustainable food standard be developed and implemented across trading blocs, such as European Union or North American Free Trade Agreement, to serve environmental, health (nutrition), food quality, and social values, and how could this be effectively communicated to shape food purchasing behavior?
238	Where is food waste greatest in food chains in industrialized and developing countries, and what measures can be taken significantly to reduce these levels of food waste?
239	What is the best way to make food chains more resilient to exogenous trends (e.g., the upward price of hydrocarbons) and shocks (e.g., disruption to air freight)?
240	What is the potential contribution of localized food production to the overall sustainability of food systems?
241	How might appropriate limits be established on national per capita levels of meat consumption, while recognizing projected demographic and economic growth, given the aggregate impact of global livestock numbers, particularly in relation to feed requirements and waste streams?
242	What are the best indicators that could be used to define agricultural sustainability thresholds (e.g., soil condition, biodiversity, nutrient cycling, energy use, and key biological processes such as pollination), and how might these be communicated through the food chain?
243	What are the best institutional mechanisms to manage food stocks, storage, distribution, and entitlement systems to ensure continued and sustainable supplies of food?
244	How can we expand the range and commercial development of food plants (given calorie dependence on the seven key crops of wheat, rice, maize, potatoes, soya, sugar cane, and sugar beet) to enhance resilience in food chains while retaining genetic diversity in crops and their wild relatives?

Table C2. Unfiltered List of Research Topics Selected from the Literature on Conservation and Development.

#	Leading research topics from the literature on conservation and development
245	How much land in agricultural regions should be left as natural habitats to provide ecosystem services and mitigate climate change threats?
246	What priority investments are needed to develop effective input and output markets in the poorest developing countries (especially Sub-Saharan Africa)?
247	As energy prices rise, how can agriculture increase its efficiency and use fewer inputs and fertilizers to become economically sustainable and environmentally sensitive, yet still feed a growing population?
248	What mechanisms can be devised to buffer against growing market volatility and subsequent risk for farmers and under which conditions do different mechanisms work best?
249	How can market-based food supply systems be developed that offer economically sustainable levels of financial reward to all participants in the food chain (i.e., farmers, processors, and retailers) while simultaneously providing safe, nutritious, natural resource-stewarding, and affordable food to consumers?
250	What mechanisms will provide incentives for further investment in sustainable, high-yielding agriculture that also maintains ecosystem services?
251	What mechanisms for institutional capacity can be used to create an efficient and equitable global marketing system so that food is produced in an economic and ecologically efficient manner and traded appropriately to achieve food security?
252	How can national food security policies be designed to be more compatible with worldwide open market food policies while securing the interests of local farmers and equitable access to food?
253	How will predicted changes in meat consumption across different countries affect demand for the range of agricultural produce?
254	What information is most useful to consumers wishing to make informed decisions about the environmental and social impacts of their food choices, and can intervention methods be developed that encourage and provide incentives to all consumers to eat healthy diets?
255	Under which conditions can governmental health policy successfully affect consumers' diets by promoting good food as preventative medicine?
256	What programs (or combinations) are most effective in promoting broad-based access to healthy food across different socioeconomic groups?
257	How effective are experiential learning programs (e.g., garden-based learning, wilderness therapy, forest schools, and outdoor learning) in promoting child nutrition, healthy child development, and prevention of obesity and diabetes?
258	What is the effectiveness of different systems aimed at enabling informed consumer choice to directly reward farmers and thereby encouraging the spread of positive environmental attributes in food production (e.g., direct distribution networks organized by farmers, labeling schemes on food, and information on farm websites)?
259	What is the impact of rapid growth of concentrated solar power on species viability?

Table C2. Unfiltered List of Research Topics Selected from the Literature on Conservation and Development.

#	Leading research topics from the literature on conservation and development
260	What are the potential risks and biodiversity impacts of sea-bed located oil drilling and processing?
261	What are the negative impacts on species and human health of the development and use of thorium-fuelled nuclear power?
262	What are the consequences of accelerating the water cycle (e.g., ocean salinity)?
263	What is the impact on species viability and land-cover fragmentation of the proliferation of hydropower in the Andean Amazon?
264	What are the consequences of species loss on global environmental change? What number of species is necessary to deliver ecosystem services?
265	What are the direct and indirect effects of switching to vegetarian aquaculture feed?
266	How does the increasing global demand for coconut water drive land-use change and potentially impact ecosystems in some areas?
267	Is the use of environmental DNA effective in detecting alien invasive species?
268	Is the propagation of coral nurseries and cultivation of coral from coral fragments and sexually produced propagules an effective strategy for reef restoration?
269	How can drones be used in species surveys, land-cover mapping, and patrolling of illegal activities?
270	What are the impacts of 3D printing on waste reduction and decreased emissions from transporting manufacturing goods?
271	How does species richness and organic food production in urban and suburban environments contribute to the combatting rates of allergy and autoimmune diseases which have steadily increased?
272	How are antimicrobial peptides transported from one environment to the other and what is the impact of the proliferation of their use on humans and other animals?
273	What are the impacts of the use of genetically modified organisms on wild species and ecosystems?
274	What is the impact of increasing consumption of milk and dairy products on land use and the structure of natural vegetation (e.g., clearance of tropical forests for cattle)?
275	What are the biological impacts of perfluorinated compounds (e.g., on fish and mammals)?
276	What are the environmental impacts of expanding mining for lithium?
277	What are the negative biological effects of genetic techniques to eradicate mosquitoes (e.g., on other species)?
278	What are the impacts of nitric acid rain from industrial emissions on species richness?
279	What is the extent of protected area failure?
280	How does the outbreak or reemergence of certain diseases affect species habitat and ecosystems (e.g., rinderpest)?
281	What are the impacts of hydraulic fracturing on natural landscapes?

Table C2. Unfiltered List of Research Topics Selected from the Literature on Conservation and Development.

#	Leading research topics from the literature on conservation and development
282	What are the impacts of increases in methane concentration and the mass destabilization of hydrate reservoirs on regional ocean deoxygenation, especially in circumpolar basins?
283	What are the impacts of temperature changes in Antarctic waters on species?
284	What are the impacts of pharmaceutical discharges on species and the environment?
285	Can genetically engineered crops that are able to fix their own nitrogen, reduce eutrophication of terrestrial, aquatic, and marine ecosystems?
286	What are the cross-sectoral benefits of switching from annual to perennial cereals, for example for species richness, reduction in desertification, soil erosion, and water contamination?
287	How can rapid and low-cost genetic sequencing be used to monitor the genetic status and stress levels of species?
288	What are the impacts of widespread commercial use of graphene on species (e.g., vegetable seedlings and animal species)?
289	What are the impacts of increased use of nuclear energy and batteries on land-use patterns?
290	What are the effects of the increased demand for cement on karst forest and cave ecosystems?
291	What are the impacts of in-stream hydrokinetic technologies on the structure of river bottoms and population dynamics of fish?
292	What are the toxic effects of microplastics on water, soil, and species?
293	What are the risks of nanosilver in wastewater to aquatic species?
294	What are the benefits and risks of shifting to synthetic meat (e.g., reduction in agricultural land and pressure on fish stock)?
295	What are the potential interactions between genetically modified organisms and genes and species in the natural environment?
296	What are the impacts of stratospheric aerosols on biological diversity?
297	How can the shift to biochar as a strategy for carbon sequestration impact land cover and species richness?
298	How can mobile-sensing technologies contribute to biodiversity monitoring (e.g., camera traps to sense wildlife, ground-truthing of remotely sensed data, and sound recognition of bird calls)?
299	What are the impacts of the deoxygenation of oceans on ocean ecosystems?
300	What are the potential effects of assisted colonization of species?
301	What are the possible impacts of REDD on species and processes in non-forested ecosystems?
302	How can the large-scale acquisition or leasing of agricultural land in Africa and Central and Southeast Asia be managed to prevent conversion of forests and grasslands?

Annex D: List of Priority Research Topics that Align with the BDRA Conceptual Framework

The following table lists research topics that align with the thematic areas of the BDRA conceptual framework, met the minimum scores for strategic value and result-specific prioritization criteria and are feasible to implement, listed in order of prioritization score and by source. Some questions from the peer-reviewed literature align with more than one thematic area of the BDRA conceptual framework. The questions included in the main body of the BDRA may appear in slightly modified form or placement relative to the questions in this annex. The themes and sub-themes in the main body of the BDRA may appear slightly modified compared with this annex of original data because the RAWG refined some terminology in later stages.

Table D1. List of Priority Research Topics that Align with the BDRA Conceptual Framework.

#	Research Topics	Theme of BDRA Conceptual Framework	Source	Average Score on Strategic Value Criteria
1	How do the benefits of intact ecosystems, such as biodiversity and genetic variability, help mitigate climate change impacts on food security, fire resistance, water quality and quantity, corals, and fisheries?	Climate change	FAB Office Retreat	2.24
2	To what extent does climate change variability impact the resilience of a resource (e.g., a biodiverse system can help provide resilience to climate change and also be impacted by it)?	Climate change	FAB Office Retreat	1.49
3	Is an area with greater biodiversity more resilient to climate change?	Climate change	FAB Office Retreat	1.49
4	To what extent does integration of climate change adaptation into the planning of 'eco-towns' have a positive impact?	Climate change	FAB Office Retreat	1.49
5	Regarding adaptation approaches to climate change, what are the benefits of an ecosystem-based approach compared with a traditional approach?	Climate change	FAB Office Retreat	1.49

Table D1. List of Priority Research Topics that Align with the BDRA Conceptual Framework.

#	Research Topics	Theme of BDRA Conceptual Framework	Source	Average Score on Strategic Value Criteria
6	If there are benefits to an ecosystem-based adaptation approach, what is the economic value of these benefits?	Climate change	FAB Office Retreat	1.49
7	What are the key intersections of human and natural vulnerability and resilience in the context of climate change adaptation in biodiverse areas?	Climate change and natural disaster mitigation	RAWG	2.49
8	(How) does enhancing the resilience of people to adapt to climate change impact the resilience of other system?	Climate change and natural disaster mitigation	RAWG	2.24
9	What are the consequences for biodiversity conservation and delivery of other ecosystem services if crop and livestock management is driven by the objectives of GHG emission reduction?	Threats\Climate change\Adaptation	Peer-reviewed literature	1.74
10	How will human responses to climate change (e.g., changes in agriculture, resource conflicts, and migration) affect biodiversity?	Threats\Climate change\Adaptation	Peer-reviewed literature	1.62
11	How is climate migration impacted by the integrity of the ecosystems in the areas from which people migrate?	Threats\Climate change\Adaptation	RAWG	1.49
12	Is a focus on small-scale diversification of livelihoods as a climate adaptation approach effective in conserving biodiversity?	Threats\Climate change\Adaptation	RAWG	1.49
13	What clean energy approaches are least harmful to biodiversity?	Threats\Climate change\Energy & fuel	RAWG	1.49

Table D1. List of Priority Research Topics that Align with the BDRA Conceptual Framework.

#	Research Topics	Theme of BDRA Conceptual Framework	Source	Average Score on Strategic Value Criteria
14	When building dams, under what conditions do fish passages/ladders work?	Threats\Climate change\Energy & fuel	RAWG	1.49
15	How do the type, location, and associated mitigation measures of renewable energy technologies affect biodiversity?	Threats\Climate change\Energy & fuel	Peer-reviewed literature	1.49
16	How do different strategies for growing and harvesting biomass or biofuel affect ecosystems and associated social and economic systems?	Threats\Climate change\Energy & fuel	Peer-reviewed literature	1.24
17	What are the potential effects on ecosystems of developing new sources of renewable and nonrenewable energy?	Threats\Climate change\Energy & fuel\Adaptation	Peer-reviewed literature	1.24
18	What ecological and economic changes will result from ocean acidification (in the Coral Triangle region)?	Threats\Climate change\Ocean acidification	Peer-reviewed literature	1.49
19	What are good practices for the integration of climate change into corridor planning?	Threats\Climate change\Other	RAWG	1.49
20	What will the impacts of climate-driven human migration be on high biodiversity areas?	Threats\Climate change\Other	RAWG	1.49
21	What is the contribution of wild foods to food security for the extreme poor and what is the value (e.g., economic and health) of this contribution?	Food security	FAB Office Retreat	2.12
22	What are the benefits that communities perceive from biodiverse areas, and how will this understanding help create better policy?	Food security and sustainable agriculture	RAWG	1.99

Table D1. List of Priority Research Topics that Align with the BDRA Conceptual Framework.

#	Research Topics	Theme of BDRA Conceptual Framework	Source	Average Score on Strategic Value Criteria
23	How can estate crops, such as coffee, cocoa, oil palm, and other commercial agricultural commodities, be managed to mitigate biodiversity loss or enhance biodiversity protection?	Food security and sustainable agriculture	RAWG	1.74
24	How do ecosystem services, including the provision of water and wild foods, contribute to food security?	Food security and sustainable agriculture	RAWG	1.74
25	How could we sustainably manage crop wild relatives outside protected areas?	Food security and sustainable agriculture	RAWG	1.62
26	How can increasing crop and non-crop biodiversity help in pest and disease management?	Food security\Value of Natural Resource Management to Agriculture	Peer-reviewed literature	1.49
27	What is the contribution of wild foods (wild plants and animal sources) to human nutritional outcomes?	Nutrition	FAB Office Retreat	1.87
28	What is the role of wildlife trafficking or trade on zoonotic disease transmission patterns?	Health	FAB Office Retreat	1.74
29	What is the role of medicinal plants in determining human health outcomes?	Health	FAB Office Retreat	1.74
30	What is the correlation between unmet needs or demand for family planning and reproductive health and conservation impacts?	Health	FAB Office Retreat	1.62
31	What is the role of deforestation on patterns of zoonotic disease transmission?	Health	FAB Office Retreat	1.62

Table D1. List of Priority Research Topics that Align with the BDRA Conceptual Framework.

#	Research Topics	Theme of BDRA Conceptual Framework	Source	Average Score on Strategic Value Criteria
32	Are educational programs focused on teaching people about wildlife disease effective or harmful as a conservation strategy, and how could these educational programs be more effective?	Health	FAB Office Retreat	1.49
33	What is the impact of water pollution on ecosystems and, thus, on health?	Health and nutrition	RAWG	1.87
34	Does ecosystem degradation result in reversals of global health gains (e.g., does deforestation in areas that had eradicated malaria result in a resurgence of malaria, and hence a loss of progress)?	Health and nutrition	RAWG	1.74
35	How do aquatic conservation policies directly or indirectly affect human health?	Health\Nutrition	Peer-reviewed literature	1.37
36	How can drones be used in species surveys, land-cover mapping, and patrolling of illegal activities?	Accountable & capable institutions\Capacities, skills, & resources	Peer-reviewed literature	1.49
37	What approaches are most effective for capacity building?	Accountable & capable institutions\Capacities, skills, and resources	RAWG	1.49
38	Where should the Agency invest funds to improve capacities for enforcement?	Accountable & capable institutions\Capacities, skills, and resources	RAWG	1.24
39	How can brain drain be prevented?	Accountable & capable institutions\Capacities, skills, and resources	RAWG	1.24
40	What is the role of universities in providing training for biodiversity conservation?	Accountable & capable institutions\Capacities, skills, and resources	RAWG	0.99

Table D1. List of Priority Research Topics that Align with the BDRA Conceptual Framework.

#	Research Topics	Theme of BDRA Conceptual Framework	Source	Average Score on Strategic Value Criteria
41	What is the relationship between decentralization and corruption?	Accountable & capable institutions\Corruption & transparency	RAWG	1.49
42	Under what conditions do watchdogs and civil society groups improve conservation outcomes?	Accountable & capable institutions\Corruption & transparency	RAWG	1.24
43	How can accountability and transparency be improved at the community level?	Accountable & capable institutions\Corruption & transparency	RAWG	1.24
44	Does co-management of protected areas promote transparency?	Accountable & capable institutions\Corruption & transparency	RAWG	0.99
45	What is the impact of democratization on biodiversity conservation?	Accountable & capable institutions\Corruption & transparency	RAWG	0.99
46	How does corruption influence the effectiveness of conservation, and what are effective ways to prevent negative consequences?	Accountable & capable institutions\Corruption and transparency	Peer-reviewed literature	1.49
47	How can the Agency bring women's organizations into conservation efforts (e.g., women's farmers groups)?	Constituencies for conservation	RAWG	1.49
48	How does the Agency bring farmers into the fold to support conservation programs?	Constituencies for conservation	RAWG	1.49
49	How does the Agency mobilize religious constituencies to support conservation?	Constituencies for conservation	RAWG	1.24
50	What is the relationship between individuals learning about environmental problems and their conservation attitudes, knowledge, beliefs, and behaviors?	Constituencies for conservation	Peer-reviewed literature	1.24

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#	Research Topics	Theme of BDRA Conceptual Framework	Source	Average Score on Strategic Value Criteria
51	How does public involvement, especially of marginalized groups, in conservation decision-making shape the effectiveness of conservation interventions?	Constituencies for conservation\Constituencies	Peer-reviewed literature	1.24
52	What factors shape human (in)tolerance of the presence and activities of wild animals, especially where those animals induce human–wildlife conflict?	Economic systems\Cultural valuation	Peer-reviewed literature	1.24
53	How are changes in food consumption (e.g., shift from bushmeat to domestic meat and from fish to plant-based protein) shaped by education programs, financial incentives, and other policy instruments?	Economic systems\Cultural valuation\Economic valuation	Peer-reviewed literature	1.49
54	What are the impacts of different conservation incentive programs on biodiversity and human well-being?	Economic systems\Cultural valuation\Economic valuation	Peer-reviewed literature	1.49
55	What are reliable and scientifically defensible metrics for quantifying the benefits humans receive from ecosystems and trade-offs among those benefits?	Economic systems\Economic valuation	Peer-reviewed literature	1.99
56	How can biodiversity conservation be successfully integrated into economic planning?	Economic systems\Economic valuation	RAWG	1.49
57	Do market incentives (e.g., alternative livelihood approaches, certification of green products) improve conservation outcomes?	Economic systems\Economic valuation	RAWG	1.24
58	Are different valuations more effective than others?	Economic systems\Economic valuation	RAWG	0.99

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#	Research Topics	Theme of BDRA Conceptual Framework	Source	Average Score on Strategic Value Criteria
59	How does the valuation of ecosystem services impact conservation outcomes?	Economic systems\Economic valuation	RAWG	0.99
60	How do payment for ecosystem services (PES) programs impact conservation outcomes?	Economic systems\Economic valuation	RAWG	0.99
61	Do alternative sources of incentives, like those provided by the banking and manufacturing industries, have positive impacts on conservation?	Economic systems\Economic valuation	RAWG	0.99
62	Are the activities being paid for by PES schemes and water funds protecting the water sources?	Economic systems\Economic valuation	RAWG	0.99
63	What are the barriers to implementing more forward thinking conservation policies (e.g., tax incentives, land-use incentives, and offsets)?	Economic systems\Economic valuation	RAWG	0.99
64	How can freshwater biodiversity and ecosystem service values best be incorporated in the design of water-provisioning schemes for direct human use and food production?	Economic systems\Economic valuation\Cultural valuation	Peer-reviewed literature	1.99
65	What are barriers preventing legal engagement in forestry activities?	Legal & regulatory framework\Regulation	RAWG	0.99
66	What approaches are most effective for securing resource tenure in ways that incentivize conservation?	Legal & regulatory framework\Resource tenure and access	RAWG	1.24

Table D1. List of Priority Research Topics that Align with the BDRA Conceptual Framework.

#	Research Topics	Theme of BDRA Conceptual Framework	Source	Average Score on Strategic Value Criteria
67	What is the impact on conservation outcomes when the linkages between different components of the bundle of rights (e.g., access, ownership, management, transfer, exclusion, and use) are not well defined or not implemented?	Legal & regulatory framework\Resource tenure and access	RAWG	0.99
68	Does granting legal rights first work better than granting management responsibility first?	Legal & regulatory framework\Resource tenure and access	RAWG	0.99
69	What are the conservation impacts of improved access to education, employment, and reproductive choice?	Drivers\Demography\Economy	Peer-reviewed literature	1.49
70	What are the impacts on biodiversity of shifting patterns and trends in human demography, economic activity, consumption, and technology?	Drivers\Demography\Economy\Science & technology	Peer-reviewed literature	1.49
71	What are the impacts of Feed the Future initiative on biodiversity?	Drivers\Development	RAWG	1.49
72	Which lessons learned from studies of agrarian change can lead to improved conservation practices?	Drivers\Development	RAWG	1.49
73	What does good development look like in relation to biodiversity?	Drivers\Development	RAWG	1.49
74	Are there effective financial incentives that encourage foreign direct investments to positively impact biodiversity (e.g., Equator Principles)?	Drivers\Economic & political systems	RAWG	1.49

Table D1. List of Priority Research Topics that Align with the BDRA Conceptual Framework.

#	Research Topics	Theme of BDRA Conceptual Framework	Source	Average Score on Strategic Value Criteria
75	How does access to health care impact biodiversity and what are the effects at different spatial and temporal scales (e.g., the impacts of PEPFAR on land-use change)?	Drivers\Population	RAWG	1.49
76	The Tropical Forest Alliance 2020 is a public-private partnership aimed at reducing the tropical deforestation associated with key global commodities, such as soy, beef, palm oil, and pulp and paper. What will be the biodiversity impacts of the Tropical Forest Alliance 2020-supported changes in value chain production?	Drivers\Private sector	RAWG	1.49
77	What are the social and ecological impacts of certification schemes?	Drivers\Private sector	RAWG	1.49
78	How can the power of the private sector be harnessed to do good for biodiversity?	Drivers\Private sector	RAWG	1.49
79	What are the best lessons learned regarding motivating the private sector to do good for biodiversity?	Drivers\Private sector	RAWG	1.49
80	How can the shift to biochar as a strategy for carbon sequestration impact land cover and species richness?	Drivers\Science & technology	Peer-reviewed literature	1.49
81	How can mobile-sensing technologies contribute to biodiversity monitoring (e.g., camera traps to sense wildlife, ground-truthing of remotely sensed data, and sound recognition of bird calls)?	Drivers\Science & technology	Peer-reviewed literature	1.49

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#	Research Topics	Theme of BDRA Conceptual Framework	Source	Average Score on Strategic Value Criteria
82	Is minor forest production (e.g., beekeeping) or community forestry a poverty trap?	Economic growth, poverty alleviation, and livelihoods	RAWG	1.62
83	Does broad-based economic growth focused on equitable distribution yield better outcomes for biodiversity than free-market approaches?	Economic growth, poverty alleviation, and livelihoods	RAWG	1.62
84	How do shifts in agricultural subsidies, commodity prices, and markets affect the location and rate of conversion of natural ecosystems to agricultural uses?	Legal & regulatory factors\Policy	Peer-reviewed literature	1.24
85	What are the possible impacts of REDD on species and processes in non-forested ecosystems?	Legal & regulatory factors\Policy\ Regulation	Peer-reviewed literature	1.24
86	How effective are different types of protected areas (e.g., strict nature reserves, hunting reserves, and national parks) at conserving biodiversity and providing ecosystem services?	Legal & regulatory factors\Regulation	Peer-reviewed literature	1.99
87	How do alternative ways of managing fisheries affect marine ecosystems and coastal human communities?	Legal & regulatory factors\Regulation	Peer-reviewed literature	1.99
88	What are the impacts on biodiversity and human well-being of differing approaches to devolving different rights (e.g., access, ownership, management, transfer, exclusion, and use) to land and natural resources?	Legal & regulatory factors\Regulation	Peer-reviewed literature	1.99

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#	Research Topics	Theme of BDRA Conceptual Framework	Source	Average Score on Strategic Value Criteria
89	How does the management of protected areas affect conservation beyond the boundaries of the protected area, such as through the displacement of human populations, hunting, or fishing?	Legal & regulatory factors\Regulation	Peer-reviewed literature	1.74
90	What are the impacts of alternative configurations of, and management strategies for, aquatic reserves on human well-being?	Legal & regulatory factors\Regulation	Peer-reviewed literature	1.37
91	Which management approaches to fisheries are most effective at mitigating the impacts of fish extraction and fishing gear on non-target species and their habitats?	Legal & regulatory factors\Regulation	Peer-reviewed literature	1.24
92	What are the human well-being costs and benefits of protected areas; how are these costs and benefits distributed to stakeholders and in local communities; and how do they vary with governance, resource tenure arrangements, and site characteristics?	Legal & regulatory factors\Resource tenure & access	Peer-reviewed literature	2.49
93	What factors shape the likelihood and extent of formal recognition of informal (potentially including traditional or customary) rights to land, wildlife and other natural resources and traditional institutions for managing or administering these rights as the basis for conservation policy and practices?	Legal & regulatory factors\Resource tenure & access\Constituencies	Peer-reviewed literature	1.49
94	Under what conditions does investing in policy improve conservation outcomes?	Legal & regulatory framework\Policy	RAWG	0.99

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#	Research Topics	Theme of BDRA Conceptual Framework	Source	Average Score on Strategic Value Criteria
95	Is it more effective to do simultaneous policy implementation at local and national ends of scale, or is sequential implementation more effective?	Legal & regulatory framework\Policy	RAWG	0.99
96	At what scale is policy engagement most effective for conservation (e.g., local, national, regional, or international level)?	Legal & regulatory framework\Policy	RAWG	0.99
97	What are more effective ways of influencing outcomes: policies focused on conservation compared with policies around free trade agreements with the United States (e.g., timber trade)?	Legal & regulatory framework\Policy	RAWG	0.99
98	What are the impacts of policies related to economic incentives or disincentives on conservation outcomes, including the policies of banking institutions, multilaterals, and multinational corporations?	Legal & regulatory framework\Policy	RAWG	0.99
99	What are the impacts of the Lacey Act and similar policies on conservation outcomes?	Legal & regulatory framework\Policy	RAWG	0.99
100	Is decentralization effective, and if so, what are the critical components of decentralization that make it effective?	Legal & regulatory framework\Policy	RAWG	0.99
101	How do gender differences in (legal, informal, traditional, or customary) rights around land ownership, inheritance, and access to land, resources and capital impact conservation outcomes?	Legal & regulatory framework\Resource tenure and access	RAWG	1.74

Table D1. List of Priority Research Topics that Align with the BDRA Conceptual Framework.

#	Research Topics	Theme of BDRA Conceptual Framework	Source	Average Score on Strategic Value Criteria
102	How do inequalities in access to information on land tenure and property rights impact conservation?	Legal & regulatory framework\Resource tenure and access	RAWG	1.49
103	How do gender differentiated roles in access to and use of natural resources impact conservation outcomes?	Legal & regulatory framework\Resource tenure and access	RAWG	1.49
104	To what extent does strengthening local rights improve conservation outcomes?	Legal & regulatory framework\Resource tenure and access	RAWG	1.49
105	Does diversification of livelihoods for climate change adaptation address degradation and leakage?	Livelihoods	FAB Office Retreat	1.87
106	Under what conditions do enterprise approaches to conservation, such as ecotourism, benefit biodiversity?	Livelihoods	FAB Office Retreat	1.49
107	How do forests, coastal vegetation, native grasses, and wetlands help to mitigate natural disasters (e.g., floods, fire, etc.)?	Natural disaster mitigation	FAB Office Retreat	1.49
108	What is the role of crop genetic diversity in climate change resilience?	Sustainable agriculture	FAB Office Retreat	1.62
109	How can the value of inputs from natural resources management, such as water quality and quantity and soil fertility, that impact agricultural productivity be captured?	Sustainable agriculture	FAB Office Retreat	1.62
110	Does agricultural intensification reduce deforestation and land conversion?	Sustainable agriculture	FAB Office Retreat	1.49
111	Does an ecoagriculture approach work to maintain biodiversity?	Threats\Habitat fragmentation & ecological viability\Agricultural expansion	RAWG	1.49

Table D1. List of Priority Research Topics that Align with the BDRA Conceptual Framework.

#	Research Topics	Theme of BDRA Conceptual Framework	Source	Average Score on Strategic Value Criteria
112	For which types of species is an ecoagriculture approach most effective (e.g., generalists compared with endemics)?	Threats\Habitat fragmentation & ecological viability\Agricultural expansion	RAWG	1.49
113	What is the smallest area of habitat needed in an agricultural landscape to have positive impacts on biodiversity?	Threats\Habitat fragmentation & ecological viability\Agricultural expansion	RAWG	1.49
114	What are the issues of scale with fragmentation, particularly across sectors?	Threats\Habitat fragmentation & ecological viability\Deforestation	RAWG	1.49
115	What is the impact on species viability and land-cover fragmentation of the proliferation of hydropower in the Andean Amazon?	Threats\Habitat fragmentation & ecological viability\Deforestation	Peer-reviewed literature	1.49
116	How will changes in land use affect species composition, and how will those changes impact ecosystems?	Threats\Habitat fragmentation & ecological viability\Deforestation	Peer-reviewed literature	1.49
117	Where do invasive species pose threats to human health and livelihoods?	Threats\Habitat fragmentation & ecological viability\Invasive species	RAWG	1.49
118	Where are the overlaps and opportunities to work on invasive species across sectors?	Threats\Habitat fragmentation & ecological viability\Invasive species	RAWG	1.49
119	How can looking at historical patterns of wide-scale development inform future planning in less fragmented areas?	Threats\Habitat fragmentation & ecological viability\Other	RAWG	1.49
120	To what degree can biodiversity be managed in non-protected areas to benefit protected areas and biodiversity in general?	Threats\Habitat fragmentation & ecological viability\Other	RAWG	1.49

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#	Research Topics	Theme of BDRA Conceptual Framework	Source	Average Score on Strategic Value Criteria
121	What are the development impacts of corridors (e.g., increases in human wildlife conflict and impacts on agriculture)?	Threats\Habitat fragmentation & ecological viability\Population connectivity	RAWG	1.49
122	Under what conditions do corridors work?	Threats\Habitat fragmentation & ecological viability\Population connectivity	RAWG	1.49
123	What are the human health impacts of wildlife corridors (e.g., on nutrition and malaria)? If there are positive impacts, can they be used to build support for conservation?	Threats\Habitat fragmentation & ecological viability\Population connectivity	RAWG	1.49
124	For which species groups are corridors most effective, and what scale is necessary for different groups to maintain ecological viability?	Threats\Habitat fragmentation & ecological viability\Population connectivity	RAWG	1.49
125	With regards to the impacts of chemical pollutants on ecosystem degradation, are there tipping points for delivery of ecosystem services?	Threats\Pollution & disease\Chemical pollutants	RAWG	1.49
126	How does exposure to endocrine disruptors impact threatened species, particularly reproduction rates?	Threats\Pollution & disease\Chemical pollutants	RAWG	1.49
127	To what extent do small-scale extractive activities and artisanal mining contribute to biodiversity loss?	Threats\Pollution & disease\Chemical pollutants	RAWG	1.49
128	Does intensification of agriculture, particularly with fertilizer use, decrease overall food production?	Threats\Pollution & disease\Eutrophication	RAWG	1.49
129	How are patterns of zoonotic disease changing with development and ecosystem degradation?	Threats\Pollution & disease\Wildlife diseases	RAWG	1.49

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#	Research Topics	Theme of BDRA Conceptual Framework	Source	Average Score on Strategic Value Criteria
130	How do we manage zoonotic diseases under different development paradigms?	Threats\Pollution & disease\Wildlife diseases	RAWG	1.49
131	To what extent is illegal harvesting contributing to biodiversity loss?	Threats\Unsustainable use\Trafficking	RAWG	1.49
132	What are the development impacts of wildlife trafficking at the source place?	Threats\Unsustainable use\Trafficking	RAWG	1.49
133	What are the impacts of trafficking on natural capital, local livelihoods, and ecology?	Threats\Unsustainable use\Trafficking	RAWG	1.49
134	Some countries have wildlife trafficking laws that only apply certain months of the year. What is the impact of the seasonality of certain wildlife trafficking laws?	Threats\Unsustainable use\Trafficking	RAWG	1.49
135	What are the dominant theories of change for programs that combat wildlife trafficking, and under what conditions are they effective (e.g., substitution and alternative livelihoods)?	Threats\Unsustainable use\Trafficking	RAWG	1.49
136	What is the impact of poaching on local economies (e.g., to ecotourism ventures)? Is it possible to put a monetary value on a single rhino poached (i.e., 1 rhino poached = $x in lost revenue)?	Threats\Unsustainable use\Trafficking	RAWG	1.49

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#	Research Topics	Theme of BDRA Conceptual Framework	Source	Average Score on Strategic Value Criteria
137	What is the relationship between the trafficking in wildlife and other forms of trafficking, such as guns, arms, drugs, and humans? What lessons can be learned from these other sectors? In what ways are they similar and different?	Threats\Unsustainable use\Trafficking	RAWG	1.49
138	What is the efficacy of community scouts, and under what conditions are they most effective?	Threats\Unsustainable use\Trafficking	RAWG	1.49
139	What are the impacts of wildlife trafficking on different development outcomes such as health and conflict?	Threats\Unsustainable use\Trafficking	RAWG	1.49
140	How can the Agency engage communities when members are already engaged in poaching?	Threats\Unsustainable use\Trafficking	RAWG	1.49
141	What are the development impacts of community scouts?	Threats\Unsustainable use\Trafficking	RAWG	1.49
142	How can the Agency effectively deal with corruption related to wildlife trafficking? What are the hotspots or choke points?	Threats\Unsustainable use\Trafficking	RAWG	1.49
143	To what extent does subsistence bushmeat harvesting contribute to biodiversity loss, particularly in different geographic subsets?	Threats\Unsustainable use\Unsustainable harvesting	RAWG	1.49
144	What are the impacts of bushmeat hunting on keystone species, vegetation, and predator-prey relationships?	Threats\Unsustainable use\Unsustainable harvesting	RAWG	1.49
145	What is the natural capital of wildlife, particularly with respect to bushmeat and ecotourism?	Threats\Unsustainable use\Unsustainable harvesting	RAWG	1.49

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#	Research Topics	Theme of BDRA Conceptual Framework	Source	Average Score on Strategic Value Criteria
146	What are the relative ecosystem impacts of alternative sources of protein (e.g., bushmeat hunting compared with raising livestock)?	Threats\Unsustainable use\Unsustainable harvesting	RAWG	1.49
147	How does the devolution of rights to access wildlife affect sustainability of the harvest?	Threats\Unsustainable use\Unsustainable harvesting	RAWG	1.49
148	What are the effects of changes in human patterns of food consumption on biodiversity (e.g., shift from bushmeat to domestic meat and from fish to plant-based protein)?	Threats\Unsustainable use\Unsustainable harvesting	Peer-reviewed literature	1.49
149	What are the direct and indirect impacts of armed conflict on biodiversity?	Threats\War & armed conflict	Peer-reviewed literature	1.49

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