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Identification and Gap Analysis of Key Biodiversity Areas

Targets for Comprehensive Protected Area Systems

Penny F. Langhammer, Mohamed I. Bakarr, Leon A. Bennun, Thomas M. Brooks, Rob P. Clay, Will Darwall, Naamal De Silva, Graham J. Edgar, Güven Eken, Lincoln D.C. Fishpool, Gustavo A.B. da Fonseca, Matthew N. Foster, David H. Knox, Paul Matiku, Elizabeth A. Radford, Ana S.L. Rodrigues, Paul Salaman, Wes Sechrest and Andrew W. Tordoff

Peter Valentine, Series Editor

Best Practice Protected Area Guidelines Series No. 15

JCU James Cook University

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WCPA World Commission on Protected Areas

Identification and Gap Analysis of Key Biodiversity Areas: Targets for Comprehensive Protected Area Systems

IUCN

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Economic Values of Protected Areas: Guidelines for Protected Area Managers. No. 2. Task Force on Economic Benefits of Protected Areas of the World Commission on Protected Areas (WCPA) of IUCN, in collaboration with the Economics Service Unit of IUCN, 1998, xii + 52pp. Also available in Russian.

Guidelines for Marine Protected Areas. No. 3. Graeme Kelleher, 1999, xxiv + 107pp.

Indigenous and Traditional Peoples and Protected Areas: Principles, Guidelines and Case Studies. No. 4. Javier Beltrán, (Ed.), IUCN, Gland, Switzerland and Cambridge, UK and WWF International, Gland, Switzerland, 2000, xi + 133pp. Also available in Spanish.

Financing Protected Areas: Guidelines for Protected Area Managers. No. 5. Financing Protected Areas Task Force of the World Commission on Protected Areas (WCPA) of IUCN, in collaboration with the Economics Unit of IUCN, 2000, viii + 58pp.

Evaluating Effectiveness: A Framework for Assessing the Management of Protected Areas. No. 6. Marc Hockings, Sue Stolton and Nigel Dudley, 2000, x + 121pp. Also available in Chinese and Russian.

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Guidelines for Management Planning of Protected Areas. No. 10. Lee Thomas and Julie Middleton, 2003, ix + 79pp. Also available in Chinese and Japanese.

Indigenous and Local Communities and Protected Areas: Towards Equity and Enhanced Conservation. No. 11. Grazia Borrini-Feyerabend, Ashish Kothari and Gonzalo Oviedo, 2004, xvii + 112pp.

Forests and Protected Areas: Guidance on the use of the IUCN protected area management categories. No. 12. Nigel Dudley and Adrian Phillips, 2006, x + 58pp.

Sustainable Financing of Protected Areas: A global review of challenges and options. No. 13. Lucy Emerton, Joshua Bishop and Lee Thomas, 2006, x + 97pp.

Evaluating Effectiveness: A Framework for Assessing Management Effectiveness of Protected Areas 2nd Edition. No. 14. Marc Hockings, Sue Stolton, Fiona Leverington, Nigel Dudley and José Courrau, 2006, xiv + 105pp.

Online versions available at www.iucn.org/themes/wcpa/pubs/guidelines.htm or through the IUCN Online Library Catalogue http://app.iucn.org/dbtw-wpd/iucn.htm

Identification and Gap Analysis of Key Biodiversity Areas

Targets for Comprehensive Protected Area Systems

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WORLD COMMISSION ON PROTECTED AREAS

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Created in 1948, the World Conservation Union (IUCN) brings together more than 80 States, 110 government agencies, 800 NGOs, and 10,000 scientists and experts from over 180 countries in a unique worldwide partnership. The Union's mission is to influence, encourage and assist societies throughout the world to conserve the integrity and diversity of nature, and to ensure that any use of natural resources is equitable and ecologically sustainable. The Union is the world's largest environmental knowledge network, and has helped over 75 countries prepare and implement national conservation and biodiversity strategies. The Union is a multicultural, multilingual organization with 1,000 staff located in 62 countries. Its headquarters are in Gland, Switzerland.

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Identification and Gap Analysis of Key Biodiversity Areas

Targets for Comprehensive Protected Area Systems

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BirdLife International data zone: www.birdlife.org/datazone
CBD Programme of Work on Protected Areas (Decision VII/28): www.biodiv.org/doc/publications/pa-text-en.pdf
Critical Ecosystem Partnership Fund: www.cepf.net
Global Amphibian Assessment: www.globalamphibians.org
Global Biodiversity Information Facility: www.gbif.org
IUCN Red List of Threatened Species: www.iucnredlist.org

IUCN/SSC Species Action plans: www.iucn.org/themes/ssc/pubs/sscaps.htm

WildFinder: www.wildfinder.org

Additional websites are listed in Appendix II

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Tens of thousands of people around the planet have been responsible for the fieldwork, data compilation, analysis,

publication, advocacy, monitoring, and hands-on conservation for Key Biodiversity Areas over the last two decades, through the Important Bird Areas program, the Important Plant Areas program, the Alliance for Zero Extinction, and many other initiatives. While it is clearly impossible for us to thank these dedicated frontline conservationists individually, this volume would not have been possible without them, and indeed, belongs to them. We bid them every success in their endeavors to ensure the recognition and safeguard of Key Biodiversity Areas through the opportunity at hand of commitment to national gap analyses, mandated by the Convention on Biological Diversity, and hope that this volume provides support to these efforts.

Foreword

In 2004, the majority of the world's governments committed to expand their protected area systems to ensure the conservation of biodiversity. It is central that such conservation activities be targeted systematically and strategically. Over the last decade, the scientific conservation biology literature on systematic conservation planning has burgeoned. However, conservation practitioners have been slow to implement these ideas – and the need for them has now never been greater.

This document, *Identification and Gap Analysis of Key Biodiversity Areas: Targets for Comprehensive Protected Area Systems*, enables conservation practice to catch up with scientific theory. These guidelines draw on cutting-edge science as well as methods developed in a number of different organizations, and are already implemented as Important Bird Areas and Important Plant Areas in more than 170 countries. The Key Biodiversity Areas framework provides a bottom-up approach to extend the bird and plant work to date to identify globally significant sites for biodiversity. In doing so, it utilizes numerous data sources, most importantly those compiled and analysed through the efforts of the IUCN Species Survival Commission (specifically, through the IUCN Red List of Threatened Species).

This manual provides practical guidance to national governments to slow the rate of biodiversity loss by 2010. In the longer term, the value of Key Biodiversity Areas in informing conservation planning may be dwarfed by its importance in informing development planning. Given the huge weight of economic development unfolding across our planet, I suspect that Key Biodiversity Areas will provide essential "watch lists" of sites to safeguard. Moreover, the bottom-up nature of the Key Biodiversity Areas framework means that it empowers civil society to engage in conservation for the benefit of both local and global communities. Thus while governments and industries must be intimately involved in the conservation of Key Biodiversity Areas, their future will ultimately be determined by the emergence and engagement of local groups.

Clearly, this manual does not represent an endpoint. I am sure that the process and standards for identifying Key Biodiversity Areas will evolve over time, with input from the Species Survival Commission, the World Commission on Protected Areas, and numerous other stakeholders. However, coming as it does at a critical juncture in the implementation of national conservation strategies worldwide, it will surely provide indispensable guidance in identifying those sites which must be protected to ensure the future of both biodiversity and humanity.

Ibrahim Thiaw, Acting Director General 2006
The World Conservation Union (IUCN)

Preface

The planet's biodiversity is remarkable. No fewer than 1.5 million species have been named and described; at least three times this and possibly many more await discovery (Novotny *et al.* 2002). This biodiversity provides incalculable benefit to humanity. Most directly, it comprises a vast genetic storehouse of medicines, foods and fibers (Myers 1983). Strong evidence suggests that biodiversity endows stability to ecosystems (Naeem and Li 1997), sheltering humanity from disease and natural disasters. Moreover, these ecosystems yield services of substantial economic value (Costanza *et al.* 1997), although most of these remain significantly undervalued. Least tangibly but no less importantly, all of the world's societies and cultures value species for their own sake, over and above any utilitarian purpose (Wilson 1984).

Although biodiversity offers enormous economic, environmental and spiritual value to humanity, it is being critically threatened by unsustainable consumption in wealthy countries and rapid population growth and crushing poverty in the tropics. Expanding agriculture, industry and urbanization are fragmenting, degrading and eliminating natural environments; exotic species are wreaking havoc with native communities; pollution is altering biogeochemical and climate cycles; and fishing, hunting and trade are decimating the last populations of high-value species (Vitousek *et al.* 1997).

Species extinction is the gravest aspect of this biodiversity crisis because alone, among the catalogue of environmental problems, it is irreversible. Fossil records indicate that, in the absence of humans, species persist for an average of one million years (May *et al.* 1995); however, human impacts have now elevated the natural rate of species extinction by at least a thousand times (Pimm *et al.* 1995).

To address this crisis, we require a range of responses. At the most general level, we need extensive societal and cultural change to focus on the root causes of biodiversity loss (Wood *et al.* 2000). At the most specific level, saving some species will require case-by-case interventions, such as the elimination of invasive species (Atkinson 1996) or the control of hunting (Reynolds *et al.* 2001). However, because the primary threat for most terrestrial and freshwater species is the destruction of their habitats (Baillie *et al.* 2004), the establishment of protected areas for these species has emerged as one of our most important and effective tools to safeguard biodiversity (Bruner *et al.* 2001).

Since the 1960s, the World Parks Congress has fundamentally influenced the protected areas agenda. At the Fifth Congress in 2003, a workshop on "Building Comprehensive Protected Area Systems" demonstrated that despite substantial gains, global protected area systems are still far from comprehensive. To redress this shortcoming, many governments have made major new commitments to protect areas for biodiversity. Most importantly, the 188 Parties to the Convention on Biological Diversity have established the Programme of Work on Protected Areas, to establish "comprehensive, effectively managed, and ecologically representative national and regional systems of protected areas". As part of this commitment, they have mandated gap analyses to assess how well protected areas conserve biodiversity, and where the highest priorities are for expanding and reinforcing existing protected areas.

The purpose of these guidelines is to explain how the identification, prioritization and gap analysis of Key Biodiversity Areas (KBAs) can help fulfill that mandate. KBAs are sites of global significance for biodiversity conservation, identified using globally standard criteria and thresholds, based on the occurrence of species requiring safeguards at the site scale (Eken *et al.* 2004); they thus provide an effective, justifiable and transparent set of conservation targets from which a gap analysis can be conducted. The KBA criteria have been defined such that they can be easily and consistently applied across all biogeographic regions and taxonomic groups. They are designed for application through a national or regional-level, bottom-up, iterative process, involving local stakeholders, to maximize the usefulness and the prospects of implementation of the resulting site priorities (Younge and Fowkes 2003).

This volume is directed towards technical staff in governments, non-governmental organizations (NGOs), academia and local communities who are charged with implementing intergovernmental commitments on protected areas at the national level, and with site-scale biodiversity conservation generally. It details the steps required to identify and delineate KBAs and conduct gap analysis so that new conservation actions can be prioritized. As countries have committed themselves to conducting national-level gap analyses of their protected area systems, it is hoped that KBA processes will be initiated by the government agencies responsible for their nations' protected area systems. This will often be done in partnership with local or national conservation organizations, and/or universities, where much of the expertise to do such work resides. Practical examples are provided throughout these guidelines, and we focus particularly on data needs for defining KBAs, delineating and mapping KBAs relative to existing protected areas, and prioritizing KBAs as part of national or regional-level gap analyses.

Currently, KBAs have been identified and are being safeguarded in over 100 countries around the world through the efforts of the BirdLife International partnership, Plantlife International and the Alliance for Zero Extinction, among others. These can therefore be used as a starting point for national and regional-level gap analyses and conservation action – there is no need to identify every KBA before conservation begins.

While their immediate value is in national conservation planning and gap analysis, the identification of KBAs is likely to have much broader societal implications. For industry, KBAs provide a watch list of sites essential in informing development planning. For local communities, KBAs provide livelihood opportunities through employment, recognition, economic investment, societal mobilization and civic pride. The long-term future of KBAs rests first and foremost with the people living in and around them.

We would like to emphasise that this document does not represent the final word on KBAs. Rather, it consolidates our experience and ideas in many countries and suggests best practices for identifying and prioritizing among KBAs to target conservation on the ground, towards those globally important sites where action is most urgently needed. These guidelines therefore provide guidance for identifying priorities for both expanding and strengthening the global protected area system, in order to ensure its representativeness, comprehensiveness and long-term effectiveness. A number of questions around the KBA process remain – such as testing KBA thresholds and identifying KBAs in aquatic environments – and are highlighted as urgent research priorities. The development of a global umbrella for KBAs could help ensure coordination and standards in KBA identification and prioritization as a core strategy to guide conservation action at the site scale.

The establishment of systems to safeguard and monitor protected areas themselves, clearly the next steps following gap analyses, are not covered here, but are treated in other volumes of the IUCN Best Practice Protected Area Guidelines Series. Two other important issues are not covered in these guidelines. First, the actual standards and criteria for the IUCN Red List of Threatened Species are not discussed in this manual. These methods are covered in detail elsewhere (IUCN 2001). Second, the science for identifying broad-scale conservation targets (beyond the site-scale) is not discussed here, although a number of approaches have been proposed and are important to preserving KBAs including ecoregional assessments (Groves 2003), biodiversity visions (Dinerstein *et al.* 2000), conservation of landscape species (Sanderson *et al.* 2002) and highly interactive species (Soulé *et al.* 2005), biodiversity conservation corridors (Sanderson *et al.* 2003), and habitat planning (Tucker and Evans 1997). In the longer term, habitat restoration will be essential at this scale (Dobson *et al.* 1997a), as will responses to anthropogenic climate change (Lovejoy and Hannah 2005). The CBD overview of gap analysis (Dudley 2005) suggests how broader ecoregional, habitat, and landscape and seascape-scale planning can relate to gap analysis.

1. Building comprehensive protected area networks

In this chapter we provide a brief introduction to how protected area systems have evolved – from the historical 10% representation target to our current recognition that gap analyses are required to assess where these protected areas best safeguard, or should safeguard, our planet's biodiversity. We summarize recent intergovernmental mandates that call for strategic assessment of the effectiveness of protected area networks, and we introduce the concept of KBAs as a tool for fulfilling these mandates.

Protected areas have emerged as one of the world's most important and effective tools for safeguarding biodiversity (Bruner *et al.* 2001) because they protect species from their greatest threat: habitat loss. The Programme of Work on Protected Areas of the Convention on Biological Diversity (CBD) states that protected areas are "essential components in national and global biodiversity conservation strategies."

The term 'protected area' as used throughout this guide refers to "An area of land and/or sea especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means" (IUCN 1994).

The evolution of global protected area systems has been largely influenced by the World Parks Congress, a gathering of professionals and experts in the field of conservation and protected area management, convened every ten years by IUCN – the World Conservation Union. The congress, which started in the early 1960s, has provided a forum for discussion on all ecological, social, economic, political and practical matters related to protected areas.

1.1 How the concept of comprehensive protected areas has evolved

The 10% target for protected areas is established

The establishment of a 10% target for protected areas stemmed from the Fourth World Parks Congress in Caracas, Venezuela, in 1992, where it was recommended "that protected areas cover at least 10 percent of each biome by the year 2000" (IUCN 1993). Subsequently, the 10% target for protected areas has become deeply entrenched in the thinking of many conservationists and incorporated into the national legislation of many countries for establishing protected areas. It has often been generalized to apply to individual countries and to the entire planet, despite its major shortcomings (Soulé and Sanjayan 1998).

The development of the World Database on Protected Areas

At the 2003 Fifth World Parks Congress in Durban, South Africa, however, the effectiveness of this 10% target in protecting our biodiversity was examined more closely. A broad consortium of organizations (including the American Museum of Natural History, BirdLife International, Conservation International, Fauna & Flora International, IUCN, The Nature Conservancy, the United Nations Environment Programme-World Conservation Monitoring Centre, the World Resources Institute, the Wildlife Conservation Society, and the World Wildlife Fund) joined with the World Commission on Protected Areas to produce the World Database on Protected Areas, a geospatial catalogue of protected areas (WDPA 2004). While this database is not perfectly comprehensive and does not indicate which protected areas are effectively managed, it nevertheless provides a relatively accurate estimate of the land area covered by protected areas globally, at 11.5% (Chape *et al.* 2003), with the coverage of individual biomes varying from 4.6% to 26.3% (Hoekstra *et al.* 2005).

A global gap analysis reveals that much biodiversity falls outside protected areas

Dramatic advances in the compilation of data on species distributions over the last decade (Brooks *et al.* 2004a), together with the World Database on Protected Areas, enabled the first-ever global gap analysis of terrestrial vertebrate species covered by protected areas (Rodrigues *et al.* 2004a,b; Box 16). Presented during the Fifth World Parks Congress, this gap analysis found that at least 1,400 terrestrial vertebrate species are not represented in any protected areas. Despite exceeding 10% of the global land area, the coverage of biodiversity by protected areas is far from complete – largely due to the lack of a systematic approach to protected area planning (Pressey and Tully 1994). These gaps are undoubtedly even more serious in freshwater and marine biomes (Chape *et al.* 2003).

The Fifth World Parks Congress calls for *strategic* expansion of protected areas

The results of this gap analysis point to the need for not merely expanding protected area coverage, but for expanding it strategically, so as to best address the distribution of and threats to biodiversity, neither of which are distributed evenly. This message was widely incorporated into the results of the Fifth World Parks Congress. The congress stated to the CBD that "the global system of protected areas needs to safeguard all globally and nationally important areas for biodiversity", and in the Durban Accord, it asked the global community for a "commitment to expand and strengthen worldwide systems of protected areas, prioritized on the basis of imminent threat to biodiversity". This message was immediately taken up by world leaders, with the President of Madagascar and the Governors of the Brazilian states of Amazonas and Amapá announcing at the congress itself that they would strategically expand their protected area systems.

1.2 The intergovernmental mandate

Building on a commitment to biodiversity

Many of the world's governments have endorsed the Fifth World Congress' recent call to expand protected area networks for conserving biodiversity strategically, building on 15 years of momentum that has seen the establishment of the following organizations and actions:

- 1992 – The Convention on Biological Diversity (CBD) is established at the Earth Summit in Rio de Janeiro, to which 188 nations are now parties.
- 2000 – The Millennium Development Goals recognize "land area protected to maintain biological diversity" as a core measure to achieve Goal 7 on environmental sustainability, and towards all eight goals aimed at reducing poverty and improving sustainable development.
- 2002 – The Sixth Conference of the Parties of the CBD formalizes a target to significantly reduce the rate of biodiversity loss by 2010.
- 2002 – World Summit on Sustainable Development affirms the above target in its Johannesburg Plan of Implementation.
- 2002 – The United Nations includes biodiversity as one of five priority issues for sustainable development ("WEHAB" Water, Energy, Health, Agriculture and Biodiversity).

The CBD Programme of Work on Protected Areas

Towards meeting the mandates of the Fifth World Parks Congress, the Seventh Conference of the Parties adopted a Programme of Work on Protected Areas (Decision VII/28[1]) with "the objective of the establishment and maintenance by 2010 for terrestrial and by 2012 for marine areas of comprehensive, effectively managed, and ecologically representative national and regional systems of protected areas". This Programme of Work is comprised of four elements (implementation, governance and equity, enabling activities, and monitoring) each consisting of several specific goals. The first goal of the first element – "to establish and strengthen national and regional systems of protected areas integrated into a global network as a contribution to globally agreed goals," – requires the identification of sites of global biodiversity significance in each country to determine which sites are currently not represented in protected area systems, and prioritization of conservation actions among sites (Box 1). Gap analyses are also necessary for reporting on the "coverage of protected areas" indicator, which was provisionally adopted by the Parties for measuring progress towards the 2010 target of reducing biodiversity loss (Decision VII/30).

Other global mandates for site-scale biodiversity conservation

Although it is the first intergovernmental agreement towards specific, measurable targets for protected areas, the Programme of Work on Protected Areas builds on a number of existing CBD Programmes of Work including those on forests, inland waters, and marine and coastal biodiversity. Of particular relevance is the Global Strategy for Plant Conservation, adopted at the Sixth Conference of the Parties (Decision VI/9), which incorporates sixteen targets for conserving plant biodiversity. The fifth of these – "protection of 50 per cent of the most important areas for plant diversity assured" – specifically mandates that sites of global significance for plant conservation be identified, and that half of these be safeguarded by 2010.

In addition, 145 Parties to the Ramsar Convention on Wetlands have designated 1,429 Wetlands of International Importance for conservation and wise use. Other conventions that strengthen the intergovernmental policy environment for safeguarding important sites for biodiversity include the Convention on Migratory Species and the Convention to Combat Desertification.

Implementation of the Programme of Work on Protected Areas

Impressive as these commitments are, progress by parties is slow, funding to implement the Programme of Work is not a priority for many donors and governments, and 2010 is quickly approaching. Therefore an urgent need exists to provide guidance to those charged with implementing and funding the Programme of Work on Protected Areas so that these important commitments can be met as efficiently and expediently as possible. At the broadest level, the CBD has addressed this by commissioning The Nature Conservancy to write an overview of approaches to gap analysis (Dudley 2005). However, the need for specific guidelines remains. The purpose of this publication is to show how the identification, prioritization and gap analysis of Key Biodiversity Areas (KBAs) – sites of global importance for biodiversity conservation – can fulfill the mandate to strategically expand the global protected area network to safeguard biodiversity.

[1] www.biodiv.org/doc/publications/pa-text-en.pdf

Box 1. Suggested activities of the Parties to the CBD towards Goal 1.1 of the Programme of Work on Protected Areas

To establish and strengthen national and regional systems of protected areas integrated into a global network as a contribution to globally agreed goals.

1.1.1 By 2006, establish suitable time-bound and measurable national and regional level protected area targets and indicators.

→ KBAs provide geographic targets for protected area coverage (Chapters 2 and 3).

1.1.2 As a matter of urgency, by 2006, take action to establish or expand protected areas in any large, intact or relatively unfragmented or highly irreplaceable natural areas, or areas under high threat, as well as areas securing the most threatened species in the context of national priorities, and taking into consideration the conservation needs of migratory species.

→ KBAs identify these sites for urgent protected area expansion quickly, simply, and cheaply (Chapters 5 and 7).

1.1.3 As a matter of urgency, by 2006 terrestrially and by 2008 in the marine environment, take action to address the under-representation of marine and inland water ecosystems in existing national and regional systems of protected areas, taking into account marine ecosystems beyond areas of national jurisdiction in accordance with applicable international law, and transboundary inland water ecosystems.

→ KBAs are already being identified in both freshwater (Box 3) and marine (Box 5) environments, although there is an urgent need to increase the availability of data on aquatic biodiversity, especially through assessments of aquatic taxa for the IUCN Red List.

1.1.4 By 2006, conduct, with the full and effective participation of indigenous and local communities and relevant stakeholders, national-level reviews of existing and potential forms of conservation, and their suitability for achieving biodiversity conservation goals, including innovative types of governance for protected areas that need to be recognized and promoted through legal, policy, financial, institutional and community mechanisms, such as protected areas run by government agencies at various levels, co-managed protected areas, private protected areas, indigenous and local community conserved areas.

→ KBAs and subsequent gap analysis use a diversity of site-based initiatives to provide a basis for safeguarding biodiversity (Chapters 7 and 8).

1.1.5 By 2006 complete protected area system gap analyses at national and regional levels based on the requirements for representative systems of protected areas that adequately conserve terrestrial, marine and inland water biodiversity and ecosystems. National plans should also be developed to provide interim measures to protect highly threatened or highly valued areas wherever this is necessary. Gap analyses should take into account Annex I of the Convention on Biological Diversity and other relevant criteria such as irreplaceability of target biodiversity components, minimum effective size and viability requirements, species migration requirements, integrity, ecological processes and ecosystem services.

→ KBAs provide the basis for national and regional gap analyses of protected area networks (Chapter 6).

1.1.6 By 2009, designate the protected areas as identified through the national or regional gap analysis (including precise maps) and complete by 2010 terrestrially and 2012 in the marine environments the establishment of comprehensive and ecologically representative national and regional systems of protected areas.

→ KBAs represent targets for comprehensive and representative protected area systems (Chapters 2 and 6).

1.1.7 Encourage the establishment of protected areas that benefit indigenous and local communities, including by respecting, preserving, and maintaining their traditional knowledge in accordance with article 8(j) and related provisions.

→ The KBA approach emphasises local ownership, participation and capacity building (Chapter 5).

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2. Overview of Key Biodiversity Areas

This chapter defines KBAs, explains their origin, discusses their relationship to existing protected areas, and distinguishes them from conservation priorities defined at scales other than the site scale.

At the species level, quantitative and threshold-based criteria have been developed to assess extinction risk (IUCN 2001), forming the basis for the *IUCN Red List of Threatened Species* (IUCN 2006). However, as the intergovernmental mandate described in Chapter 1 indicates, we now face an urgent need to establish a similar world-wide standard for the identification of sites of global biodiversity significance. KBAs provide just such a standard, employing quantitative criteria that can consistently be applied by drawing on available information. These guidelines build on progress and application of this standard to date in the identification of and prioritization among KBAs (Eken *et al.* 2004). As Box 1 explains, KBAs offer a practical immediate way to support the national gap analyses mandated by the Programme of Work on Protected Areas.

KBAs are sites of global significance for biodiversity conservation. They are identified using globally standard criteria and thresholds, based on the needs of biodiversity requiring safeguards at the site scale. These criteria are based on the framework of vulnerability and irreplaceability widely used in systematic conservation planning.

The KBA framework builds on strong precursors

KBAs build on the 25 years of experience through the BirdLife International partnership in identifying, safeguarding and monitoring Important Bird Areas (IBAs; Collar 1993–4, BirdLife International 2004b). National IBA directories have been published for at least 50 countries, with regional inventories produced for Europe (Heath and Evans 2000), the Middle East (Evans 1994), Asia (BirdLife International 2004c) and Africa (Fishpool and Evans 2001), and currently underway for other regions. Numerous projects have extended the IBA approach to other taxa. These include Important Plant Areas (IPAs) (Anderson 2002, Plantlife International 2004), Prime Butterfly Areas (van Swaay and Warren 2003), Important Mammal Areas (Linzey 2002) and Important Sites for Freshwater Biodiversity, with prototype criteria developed for freshwater molluscs and fish (Darwall and Vié 2005). In 2003, the Critical Ecosystem Partnership Fund[2] instituted a requirement that KBA identification underlie its five-year investment strategies, or Ecosystem Profiles.

KBAs and protected areas

Bibby (1998) developed a definition of IBAs – and this directly extends to KBAs – as sites of global significance for biodiversity conservation that are large enough or sufficiently interconnected to support populations of the species for which they are important. We use the terms "site" and "area" interchangeably to imply homogeneous units that may be delimited and, actually or potentially, managed for conservation. Thus, KBAs are an overlapping subset of current and potential protected areas, in the broadest sense. Many existing protected areas are directly equivalent to KBAs. Some protected areas (or parts of protected areas) do not meet the criteria for global biodiversity significance, although they may be important for other reasons such as local natural or cultural significance. In other cases, the boundaries of protected areas were not created on the basis of the conservation needs of the species for which they are (or, indeed, have subsequently been found to be) of global importance, in which case the KBA will include areas outside the protected area, or will lie wholly outside current protected areas.

Benefits of the KBA process

The KBA framework offers several advantages in its implementation:

- It builds on previous initiatives (e.g., IBAs, IPAs) and considers all taxonomic groups for which data exist.
- It targets all known biodiversity that would benefit from site-scale conservation.
- It can build from existing KBAs that have already been identified in many countries.
- It builds on existing data, so even if species data are not complete, the KBA process can begin immediately and be updated iteratively.
- The KBA methodology is inexpensive and straightforward to apply and can typically be completed within a short time.

KBAs as distinct from global-scale priorities

Efforts to identify global-scale priorities for conservation such as the Centres of Plant Diversity (WWF and IUCN 1994–97), the Global 200 ecoregions (Olson and Dinerstein 1998), biodiversity hotspots (Mittermeier *et al.* 2004), and Endemic

[2] www.cepf.net

Bird Areas (Stattersfield *et al.* 1998), have been highly effective at directing conservation resources at a global scale (Brooks *et al.* 2006). However, these broad-scale approaches do not allow for the identification of site-scale conservation targets; furthermore, some sites that are globally important for biodiversity conservation will inevitably fall outside of these broad priority regions. KBAs help to identify important sites not just within broad regions of global priority, but in all countries worldwide. The KBA framework can therefore help provide the fundamental basis of national and regional-scale gap analyses.

KBAs help set national priorities within the global context

Because political and ecological boundaries frequently do not coincide, priorities may become distorted during conservation planning at the national or regional scale. Global priorities may be overlooked if, for example, a globally threatened species is not considered a priority in a country where it is locally abundant (precisely where its conservation would be most effective). Investment may instead be diverted to local priorities, such as conserving species that are globally non-threatened and widespread, though locally rare (Hunter and Hutchinson 1994). Given that conservation planning and action usually happens at national or sub-national scales, it is key that the global context is taken into account to ensure that it is in accord with international conservation efforts aimed at maximizing the prevention of biodiversity loss.

KBAs focus on the identification of globally important sites that are essential for conserving biodiversity. Clearly, all of the world's nations have a responsibility to ensure that these sites are safeguarded, although the financing of necessary conservation actions will often need to come from the global community. That KBAs represent globally significant site-scale targets for biodiversity conservation does not imply that no other sites are worthy of conservation. In addition to sites of global biodiversity significance, many countries have identified sites of national or regional biodiversity significance, as part of ongoing gap analyses. BirdLife International has formalized this by defining regionally (as well as globally) significant thresholds for IBAs (e.g., Heath and Evans 2000). Other sites will be identified for reasons other than biodiversity conservation (for example, the preservation of cultural monuments or scenic views). Ideally, the framework for identifying sites of national importance will differ from that of identifying globally important sites only in that lower (or regionally defined) thresholds will be considered "significant". Further, in any given country, globally significant sites – KBAs – should factor into the highest priorities among nationally important sites, especially when conservation resources are flexible enough to be invested anywhere on the planet (e.g., from multilateral, bilateral and foundation donors). This process does not in any way invalidate existing national protected area systems, but rather adds value to them.

KBAs are not the only scale at which conservation is necessary

While the safeguarding of KBAs is essential to prevent biodiversity loss, it is not sufficient. Site-scale conservation is not the only tactic necessary to maintain biodiversity: it must be complemented by conservation actions for species imperiled by threats other than habitat loss, and by landscape and seascape management to address the long-term persistence of biodiversity in the face of degraded ecological processes, habitat fragmentation, and climate change. Nevertheless, safeguarding globally significant KBAs can form a backbone of conservation implementation in most countries.

3. Key Biodiversity Areas in conservation priority-setting

In this chapter we review the basic principles for why and how to set conservation priorities, placing KBAs in a broader conservation planning context.

No biodiversity is dispensable or redundant – every population of every species, in fact all of nature, is worth conserving. Prioritization is not about selecting which elements of biodiversity deserve conservation attention and which do not ('triage': Myers 1983), but about deciding which elements need attention first. It is based on the rationale that biodiversity elements do not all have the same conservation needs, nor do they all provide the same contribution to the conservation of global biodiversity. Prioritization is needed because resources available for conservation efforts are scarce and therefore need to be invested in strategic ways to ensure that our conservation efforts make the greatest contribution to preserving global biodiversity (Pressey *et al.* 1993).

The past two decades have witnessed rapid development of methods for systematic conservation planning (Kirkpatrick 1983, Pressey *et al.* 1993, Margules and Pressey 2000). Until recently these exercises were largely theoretical (Prendergast *et al.* 1997) but the last few years have seen increasing development of practical applications (e.g., Noss *et al.* 2002, Cowling *et al.* 2003). The following sections present the important lessons from this body of work and explain the principles that underlie the KBA approach.

3.1 Principles for setting conservation priorities

Irreplaceability and vulnerability as the key measures of conservation planning

Two main variables determine how we prioritize conservation targets and actions (Margules and Pressey 2000): irreplaceability and vulnerability.

- The irreplaceability (or uniqueness) of a site is the degree to which geographic (or spatial) options for conservation will be lost if that particular site is lost (Pressey *et al.* 1994). In an extreme example, a site is completely irreplaceable if it contains one or more species that occur nowhere else. In contrast, when sites contain only species that are widely distributed, many alternatives exist for conserving these species. Sites that hold significant fractions of a species' entire population during particular periods of the year (e.g., migratory bottlenecks and routes) are also highly irreplaceable.
- Vulnerability (or threat) refers to the likelihood that a site's biodiversity value will be lost in the future (Pressey and Taffs 2001). Thus, vulnerability can also be seen as a measure of irreplaceability, but over time, rather than space. Thus, highly vulnerable sites can either be protected now or never. Sites facing low threat will retain options for conservation in the future. Vulnerability may be measured on a site basis (likelihood that the species will be locally extirpated from a site) or a species-basis (likelihood that the species will go globally extinct). This distinction is further explored in Chapter 6.

High irreplaceability + high vulnerability = high conservation urgency

Sites of high irreplaceability and high vulnerability have the highest conservation urgency (Pressey and Taffs 2001): protection must occur right there, right now, to prevent imminent and irreversible biodiversity loss. The application of these principles to identifying and prioritizing among KBAs is discussed in more detail in Chapters 5 and 6, respectively.

Additional principles governing the priority-setting process

- *Complementarity* – In order to maximize conservation investment, prioritization exercises must evaluate how much each site contributes towards achieving conservation objectives by complementing existing investment. The priority level of each site is thus not simply based on its biological composition but on that of other sites as well, and on the previous conservation decisions. The principle of complementarity (Vane-Wright *et al.* 1991) means that the priority level of each given site may change depending on previous decisions. In the most classical sense, gap analysis identifies sites that best complement the existing network of protected areas (Scott *et al.* 1993). In these guidelines, we broaden the concept of gap analysis to identify where existing protected areas might best be strengthened as well as where new ones should be established, thus better addressing Goal 1.1 of the CBD Programme of Work on Protected Areas (Box 1). This is discussed further in Chapter 6.

- *Iteration* – Prioritization must be an iterative process, one that is continuously updated to ensure the best conservation decisions at each moment in time.
    - *New decisions* – As mentioned above, addressing complementarity requires considering how much each site contributes to overall conservation objectives, by complementing previous investment. This means that new decisions on which sites are already protected are likely to change the relative priority value of unprotected sites. For example, if two sites contain 50% each of the global population of a threatened species, they are both highly irreplaceable and thus very high priorities for conservation planning. However, as soon as one of those sites becomes protected, the priority value of the second drops in relation to other sites containing species in equal circumstances occurring outside of any protected areas.
    - *New data* – If new data reveal the existence of previously unknown populations or the absence of a species from sites it previously occupied, or if conditions change (e.g., a species goes locally extinct in some sites, or more rarely, colonizes others), the priorities will need to be updated accordingly.
- *Accountability* – Solutions for conservation planning should be obtained in a transparent way, so that others can understand why and how the result was derived and, if desired, challenge the findings.
- *Repeatability* – Related to accountability, repeatability ensures that others with the same data and the same set of criteria would derive similar solutions.

Accountability and repeatability are important because protected area networks chosen objectively can be more easily justified and defended, which is particularly crucial when there are many competing interests for the same land (Pressey *et al.* 1993, Williams 1998).

3.2 Methods for setting conservation priorities

Ad hoc decision-making

In the past, protected areas have generally been selected on a site-by-site basis, in an *ad hoc* way, often based on factors such as opportunity (i.e., the site is not seen as valuable for major commercial land use such as agriculture), scenery, recreation, tourist potential, the influence of lobby groups, and historical protection for uses such as hunting or water supply (Pressey and Tully 1994). This approach is not strategic: it does not ensure that the sites with the most important contributions to global biodiversity are adequately protected, and it has already resulted in protected area networks that do not safeguard the most vulnerable habitats in favor of less biodiverse regions that have low human pressure (Pressey *et al.* 1996). It also often neglects to involve the breadth of stakeholders necessary for conservation to succeed in the long term.

Conservation priority-setting workshops

Priority-setting workshops, in which experts from a wide range of taxonomic, biological, ecological and socio-economic disciplines identify priority areas based on their specialist opinions, have become a major tool in conservation planning in recent years (Prance 1990, Hannah *et al.* 1998, Huber and Foster 2003). These workshops offer many advantages over *ad hoc* decision-making:

- They define priorities on a regional scale instead of looking at each site in isolation.
- They provide fora to exchange information and ideas, particularly useful in poorly studied regions where most data are not yet published.
- They are key in building a broad consensus amongst stakeholders (scientists, government agencies, resource users, NGOs and donors) and a sense of ownership of the results, thus creating favorable conditions for implementation (Hannah *et al.* 1998).

Nonetheless, workshops do have some limitations:

- There is great margin for subjectivity, as priorities are frequently identified based on intuition and opinion rather than biological data and explicit criteria. Thus, accountability and repeatability are compromised, and results often don't effectively target the most urgent conservation investments.
- There is a tendency to prioritize data-rich areas over data-poor ones, although this is not a limitation unique to workshops (Cowling *et al.* 2003).

Priority-setting workshops have thus been evolving towards integrating more explicit data and criteria (e.g., in the Guayana Shield, Huber and Foster 2003). Table 1 contrasts priority-setting workshops with the KBA approach, while Box 10 explains how priority-setting workshops can be useful precursors to a KBA analysis.

Table 1. Comparison between conservation priority-setting workshops and KBAs

Conservation priority-setting workshops	Key Biodiversity Areas
Locally-led methodology development.	Globally consistent methodology applied locally.
Variability in biodiversity data associated with priority areas identified at workshops (i.e. scale, detail, breadth).	Data more standardized because strict biodiversity criteria required for identification.
Tendency to identify and prioritize areas important to experts in attendance.	Identified and prioritized based on strict criteria – subjectivity reduced.
Variable criteria for identification and largely based on expert opinion. Can result in more commission errors (section 3.5).	Require known occurrence of a globally threatened species or a globally significant proportion of a species' total population, minimizing commission errors.
Priority areas often delineated as fairly large, general polygons. Manageability for conservation not typically a consideration.	KBAs delineated as areas that can actually or potentially be managed for conservation.

Data-driven systematic conservation planning

Data-driven, systematic analysis is necessary for strategic and sound conservation planning. As with all analytical processes, the quality of the results depends directly on the quality of the input data; no methodology, however sophisticated, can extract good results from bad data (the GIGO rule, "Garbage In Garbage Out": Rosing *et al.* 2002). The reality is that there are gaps and biases in the data currently available for conservation planning:

- Data availability and quality vary tremendously spatially (e.g., amongst countries, or even within regions of a country) and between different types of data (e.g., between different groups such as birds and plants). Often those regions of the world with poorer data are those most in need of conservation planning (Pimm 2000).
- Although strategic investments in acquiring new data can fill crucial gaps in knowledge, conservation planning is often required too urgently to allow time for extensive data collection.
- Reviewing and spatially referencing all relevant existing data may also be time consuming and reveal many gaps and biases in the existing data, perhaps discouraging planners from using these methods (Stoms *et al.* 1997, Davis *et al.* 1999).

Nonetheless, conservation planning must proceed despite these gaps and biases, making the best use of the available data, as is done for KBAs; shortcomings should be acknowledged explicitly and provisions taken for reducing them, as we will discuss further in Chapter 7, not hidden under subjectivity.

Workshops combined with data-driven conservation planning

Data-driven conservation planning is not a replacement for expert input, but a way to formalize and make the best use of such input. Expert workshops are one way of consolidating, synthesizing and, especially, reviewing and interpreting these data, particularly unpublished information. A successful approach delivering objectivity and buy-in has been used by the BirdLife International partnership in identifying IBAs: it starts with initial data collation by an expert team, followed by a workshop where data are presented, supplemented, revised, and applied to criteria, before being finalized by an expert team. In this way, the advantages of priority-setting workshops (consensus building, stakeholder engagement and result ownership) are combined with the accountability and repeatability of data-driven planning.

3.3 How does one measure biodiversity?

Biodiversity represents a continuum of ecological organization (from genes to populations, to species, to the entire biosphere) that cannot be encapsulated into a single variable. This makes setting targets for protected area planning a non-trivial task. Furthermore, given that conservation planning is a spatial exercise, only biodiversity features that can be mapped are useful. Although techniques for mapping and measuring ecological and evolutionary processes are progressing (Cowling *et al.* 1999, Rouget *et al.* 2003), they are still in their infancy; thus, conservation planning has focused mainly on biodiversity pattern (e.g., concentrations of restricted-range species) rather than process (e.g., species movements in response to climate change). Biodiversity features most commonly used in conservation planning are species and broad-scale attributes obtained from data on ecosystems and/or data of abiotic, or nonliving, systems (Noss 2004).

Problems with using species richness

Species richness should not be used as the criterion for establishing protected area networks. A site may contain many species, but if all of these are already well protected at other sites, this site remains a lower conservation priority than an area with fewer species of which none are protected by existing networks. Also, a site with many widespread species (which can be protected elsewhere) is of less concern than a site containing fewer species that occur nowhere else (i.e., a site of high irreplaceability) (Pressey and Nicholls 1989, Pressey *et al.* 1993, Orme *et al.* 2005, Lamoreux *et al.* 2006; see Chapter 6 for more details).

Environmental surrogates for biodiversity

Maps of habitats, ecosystems or vegetation classes, which utilize abiotic information (e.g., climate, geology, topographic relief) to create subdivisions of environmental space, are now widely available at ~1km resolution globally; however they vary in accuracy. The quality of these data continues to improve as they depend more on direct observation via satellites and are further calibrated (Turner *et al.* 2003). These data have been used extensively in conservation planning as environmental surrogates for biodiversity, because they are perceived to save time and resources (relative to field surveys) and they generally do not suffer from spatial gaps (i.e., they can be measured across a landscape). For example, the United States Geological Survey National Gap Analysis Program (USGS-GAP) relies extensively on vegetation maps, often using vegetation classes as the biodiversity units for their gap analyses (Jennings 2000). Similarly, habitat units derived from a mix of data on vegetation types, climate, geology and topography (Lombard *et al.* 2003), ecosystem types obtained from satellite imagery (Armenteras *et al.* 2003), and environmental diversity plotted within a multidimensional environmental space (Faith and Walker 1996) have all been used for conservation planning.

While environmental surrogates have considerable value, there are, as with most approaches, some drawbacks to their use in conservation planning:

- Higher-level biodiversity attributes such as habitats, ecosystems and environmental domains are abstract and subjective ways to divide environmental space. This is illustrated by the assortment of classification schemes that have been applied to conservation planning, mentioned above. Such schemes, and the identity and number of biodiversity elements they generate, are a result of the primary variables used to produce them and the cut-offs applied to consider any two units distinct (Brooks *et al.* 2004b,c).
- The use of environmental classes in conservation planning tends to be associated with percentage targets, which often fail to account for the uneven distribution of biodiversity. Indeed, to define whether a given class is represented, a given target must be established, typically using percentage of area covered (e.g., considering a biome protected if more than 10% of its area is covered by protected areas: IUCN 1993, see Chapter 1). These one-size-fits all percentages often fail to account for regions of higher species richness and endemism, which require higher representation targets (Rodrigues *et al.* 2004b). Some studies use variable percentages that consider factors such as rarity, threats and heterogeneity (e.g., 10 to 100% of area of land classes in Lombard *et al.* 2003); for example, The Nature Conservancy has used this approach in developing a number of its ecoregional plans (Tear *et al.* 2005). However, these still do not identify *where* within a specific land class a 20% target, for example, should be implemented.
- The most comprehensive and rigorous study of the issue to date does not support environmental diversity as a surrogate for species diversity, but rather indicates that significant percentages of species may be missed altogether in reserve networks based on habitat classes (Araújo *et al.* 2001). Further, those species most likely to be missed tend to have restricted ranges and be most in need of conservation intervention (e.g., Araújo *et al.* 2001, Lombard *et al.* 2003). This said, other studies have reported higher surrogacy (Higgins *et al.* 2004), and so the verdict is still out on this debate. While recent advances have been made in habitat classification of aquatic systems (Noss *et al.* 2002, Higgins *et al.* 2005), less work has been done on the issue of testing surrogacy. Remote-sensing techniques generally do not adequately capture the environmental variability of aquatic systems, and little ground-truthing has been done to assess whether habitat classes represent associated species assemblages.

Phylogenetic surrogates for biodiversity

Measures such as Phylogenetic Diversity (Faith 1992, 1994), which consider phylogenetic, or evolutionary, relationships between taxa, have also been proposed for conservation planning. Although initially attractive as an inclusive measure of biodiversity, the value of its application to conservation is uncertain for three reasons:

- Data on phylogenetic relationships are much scarcer and more incomplete than those on species (Polasky *et al.* 2001), although the depth of available phylogenetic data is growing fast (Purvis *et al.* 2005).
- Recent research suggests that incorporating evolutionary distinctiveness into site selection techniques only rarely makes a difference (Rodrigues *et al.* 2005), for example, when species with very deep lineages are found in species-poor regions, typically in isolated islands.
- Valuing species solely according to their evolutionary distinctiveness can be misleading and may divert conservation investment towards species that do not require it (e.g., Hoatzin *Opisthocomus hoazin*, the single member of the Order Opisthocomiformes, but a

common species widespread in the Amazon and Orinoco basins).

Taxonomic surrogates for biodiversity: species that need and benefit from site-level conservation

Because species are the fundamental and most recognisable units in biodiversity (Wilson 1992), they are frequently used as taxonomic surrogates for biodiversity in conservation planning. The species level of biodiversity is by no means an absolutely stable measure, with more than one species concept in use across taxa (Isaac *et al.* 2004), especially in large mammals and birds. Opinions differ on the extent to which divergence between species concepts impacts conservation planning (Peterson and Navarro-Siguenza 1999; Fjeldså 2000), but in any case, there is much less variability amongst species classifications than amongst land-type classifications (Brooks *et al.* 2004c).

There is an urgent need to acquire (and make available) better primary species data as well as to improve existing species data with additional biotic and abiotic information (Brooks *et al.* 2004b,c, Cowling *et al.* 2004, Higgins *et al.* 2004, Pressey 2004). Major initiatives are underway in this regard (e.g., the IUCN-SSC/CI-CABS Biodiversity Assessment Unit and the Global Biodiversity Information Facility[3]). For the short term, however, the following cautions apply:

- Data on species distributions are still largely limited to the best-known taxa (particularly vertebrates and vascular plants), a very small fraction of the planet's species. Were invertebrates better known, they would undoubtedly help identify the majority of KBAs.
- Species datasets are plagued by biases in sampling effort (Nelson *et al.* 1990), and although evidence suggests that conservation plans based on one taxonomic group are good surrogates for others (Brooks *et al.* 2001b), this relationship becomes weaker when taxa are ecologically and evolutionarily distant from each other (Reid 1998).

Species are not equally in need of conservation attention, because they differ in the way they are being affected by human activities. At one extreme, some will almost certainly go extinct unless considerable resources are devoted to their conservation (e.g., Tamaraw *Bubalus mindorensis*: Custodio *et al.* 1996). At the other extreme, a small number of species benefit from human expansion, with both their range and abundance increasing (e.g., Cattle Egret *Bubulcus ibis*: del Hoyo *et al.* 1992). Species suffering higher extinction risk (as evaluated by the IUCN Red List of Threatened Species)[4] are natural targets for conservation investment. In addition, species vary substantially in the extent of their distribution, from species with nearly global ranges (e.g., Osprey *Pandion haliaetus*; del Hoyo *et al.* 1992) to species whose ranges are tiny, either naturally (e.g., Kihansi Spray Toad *Nectophrynoides asperginis*; Poynton *et al.* 1998), or as a result of range loss (e.g., Northern Bald Ibis *Geronticus eremita*; Serra *et al.* 2004). Restricted-range species have fewer spatial options for their conservation and so deserve particular attention in conservation planning aimed at preventing future species extinctions. Data collection for site-scale conservation planning can therefore usefully focus on obtaining information on these species for which it is most needed.

Amongst species in need of conservation attention, there are also substantial differences in the degree to which they require, or will benefit from, site-level conservation efforts. Species that occur at high densities in discrete, identifiable areas are more amenable to site-based conservation than species that are thinly dispersed over wide areas, making it difficult to identify sites that regularly support significant numbers of the species for all parts of their life cycles. Golden-crowned Sifaka *Propithecus tattersalli* (CR), which is restricted to the single site of Daraina Forest in Madagascar (Mittermeier *et al.* 2006), is a good example of a species that can be effectively protected at the site scale. Philippine Eagle *Pithecophaga jefferyi* (CR), in contrast, with a home range per pair estimated at 25–50 km^2 (BirdLife International 2004a), is a classic example of a species that requires conservation at the landscape scale. In addition, the persistence of species sometimes requires the maintenance of landscape-scale processes such as dispersal, trophic interactions, habitat formation and disturbance, and flow regimes, even if the species themselves are restricted to individual sites. For example, the extirpation of strongly interactive (or keystone) species from an area, such as the classic example of the Gray Wolf *Canis lupus* extirpation from Yellowstone National Park, can lead to the decline and local extinction of other species at particular sites (Soulé *et al.* 2005).

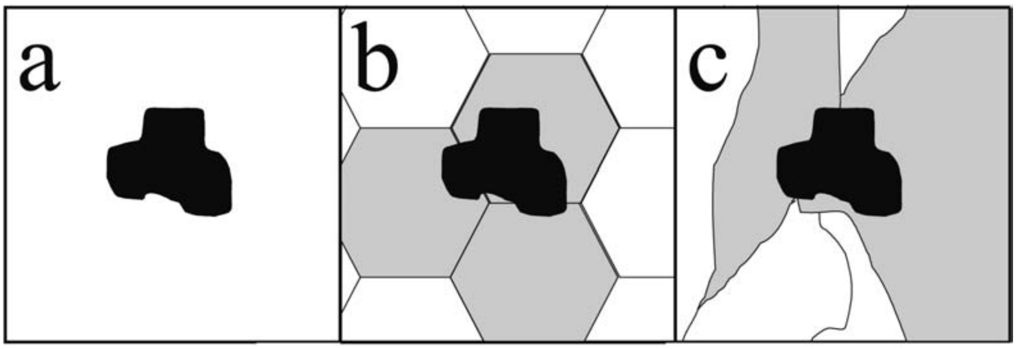
3.4 Spatial units for priority-setting

Pre-defined spatial units

When collecting data for conservation planning, one must understand what spatial units, or areas of land, might be candidates for site-level conservation. Most conservation planning studies divide the study area into a set of generally contiguous units. Many use equal-area grids, typically squares (e.g., Pressey *et al.* 1996) or hexagons (e.g., Kiester *et al.* 1996), which allow one to spatially investigate macroecological patterns such as variation in species richness with latitude (Gaston and Blackburn 2000) by allowing direct comparison of variables between units (e.g., Baillie *et al.* 2004). Sometimes these spatial units correspond with the ones used in data collection (e.g., in atlases: Harrison *et al.* 1997), which means that available data are already matched to those units. In other cases,

[3] www.gbif.org
[4] www.iucnredlist.org

Figure 1. Converting from point locality records to units for spatial analysis, for a species restricted to a single forest reserve. a) Land management units – e.g., forest reserves; b) regular pre-defined partition – e.g., hexagons; c) irregular pre-defined partition – e.g., water catchments. Black indicates where the species is known to occur; white where the species does not occur. The extent of the gray units in b) and c) gives the impression of much lower irreplaceability than is actually the case.



data across cells are obtained by extrapolating point locality distributions onto a grid (e.g., Brooks *et al.* 2001a).

Pre-defined partitions of space are, however, of little use to conservation on the ground. Equal-area partitions, such as grids, typically have little relationship to how land is managed and are seldom meaningful for species. Units such as catchments and land systems tend to be more informative, but are not necessarily adequate for all species. Indeed, these top-down units will only be meaningful to all the targeted species if these share particular ecological traits that can be mapped spatially, for example, a map of forest fragments for forest-associated species (Howard *et al.* 1998) or a map of ponds for freshwater species (Briers 2002).

In addition, pre-defined units may introduce a number of errors into analysis (Figure 1). If, for example, a species has a tiny range (e.g., a forest fragment) that gets split between two adjacent grid cells, it creates the impression that the species occurs in two units, and that these two units are not as irreplaceable (hence of lower priority) than single units that contain a species restricted to that sole unit. Species with very small and/or fragmented ranges (often those most in need of conservation) are particularly affected by these errors.

Existing management units

The best way to ensure that the conservation needs of target species are met is to define the boundaries of each spatial unit based on existing land management units. Because land management units are the scale at which site conservation actually takes place, they make the most relevant conservation planning units. Where management units do not exist, units that correspond to the habitat of target species should be used instead. This will yield distinct types of planning units (e.g., protected areas, forest fragments, wetlands, etc.) of variable size and will help to promote ownership and action at the national level. We will discuss spatial units as they relate to KBAs further in Chapter 5.

3.5 Errors in priority-setting

Conservation planning based on perfect data is impossible even in the best-known parts of the world (Pressey and Cowling 2001); thus, results are always affected by error, which can be divided into two classes;

- **Omission errors** (false negatives) result when conservationists fail to realize that a species occurs in a particular site, where it could be protected. These often result from incomplete information and are particularly associated with point locality data. The less well-known a species or a region is, the more likely that the species occurs beyond the places where it has been confirmed. The risk in using data with a geographic bias in defining conservation priorities is that areas that have been heavily sampled tend to be highlighted as higher priorities than areas with little sampling (Nelson *et al.* 1990). Point locality data are thus plagued by false-negatives (or omission errors), in which species are considered to be absent from sites at which they are, in fact, present. It is tempting to try to 'correct' for sampling effort through statistical modeling, in particular by extrapolating from known species localities to modeled distributions (e.g., Peterson and Kluza 2003). There are serious dangers, however, in this approach. Models have less statistical power for species with very few records and with small ranges in relation to the resolution of the environmental data (Peterson 2001, Anderson *et al.* 2003), making them less useful and reliable for application to rare or poorly known species, which are often among the most in need of conservation attention.

- **Commission errors** (false positives) result when a species is considered adequately protected in a site where it is not actually present. These errors tend to result from data extrapolation. For example when fitting point data to a grid format, people sometimes assume that cells in between known records are also occupied (e.g., Brooks *et al.* 2001a). They may also result from habitat suitability models, which extrapolate from point localities into un-sampled regions based on environmental similarity (e.g., Ferrier *et al.* 2002). While extrapolations are predictions of habitat suitable for occupancy, not of actual current occupancy, these models are often interpreted as the latter. Applying such modeled data to gap analyses can potentially result in an overestimate of the species' current coverage by the existing network of protected areas and in the diversion of conservation action towards sites where species do not exist.

Commission errors should be minimized

Commission errors are more serious in conservation planning than omission errors. False negatives are precautionary in that they assume that conservation efforts should be aimed at places where we know that species are present (even if more appropriate places are found subsequently). False positives, on the other hand, could lead to a species' extinction because we assume we are conserving it where it does not actually occur (Brooks *et al.* 2004c). These consequences are particularly vital for species with small ranges and/or globally threatened species. Omission errors can also result in extinctions if species are lost before their locations are mapped, but correcting for these errors must rely on field data, rather than solely on predictions that can lead to commission errors. Predicted occurrences, on the other hand, are invaluable in identifying priorities for research.

Conservation implementation priorities and conservation research priorities

As discussed above, biological data tend to be highly biased towards regions of better accessibility (e.g., near roads or rivers). Consequently, a protected area planning approach aimed at minimizing commission errors tends to identify priority areas in these regions, to the detriment of other, less-studied areas that may be equal or higher priorities. In the short term, it is important to protect areas that are known to be extremely important (even if they are on roadsides). However, it is also critical to fill knowledge gaps and to incorporate information on new priority areas into conservation planning as it becomes available. It is important to distinguish clearly between areas that are priorities for conservation action (those supported by existing data) and areas that are priorities for further exploration (those only suspected to be important). These topics are discussed further in Chapter 7.

4. Criteria and thresholds for Key Biodiversity Areas

Data-driven criteria and thresholds ensure that the KBA approach is repeatable in its application around the world, over time, and among different practitioners. In this chapter we present the rationale for the KBA criteria and propose a set of thresholds to avoid subjectivity in the selection of globally important sites, and to ensure repeatability in the application of KBA criteria.

4.1 Rationale for the KBA criteria and considerations in setting thresholds

Chapter 3 demonstrates the importance of using an approach driven by species locality data to identify site-scale targets for biodiversity conservation, and thence as a starting point for national gap analysis. The KBA identification process uses two criteria, which align with the two principal measures of systematic conservation planning: **vulnerability** and **irreplaceability**. Under these criteria, KBAs are selected based on the presence of species that require site-scale conservation.

A site meets the vulnerability criterion for KBAs if it holds globally significant numbers of one or more globally threatened species according to the IUCN Red List. These species, by definition, are threatened with extinction; thus, all areas where they occur in significant numbers must be considered global priorities for site-scale conservation.

A site meets the irreplaceability criterion for KBAs if it maintains a globally significant proportion of a species' total population at some point in that species' lifecycle. This criterion covers multiple components of irreplaceability, for species that are geographically concentrated and consequently depend on a network of sites within at least part of their ranges or life cycles. This includes many species that have restricted ranges, have highly clumped distributions within large ranges, congregate in large numbers, have source populations on which significant proportions of the global population depend, or are restricted to particular biomes or bioregions. Viewed another way, these highly irreplaceable sites are those most important for proactive conservation to prevent biodiversity loss, should threats intensify or if threats are stochastically distributed.

A KBA can be identified under the vulnerability and the irreplaceability criteria simultaneously (Table 2); indeed, many individual species trigger both the vulnerability and the irreplaceability criteria. A KBA network defined according to the presence of species meeting the vulnerability or the irreplaceability criteria would be expected to include all sites that play a crucial role in maintaining the global population of these species.

Table 2. Summary of KBA criteria and thresholds

Criterion	Sub-criteria	Provisional thresholds for triggering KBA status
Vulnerability Regular occurrence of a globally threatened species (according to the IUCN Red List) at the site	N/A	Critically Endangered (CR) and Endangered (EN) species – presence of a single individual Vulnerable species (VU) – 30 individuals or 10 pairs
Irreplaceability Site holds X% of a species' global population at any stage of the species' lifecycle	a) Restricted-range species	Species with a global range less than 50,000 km^2 5% of global population at site
	b) Species with large but clumped distributions	5% of global population at site
	c) Globally significant congregations	1% of global population seasonally at the site
	d) Globally significant source populations	Site is responsible for maintaining 1% of global population
	e) Bioregionally restricted assemblages	To be defined

We foresee that the process for establishing definitive thresholds for KBA criteria will evolve, in a fashion similar to the development of the IUCN Red List criteria (IUCN 2001). In particular, application of the proposed KBA criteria to marine and freshwater environments requires much further testing.

Detailed guidelines for delineating the boundaries of KBAs are given in Chapter 5. It is important to note that for the application of the KBA criteria and thresholds, KBAs are delineated as sites that are, or could potentially be, managed for conservation (Section 5.3).

4.2 The vulnerability criterion

Regular occurrence of globally threatened species

If KBAs are to prevent biodiversity loss, they must safeguard the species facing the highest extinction risk. Sites that meet this criterion are defined as those in which a globally threatened species (following the IUCN Red List, Box 2) occurs regularly and, wherever possible, is viable. The phrase "regularly occurs" ensures that instances of vagrancy, marginal occurrence, and historical records are excluded, while including migratory species in transit. Sites may be included where the species' occurrence is seasonal (for instance, for breeding) or episodic (such as in temporary wetlands) (e.g., Fishpool and Evans 2001).

Box 2. The *IUCN Red List of Threatened Species*

The *IUCN Red List of Threatened Species* (hereafter referred to as the Red List) is the accepted standard for assessing species extinction risk (Lamoreux *et al.* 2003, Rodrigues *et al.* 2006, De Grammont and Cuaron 2006). The identification of threatened species is of great importance to biodiversity conservation, since it enables practitioners to target those species known to be at highest risk of extinction.

International Red Data Books were first conceived of in the early 1960s, as a "*register of threatened wildlife that includes definitions of degrees of threat*" (Fitter and Fitter 1987). The first Red List assessments were largely subjective and qualitative, and primarily focused on a few hand-picked species. However, in 1994, IUCN introduced a new system of categorical rankings employing quantitative criteria and representing several advances, including: enabling consistent application by different people, being based around a probabilistic assessment of extinction risk, the incorporation of a time-scale, and the ability to handle uncertainty. These criteria formed the basis of two global assessments of the world's avifauna (Collar *et al.* 1994, BirdLife International 2000), as well as the *1996 IUCN Red List of Threatened Animals* (Baillie and Groombridge 1996) and the *World List of Threatened Trees* (Oldfield *et al.* 1998).

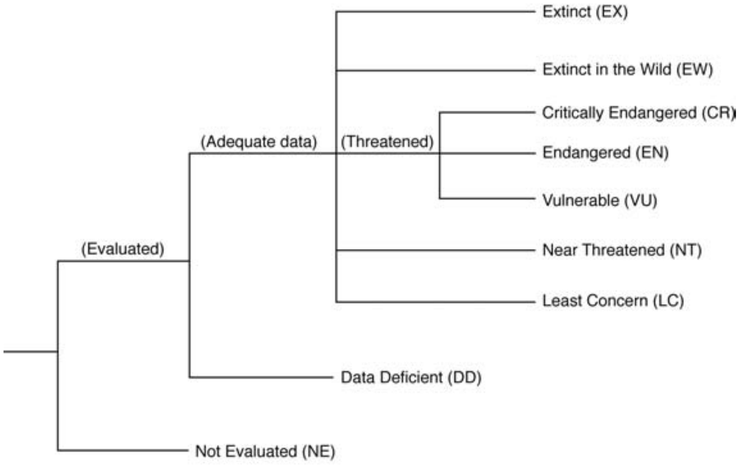
Since the adoption of the most recent version of the categories and criteria in 2001 (IUCN 2001; Figure 2), there has been considerable emphasis on improving the rigor, justification and transparency of Red List assessments. Assessments are consultative, increasingly facilitated through workshops and web-based open-access systems (e.g., BirdLife International's globally threatened bird fora), and each assessment is peer-reviewed by at least two members of a Red List Authority (RLA) – which usually, though not always, takes the form of one of the more than 100 taxon-based Specialist Groups of the IUCN Species Survival Commission. All assessments require detailed supporting documentation on geographic range, habitats, threats, and conservation responses, and all documentation must now be made publicly and freely available. IUCN also permits listings to be challenged and disagreements to be resolved through a petitions process, although changes are not permitted for political, emotional, economic or other non-biological reasons.

The Red List has also grown greatly in taxonomic and geographic coverage. Most recently, for example, the three-year Global Amphibian Assessment delivered sobering results for all the world's nearly 6,000 amphibian species showing that one-third are threatened with extinction (Stuart *et al.* 2004); mammals are under revision for the first time since 1996 through the Global Mammal Assessment, while a Global Marine Species Assessment and a number of regional Freshwater Biodiversity Assessments are underway. Two groups of plants – cycads (Donaldson 2003) and conifers (Farjon and Page 1999) – have already been fully assessed, a global tree assessment is ongoing, and a number of regional evaluations have been published (e.g., southern African countries: Golding 2002), but clearly much work remains to be done to improve the coverage of plants on the Red List (Target 2 of the Global Strategy for Plant Conservation).

In conclusion, the IUCN Red List represents the most authoritative source for the conservation status of species, one whose value extends far beyond just the classification of individual species into categories of threat, but now relies crucially on the comprehensive data collected to support these assessments (Rodrigues *et al.* 2006). These data put the IUCN Red Listings in context, helping to better understand the actual threats relative to species distributions, and proposing appropriate conservation measures. As such, while certainly not perfect, the IUCN Red List has become a valuable and important tool in the conservation planner's toolbox.

Box 2 cont.

Figure 2. **The IUCN Red List Categories.** A taxon is considered Evaluated when it has been assessed according to the latest version of the IUCN Red List Categories and Criteria (Version 3.1; IUCN 2001). Species classed as threatened (Critically Endangered, Endangered or Vulnerable) must meet one or more criteria: A – Reduction in population size; B – Restricted geographic range; C – Small population size (and decline); D – Very small population size (D1) or range (D2); and E – Quantitative analysis.



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IUCN Red List categories not included in KBA designation

For KBA designation we consider only those species quantitatively assessed as threatened on the IUCN Red List (i.e., Critically Endangered, Endangered or Vulnerable), and therefore omit species in the following categories:

- Extinct in the Wild – These require species-specific *ex situ* conservation efforts until a population has been re-established at a given site. The species would then be re-evaluated as globally threatened; and hence, the site would qualify as a KBA.
- Critically Endangered/Possibly Extinct – This category is a newly introduced marker in the Red List, rather than a category in its own right. By definition, these species are no longer confirmed to occur at any sites and may be extinct. They would trigger candidate KBA status only (Section 5.2.4), until their existence is confirmed.
- Near Threatened –Although included as trigger species for IBAs in some regions, (e.g., Heath and Evans 2000), Near Threatened species are less urgent priorities for conservation, as they are at lower risk of extinction. Additionally, there may be a degree of greater uncertainty associated with their estimated extinction risk, as the guidelines for their identification on the IUCN Red List are less explicitly quantitative and may be less consistently applied between (and within some) taxonomic groups.
- Least Concern – These species have been assessed as not globally threatened.
- Lower Risk/conservation dependent – This category from the 1994 assessments is no longer an active Red List category (IUCN 2001).
- Data Deficient – These are by definition priorities for research, rather than for conservation (Chapter 7).

Species listed as threatened in old Red List assessments

A related question is how to treat species considered threatened on previous versions of the Red List, but not yet evaluated against rigorous quantitative criteria (IUCN 1994, 2001). While the *IUCN Red List of Threatened Species* is designed to combine both animal and plant assessments in one list, including all species assessed for the *World List of Threatened Trees* (Oldfield *et al.* 1998), many of the plant taxa previously assessed for the *1997 IUCN Red List of Threatened Plants* (Walter and Gillett 1998) are not included on the current IUCN Red List. This is because most of the plants are still assessed using the older categories (pre-1994); these should not be considered in KBA identification. As more plants are reassessed using the most recent Red List assessment system they will be added to the Red List in future updates.

When to include species assessed as threatened at sub-global levels

Sub-global Red Lists are important for national and regional policy, and sometimes incorporate higher quality data than are available at the global level (Rodríguez *et al.* 2000). Further, the IUCN has produced extensive guidelines for applying the criteria at the regional level to ensure consistency (Gardenförs *et al.* 2001). Within sub-global Red Lists, any species endemic to the assessment region that has been assessed according to the Red List guidelines (Standards and Petitions Working Group 2006) and has gone through the required evaluation process should also be included in the application of the vulnerability criterion (for globally threatened species). If the IUCN guidelines are followed, then the species would have, by definition, the same listing on the global Red List, pending evaluation by the appropriate Red List Authority.

Precedents for thresholds for threatened species

A range of numerical thresholds has been used to identify IBAs, IPAs and other important sites under the vulnerability criterion. For example, Fishpool and Evans (2001) used a threshold of 10 pairs (or 30 individuals) for species classified as Vulnerable and of 1 individual for species classified as Critically Endangered or Endangered. Heath and Evans (2000) used a variable threshold for Vulnerable, which was "calculated from the size of the species' global population and also depends upon whether the species has a relatively large or small body size, and whether it has primarily dispersed or colonial nesting habits". In defining IPAs, Anderson (2002) used a relative threshold, rather than an absolute one, of either all sites holding 5% or more of the national population of a threatened species, or of the five "best sites".

Darwall and Vié (2005) also proposed percentage thresholds to identify KBAs for threatened freshwater taxa. Subsequent workshop discussions on freshwater molluscs and fish led to recommendations for separate thresholds for data-poor and data-rich situations and, in the latter case, for species with different life history strategies (Darwall, pers comm.). In data-poor situations a threshold value of $\geq$1% of the total number of sub-populations in the assessment area was proposed. In data-rich situations, the proposal was for a threshold of $\geq$1% of mature individuals in the assessment area that have contributed successful recruits within the last decade or $\geq$0.1% of total mature individuals (for species with slow life history traits) or $\geq$1% of total mature individuals (for species with fast life history traits). The process for iterative testing and refinement of these thresholds is ongoing (Box 3).

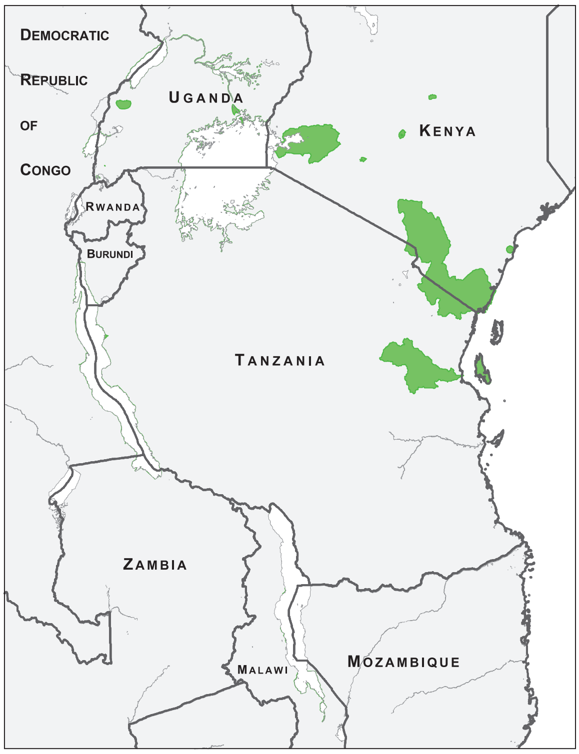
Box 3. Development of site selection criteria and thresholds for KBAs in inland waters in East Africa

There is widespread agreement that biodiversity in inland waters is highly threatened, many believe more so than in any other ecosystem (McAllister *et al.* 1997).

Although a number of site prioritization methodologies have been developed for terrestrial and marine ecosystems, few are specific to inland waters, where the high connectivity of the aquatic medium has to be considered (Abell 2002). In response to this need, the IUCN/SSC Freshwater Biodiversity Assessment Programme initiated a project to review existing site prioritization methodologies and to adopt, modify or build upon those methods thought to be most suitable to inland waters. A draft methodology was elaborated and agreed upon by representatives from a number of major conservation organizations and a range of taxonomic experts in June 2002 at a workshop held in Gland, Switzerland (Darwall and Vié, 2005).

The principles and framework of this methodology are largely consistent with those of other organizations, and are consistent with the KBA approach at the global scale (Eken *et al.* 2004). However, with the exception of water birds, for which Bird Life International and partners have developed precise guidelines, the general lack of species data for identifying key biotic targets in inland waters has left existing methodologies for species-based site selection poorly developed. This is a priority focus for the IUCN as it starts to compile new species datasets for freshwater taxa. It is conducting a series of technical workshops to adapt the guidelines for application of the species-based criteria in the methodology (originally developed for birds) to suit the full range of priority taxa. Workshops are underway for freshwater fish, molluscs and odonates. The draft thresholds for molluscs have now been evaluated using the IUCN/SSC dataset on freshwater biodiversity in Eastern Africa (Figure 3). The criteria and thresholds for fish, molluscs and odonates will be assessed shortly.

Figure 3. Preliminary KBAs for molluscs endemic to East Africa. Sites (in green) were identified for threatened species and for species with global ranges less than 500 km^2. Data provided by IUCN/SSC Freshwater Biodiversity Assessment Programme.



Will Darwall and Kevin Smith, IUCN/SSC Freshwater Biodiversity Assessment Programme

Box 4. Setting KBA thresholds – lessons from Turkey

Turkey is a key country for global biodiversity mainly because of its exceptionally rich flora, which includes nearly 9,000 species of vascular plants and ferns and 34% endemism (3,022 species). Identification of Turkey's KBAs dates back to 1989. Since then, several inventories have been produced covering globally important sites for select taxonomic groups. Doğa Derneği's (Nature Society in Turkey) collaboration with BirdLife International, Wageningen University and several Turkish universities and other NGOs, produced a draft KBA inventory in 2003 (www.sifiryoklus.org), which includes birds, mammals, herpetofauna, freshwater fishes, butterflies and dragonflies, and yields 266 KBAs (Figure 4). This inventory, which uses four KBA criteria and associated thresholds, provided the following lessons.

Figure 4. KBAs identified in Turkey. KBAs shown as green polygons. Data provided by Doğa Derneği.

Threatened species: Although the regular occurrence of one individual of a Critically Endangered species was a practical way to select KBAs, this threshold was rather low for Endangered (EN) species, given the number of such species that are relatively widespread across sites despite their high extinction risk. Because these species mainly meet the Red List Criterion A (reduction in population size), particularly sub-criterion A1, we recommend a higher threshold for EN species that meet this sub-criterion alone. For species classified as Vulnerable (VU) that meet only the Red List sub-criterion A1, even higher thresholds may be desirable.

Restricted-range species: This criterion required two thresholds: one to define "restricted-range" as species with global ranges <50,000 km^2; the second to identify globally significant populations for these species that would trigger a KBA, which we set as sites holding >5% of the total population. 50,000 km² seems to be applicable across taxon groups, including freshwater fishes. Selection of restricted-range plants required more detailed analysis due to the large number of species. Nearly all of Turkey's 3,022 endemic plants occur in areas less than 50,000 km². 68% of these occur in areas less than 500 km² – and virtually all of these qualify as globally threatened, thus triggering the first (threatened species) KBA criterion. Among restricted-range species that occur in areas over 500 km², only a few are listed as threatened. Consequently, over 70% of Turkish endemic and restricted-range plants are covered by the threatened species criterion. The remaining endemics (870 species – 28%) include plants that trigger only the restricted-range species criterion. Of these species, most had significant populations (defined using a threshold of 5%) within the KBAs already selected for other taxa. Our conclusion is that the 50,000 km² and 5% thresholds are appropriate, despite the fact that these initially give the impression of being very high for species with fine-grained distributions, such as plants.

Congregatory species: One percent of the global population seems to be an applicable threshold for most taxon groups, and a rough estimate is often available for most congregatory species in Turkey.

Bioregionally restricted assemblages: This has proven to be the most difficult criterion for applying thresholds. Originally, we used a threshold of 25% to select sites with a significant component of a bioregionally restricted bird assemblage. This requires a second threshold to set the minimum population size of each species with a significant component. For many taxon groups, however, such a complex threshold system wasn't possible; in these cases we propose using a simple population threshold – such as 5% similar to restricted-range species.

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Recommended thresholds for the vulnerability criterion

For species classified as Vulnerable, we propose a provisional threshold of 10 pairs or 30 individuals. This threshold should exclude any clearly non-viable populations, although, for most species, a population viable in the long term would require a much higher number of mature individuals.

For highly threatened species (classified as Critically Endangered or Endangered), we recommend a lower threshold because, in the extreme case, all remaining populations of a species may be non-viable. Site-scale conservation may therefore need to be simultaneous with species-specific efforts or habitat restoration at the landscape or seascape scale. However, site-scale conservation will generally be a pre-requisite, and so for highly threatened species we recommend that the presence of just one individual is sufficient to designate the site.

These thresholds provide a sensible starting point for subsequent testing, including consideration of thresholds for the percentage of a species' total population, rather than absolute numbers, at a site.

4.3 The irreplaceability criterion

Highly irreplaceable sites are globally significant for biodiversity conservation and should therefore be designated as KBAs. Three sub-criteria are in widespread use for the identification of KBAs under the irreplaceability criterion (Eken *et al.* 2004): restricted-range species; globally significant congregations; and biome-restricted species assemblages. The first two aim to identify sites as having global conservation significance if they exceed a given threshold of a species' population at a site, at least temporarily. Here, we also propose adding a further two sub-criteria to these: widespread but sedentary species that have highly uneven distributions and a threshold percentage of their global population concentrated in a single site; and source populations on which a threshold percentage of the global population of a species depends.

4.3.1 Restricted-range species

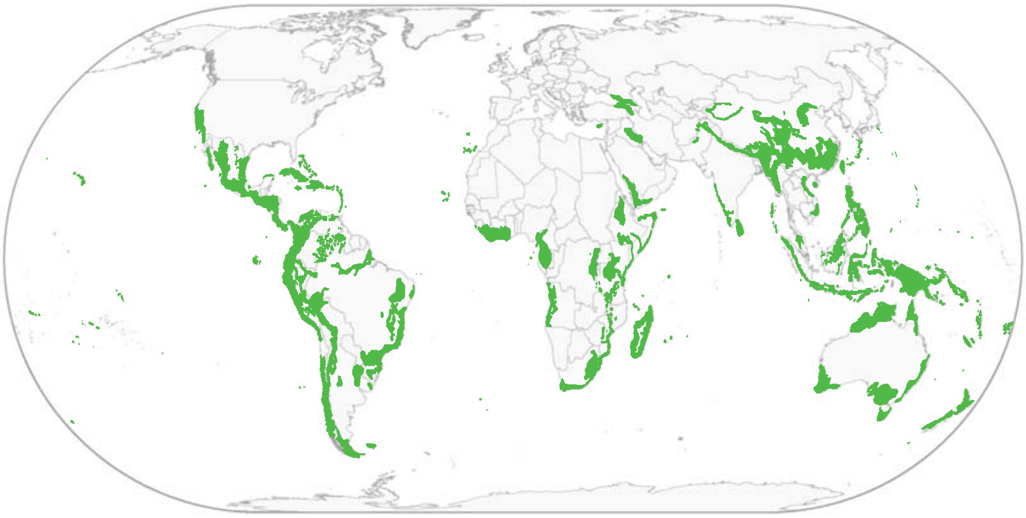
The first sub-criterion for identifying KBAs under the irreplaceability criterion is the presence of species with restricted global ranges. Species with restricted ranges, because of their small distributions, are more likely than more widespread species to occur at sites in globally significant numbers. There is a strong relationship between the size of a species' range and its extinction risk (Purvis *et al.* 2000), and, not surprisingly, geographic range is inherent in some of the IUCN Red List criteria (Box 2). (Consequently, many such "restricted-range" species are also globally threatened and so are also captured by the vulnerability criterion for KBA identification.) To meet the restricted-range sub-criterion, sites must hold a significant proportion of the global population of one or more restricted-range species on a regular basis.

How to define "restricted-range"

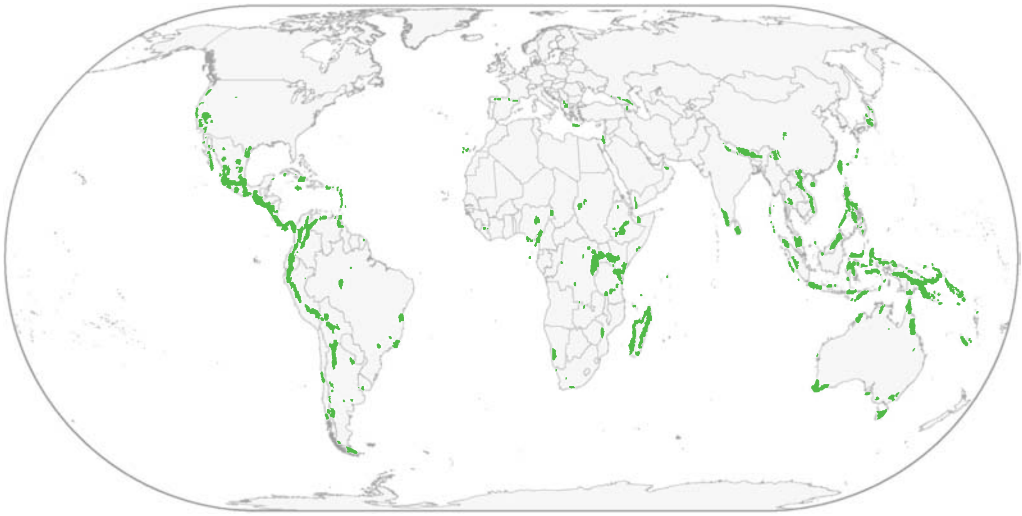
Two techniques exist for assessing a species as restricted-range:

- **Percentile approach** – This approach measures range restriction relative to the overall distribution of range sizes within a given taxon. For example, the lowest quartile of species' range sizes could be considered as restricted-range. However, this approach is both theoretically and practically problematic. Theoretically, it is silent as to the taxonomic level at which the lowest percentile of range sizes should be assessed, thus ignoring that frequency distributions for range size will vary with taxonomic level (Gaston 1996); for example, species in the mammalian order Carnivora tend to have much larger range sizes than most other mammalian orders. Practically, this approach requires that all species within a given taxon be assessed before a species can be defined as having a restricted range, potentially hindering the identification of KBAs.
- **Absolute threshold approach** – This approach, which sets an absolute threshold for all taxa, measures spatial conservation options equally across species. In a landmark analysis, Stattersfield *et al.* (1998) defined restricted-range terrestrial bird species as those with a historical breeding range of 50,000 km^2 or less, based on the work of Terborgh and Winter (1983). This definition incorporates approximately 27% of all birds (three-quarters of which are threatened), highly concentrated into 218 Endemic Bird Areas in which the ranges of two or more restricted-range species overlap (Figure 5a; Stattersfield *et al.* 1998). For mammals, the 50,000 km^2 cutoff also classifies approximately 25% of species as having restricted ranges, with the global distribution of areas holding two or more restricted-range mammals being very similar to that for birds (Figure 5b). In contrast, for amphibians, the application of Stattersfield *et al.*'s (1998) threshold yields approximately two-thirds of species – a much higher percentage. Remarkably, however, the global distribution of areas holding two or more of these restricted-range amphibians is almost identical to that for birds and mammals (Figure 5c).

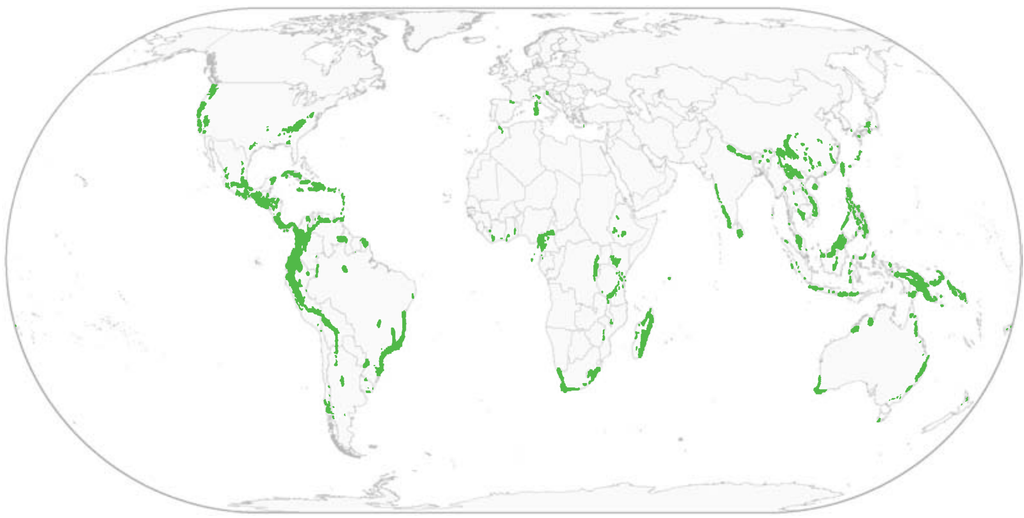
Figure 5. Global maps of areas that hold two or more bird, mammal or amphibian species with a global range less than 50,000 km^2



(a) Endemic Bird Areas



(b) Endemic Mammal Areas



(c) Endemic Amphibian Areas

Box 5. Marine KBAs in the Galapagos

A recent study in the Galapagos Marine Reserve, a 138,000-km^2 area in the Eastern Pacific revealed that KBAs could be usefully applied in the marine realm. However, KBA criteria were applied with slight modification to account for (1) the paucity of marine species assessed for inclusion on the IUCN Red List compared to terrestrial biomes, and (2) the wide local distributions of many of the threatened species; for example, recent archipelago-wide surveys encountered the Galapagos Sea Lion *Zalophus wollebaeki* (VU) and Green Turtle *Chelonia mydas* (EN) at 79% and 64% of 66 dive sites investigated, respectively.

A six-step process was used to identify KBAs in Galapagos: (a) tabulation from literature of endemic Galapagos marine species that are relatively noticeable on general field surveys, (b) compilation of all available historical and contemporary survey data on the distribution and population trends for these marine species, (c) application of the IUCN Red List criteria to identify endemic marine taxa not yet formally assessed for inclusion on the IUCN Red List, but which fulfill criteria indicating that they are globally threatened, (d) mapping of distributions of globally threatened species to identify sites where they concentrate as potential KBA sites, (e) embarkation of field surveys of potential KBA sites to confirm presence of threatened species, and hence their KBA status, and (f) comparison of species distribution, abundance and land tenure data to identify KBAs that fulfill criteria.

A total of 42 globally threatened marine species was identified in the Galapagos Archipelago, comprising five mammal, five bird, five reptile, three fish, two echinoderm, one crab, two mollusc, three coral, seven brown algal and nine red algal species. This total includes 27 species that fulfill IUCN threatened species criteria but have not yet been placed on the Red List. Globally threatened species were not evenly distributed across the archipelago, but were highly concentrated in the western region where cool, nutrient-rich currents well up to the surface and temperate rather than tropical conditions prevail.

A total of 38 sites with threatened species confirmed during recent field surveys were identified as potential KBAs. All except 11 of these sites are already protected from extractive activities as conservation or tourism zones within the Galapagos Marine Reserve zoning scheme. To safeguard marine biodiversity in Galapagos, three tasks must be undertaken – (1) delineation of KBA boundaries, (2) modification of the Galapagos Marine Reserve zoning scheme to fully encompass the identified KBAs within 'no-take' conservation or tourism zones, and (3) adequate enforcement of protected zones. The Galapagos KBA analysis will be refined as more data become available, and as the criteria and thresholds for identifying KBAs in marine ecosystems are tested and further solidified.

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Although experience suggests that the 50,000 km^2 threshold is a good first approximation for species requiring site-scale conservation, its application requires further testing, particularly:

- For plants and invertebrates, because of their generally smaller and more specialized distributions.
- For freshwater and marine systems, because measurement of range itself is frequently problematic (Box 5) and relationships between species' ranges and the distribution of threats are often very different than in terrestrial systems due to higher connectivity. Hence, approaches that account for metapopulation dynamics should be evaluated when setting thresholds for aquatic restricted-range species. Alternative metrics could involve length of water body, volume or discharge rate for riverine systems, or continental shelf area for coastal marine systems.

Precedents for thresholds for restricted-range species

As the aim of this sub-criterion is to identify globally significant sites for restricted-range species, a threshold must be set for determining what qualifies as a globally significant proportion of the species' population. The IBA approach has applied thresholds to entire assemblages of restricted-range bird species (Fishpool and Evans 2001), such that KBAs were identified where they held a significant component of a group of species whose breeding distributions define an Endemic Bird Area (Box 6). However, while this approach has been successfully applied to birds, it is difficult to extend it to other taxonomic groups as it requires comprehensive assessment of each group. It would not be possible, for example, to identify networks of sites for groups of beetles known to have shared tiny ranges. Also, application across all higher taxa would require revision every time a new higher taxon is incorporated into the assessment.

In contrast, Darwall and Vié (2005) used a species-by-species approach, setting a threshold to identify sites as holding "non-trivial numbers of one or more species of restricted range". This restricted-range criterion has been included in the selection of IPAs (Plantlife International 2004) as sites that contain 5% of the national population of threatened endemic or 'near endemic' species. Plant species are traditionally recorded as endemic if they are restricted to any particular country. To date, nationally based thresholds have been applied for this criterion, due to the paucity of global distribution data for many plant species. Nevertheless, in identifying KBAs for restricted-range species, it seems preferable to apply the threshold using a species-by-species approach.

Recommended threshold for identifying KBAs for restricted-range species

Although previous applications of this sub-criterion have mostly used qualitative rather than quantitative thresholds, quantification is desirable to minimize subjectivity. We therefore provisionally propose that sites holding 5% or more of the estimated global population of a restricted-range species qualify as KBAs, with the recommendation that this be tested, in particular, in relation to a 1% threshold.

Population data are unlikely to be available for many restricted-range species. In the absence of population data, to identify a KBA it will be necessary to use percentage of a species' global range covered by a site as an estimate of the

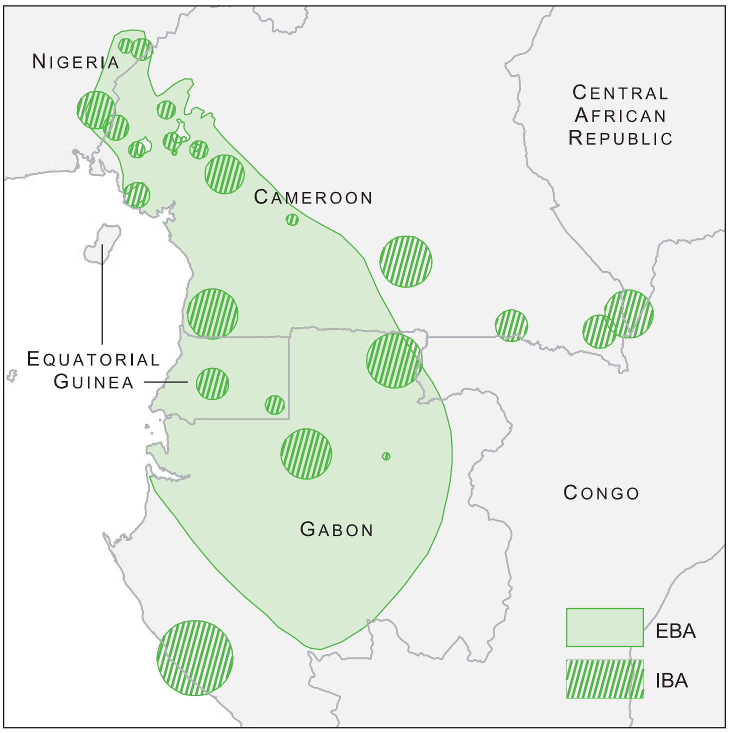
Box 6. Identifying IBAs for restricted-range birds

Some 27% of the world's birds, more than 2,500 species, are estimated to have had historical breeding ranges of 50,000 km^2 or less, qualifying them as restricted-range species. Where two or more restricted-range species overlap, the combined area of their ranges is called an Endemic Bird Area or EBA (Stattersfield *et al.* 1998). Worldwide, 218 EBAs have been identified, currently covering about 1% of the earth's land surface (Figure 5a). The number of restricted-range species confined to an individual EBA varies from two to 79, and the size of these EBAs ranges from a few square kilometers to more than 100,000 km^2.

Because of their large size and because restricted-range species are not often distributed evenly throughout these EBAs, conservation in the EBA requires the identification of a network of sites that, between them, ensure adequate representation and persistence of all the restricted-range species. This is, in part, an aim of the IBA program, which selects a network of complementary IBAs that accounts for the distribution of sites across the relevant portions of each of the range states covered by the EBA, and across the EBA as a whole (Figure 6).

To qualify as an IBA, a site must hold a 'significant component' of the group of restricted-range species whose breeding distributions define an EBA. The clause 'significant component' ensures that IBAs are not selected solely for the minority of restricted-range species that are common and widespread within the EBA, readily adapting to degraded habitat for example. These species generally occur at sites chosen for other species less tolerant of disturbance. Sites that hold only one or a few species may qualify as IBAs if, for reasons of narrow habitat requirements, these species would otherwise be un- or under-represented in the network. A modification of this approach is adopted for the identification of KBAs for restricted-range species generally, as explained in this section.

Figure 6. Example IBA coverage of a particular EBA – the Cameroon and Gabon lowlands Endemic Bird Area. The area of the circle around each IBA shows the area of the IBA, to scale with the map. Data from BirdLife International.



Lincoln Fishpool, BirdLife International

percentage of the global population (assuming, of course, that the species is known to occur at the site). This approach requires the assumption that individuals of a species are evenly distributed across its range, which is not always the case. However, the congregations sub-criterion (Section 4.3.2) – which is based on actual population data – should pick up the cases where extreme population variation means that such an assumption is wildly invalid. All assumptions made in KBA designation should be well documented (Section 5.2.1).

4.3.2 Species with large but clumped distributions

A second class of species that may trigger the irreplaceability criterion comprises those species that are widely distributed but have clumped distributions in parts of their range. In other words, large numbers of individuals may be concentrated in a single or few sites while the rest of the species is widely dispersed. Species with large extent of occurrence but small area of occupancy may also trigger this criterion. We suggest a provisional threshold of 5% of the global population of such a species as appropriate to trigger a KBA, paralleling the threshold for restricted-range species. An example is Wildebeest *Connochaetes taurinus*, which is distributed throughout much of southern and eastern Africa, and has large proportions of its global population in a few sites year-round, including the Serengeti National Park in Tanzania and the adjacent Masai Mara National Reserve in Kenya (Thirgood *et al.* 2004). Species with such wide distributions should only be considered after the other KBA criteria have been evaluated.

4.3.3 Globally significant congregations

Those sites that hold large proportions of the global population of an individual species at a given time are often considered as irreplaceable (Mittermeier *et al.* 2003). These may comprise the following:

- Breeding colonies and/or other sites used during the non-breeding season where large numbers of individuals gather at the same time (e.g., for foraging and roosting);
- Bottleneck sites through which significant numbers of individuals of a species pass over a concentrated period of time (e.g., during migration).

Precedents for thresholds for congregations

Fishpool and Evans (2001) defined the IBA criteria and thresholds for congregations in four categories:

i) The site is known or thought to hold, on a regular basis, 1% or more of a biogeographic population of a congregatory waterbird species.

ii) The site is known or thought to hold, on a regular basis, 1% or more of the global population of a congregatory seabird or terrestrial species.

iii) The site is known or thought to hold, on a regular basis, at least 20,000 waterbirds, or at least 10,000 pairs of seabirds, of one or more species.

iv) The site is known or thought to be a 'bottleneck site' where at least 20,000 pelicans (Pelicanidae) and/or storks (Ciconiidae) and/or raptors (Accipitriformes and Falconiformes) and/or cranes (Gruidae) pass regularly during spring and/or autumn migration.

The IBA criteria for congregations therefore employ percentage thresholds on a per species basis and absolute thresholds for species assemblages. This criterion is not relevant to effectively sessile organisms such as plants and molluscs. Darwall and Vié (2005) did, however, recommend the development and testing of thresholds for a congregatory species criterion for freshwater fish.

Recommended threshold for globally significant congregations

We do not recommend extending the use of multi-species congregations to identify further KBAs because it raises the question of what taxonomic level would be the most appropriate to conduct a given assessment, and also changes the emphasis from irreplaceability to biomass, which is not an appropriate target for site-scale biodiversity conservation.

To meet the KBA sub-criterion for congregations, a site must therefore hold a significant proportion of the global population of a congregatory species on a regular basis. We provisionally set this threshold at 1% of the global population of a species, based on the 1% thresholds in wide use under the Ramsar Convention (BirdLife International 2002; Box 7) and regional flyway initiatives (e.g., Asia-Pacific Migratory Waterbird Conservation Committee 2001). Strictly speaking, the Ramsar threshold is 1% of a "population" (see Box 7); for now, we recommend defining this criterion as 1% of the *global* population. We emphasise that this threshold requires further testing, especially in comparison to a 5% threshold.

4.3.4 Source populations

Some sites hold populations of species that make an inordinate contribution to recruitment of the species elsewhere. If these "source populations" contribute more than 1% of the global population of a species, they would trigger the KBA irreplaceability criterion. This category is particularly relevant for marine organisms, such as the Caribbean Spiny Lobster *Panulirus argus*, which occurs at some sites in the Caribbean islands that disproportionately generate the majority of settling juveniles of this species (Stockhausen *et al.* 2000).

4.3.5 Bioregionally restricted assemblages

The heterogeneity of the earth's surface in terms of rainfall, temperature, elevation, and other environmental characteristics

Box 7. The origins in the Convention on Wetlands (Ramsar, 1971) of the proposed KBA 1% threshold for globally significant congregations

Under the Ramsar Convention, sites are currently selected for the List of Wetlands of International Importance according to a suite of criteria adopted by the Conference of Parties, one of these being Criterion 6: "A wetland should be considered internationally important if it regularly supports 1% of the individuals in a population of one species or subspecies of waterbird". Detailed guidance on applying the criterion and definitions for the terms "regularly", "supports", "population" and "waterbird", are given in *Designating Ramsar sites* (Ramsar Convention Secretariat 2004). Parties are advised to use the international peer-reviewed population estimates and 1% thresholds published and updated every three years by Wetlands International as the basis for using this criterion. The application of this criterion clearly depends both on having data on numbers of waterbirds using a particular site, and on being able to calculate the proportion that this comprises of the overall biogeographic population.

There is no fundamental biological reason to use 1% of a population as the threshold level. The figure was agreed upon in 1974, following informal trial of the use of this and other percentage thresholds. Over the decades since then, the 1% threshold has been found by long experience and evaluation to give an appropriate degree of protection to waterbird populations and to assist in the definition of ecologically "sensible" sites.

The criterion is not effective for all waterbirds, but only for those that tend to congregate. Those species that congregate will, by definition, be those with specialized ecological requirements and that are dependent on a relatively small proportion of the total territory. They will therefore be vulnerable to changes on that area. Conversely, widely dispersed waterbird species will be better conserved through landscape-scale conservation approaches.

The 9th meeting of the Conference of Parties in November 2005 extended the application of the 1% threshold approach to certain non-avian wetland-dependent taxa for which the requisite data have been published.

The 1% criterion has gained wide acceptance throughout the world in a range of other conservation science contexts, such as BirdLife International's identification of Important Bird Areas for globally significant congregations of birds (Criterion A4).[5] The same thinking and proven efficacy of the 1% threshold, as described above, is now the basis for the proposed KBA criterion concerning congregatory species.

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defines species distributions (Holdridge 1978) and fosters assemblages of species endemic to individual bioregions (also termed biomes, ecoregions, or environmental domains). This is an additional element of irreplaceable biodiversity that may be included in the KBA approach.

The rationale for this consideration is the identification of sites that hold a significant proportion of the group of species whose distributions are restricted to a particular bioregion or one of its subdivisions. In practice, the identification of KBAs for species assemblages has been applied in different ways by different practioners. In the identification of IPAs (Plantlife International 2004), sites with high numbers of plant species are selected, such that up to 10% (or the five best sites) of each vegetation type in a country or region is represented (Box 8). This can also be thought of as an attempt to safeguard contextual species richness (species richness within a species assemblage that is restricted to a given bioregion). In the identification of IBAs (e.g. Fishpool and Evans 2001), a network of sites is selected such that, in combination, all species that are restricted to a particular bioregion are represented in these sites. While the aim is, wherever possible, to select sites that hold the largest number of bioregionally restricted species, occasionally sites are selected for one or a few species only. The reason for this is that some species, for reasons of particular habitat requirements, are not found to co-occur at sites with large numbers of other species restricted to the bioregion.

The assessment of bioregion restriction of species or contextual species richness must be undertaken separately for each targeted taxonomic group (notwithstanding the problems involved; see below). In Turkey, for example, any site with more than 25% of the bird species confined to a given terrestrial bioregion, following the ecoregional classification of Olson *et al.* (2001), qualified as a KBA (Box 4; Kılıç and Eken 2004).

Additionally, it may be necessary to scale the identification of KBAs for bioregionally restricted species or assemblages according to the characteristic distributions of different taxa (Peterson and Watson 1998). Thus, while species assemblages for four-legged vertebrates and other species with larger, or coarser-grained, distributions could

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[5] The IBA selection criteria include Criterion A4i, which reads "The site is known or thought to hold, on a regular basis, at least 1% of a biogeographic population of a congregatory waterbird species"; and A4ii, which reads "The site is known or thought to hold, on a regular basis, at least 1% of the global population of a congregatory seabird or terrestrial species".

be assessed at the level of the entire bioregion (Fishpool and Evans 2001), species with smaller, or more specialized, distributions such as many plants, could be assessed in relation to subdivisions of bioregions, such as individual habitats (Anderson 2002).

It is not efficient to derive species lists for each bioregion, ecoregion or habitat, as these numbers would need to be recalculated each time the boundary of the biogeographic unit changed. Instead, it is better to use range maps such as those derived through comprehensive species assessments like the IUCN Global Amphibian Assessment (Stuart *et al*. 2004), and then to overlay these species ranges with bioregional polygons of the resolution required for the particular taxon.

The identification of KBAs for bioregionally restricted species or assemblages presents a number of additional challenges:

- Even where based on continuous environmental data, bioregional classifications have an arbitrary element: boundaries could be drawn in many different places (Wright *et al.* 1998). More important, as a practical consideration, is the degree of acceptance and stability of a particular scheme. The ecoregional classification used by the World Wildlife Fund (Olson *et al.* 2001), while not without its limitations, has become one of the most comprehensive ways to classify the world's environmental domains and may be a useful standard for applying this sub-criterion.
- Scaling the resolution of bioregional classification (biomes, ecoregions, habitats) according to the distribution patterns (coarse-grained or fine-grained) of different species groups presents logical problems regarding the lack of equivalence within and across different taxonomic levels.
- Using an assemblage-based threshold does not address the global significance of populations of each bioregionally restricted species at a given site.

None of these problems reduce the importance of the identification of KBAs for bioregion restriction, but rather explain why it remains relatively poorly developed to date. For the time being it is only likely to be applicable to a few well-known groups, such as birds, where its application to date also needs refining. It requires further testing to determine its practical value for other, more poorly known taxon groups, often with very different ecologies.

Box 8. Using the bioregionally restricted sub-criterion for plants: case study of IPAs in Romania

Important Plant Areas (IPAs) are the most important places in the world for wild plant diversity that can be protected and managed as specific sites; as such, they represent the botanical subset of KBAs. IPAs are identified using three globally consistent criteria: A) presence of threatened species, B) botanical richness, and C) threatened habitats (Plantlife International 2004, Anderson 2002).

The botanical richness criterion (B) equates with the bioregionally restricted sub-criterion for KBAs. This IPA criterion identifies the botanically richest sites by comparing the number of (characteristic) species present in a potential IPA with other sites in the same habitat or vegetation type. In Europe the habitat classification used to compare potential IPAs is 'EUNIS level 2'; the threshold for selecting IPAs under this criterion is that they cover either up to 10% of the area of each EUNIS habitat type or the five 'best' sites.

In Romania 276 IPAs have been identified (Sârbu 2005). 104 of those sites qualify partially or wholly under the botanical richness criterion (B) (Figure 7). Twenty-one of them were selected using only the B criterion. These sites cover a total of 2,210 hectares; they are small areas of high botanical value. In Romania the IPA team assessed 19 unique Romanian EUNIS level 2 habitats that did not already qualify as IPA selection habitats under the threatened habitats criterion (C). Site selection considered the number and percentage of each EUNIS level 2 habitat types and the diversity of the species associated with them.

Examples of IPAs identified in Romania include:

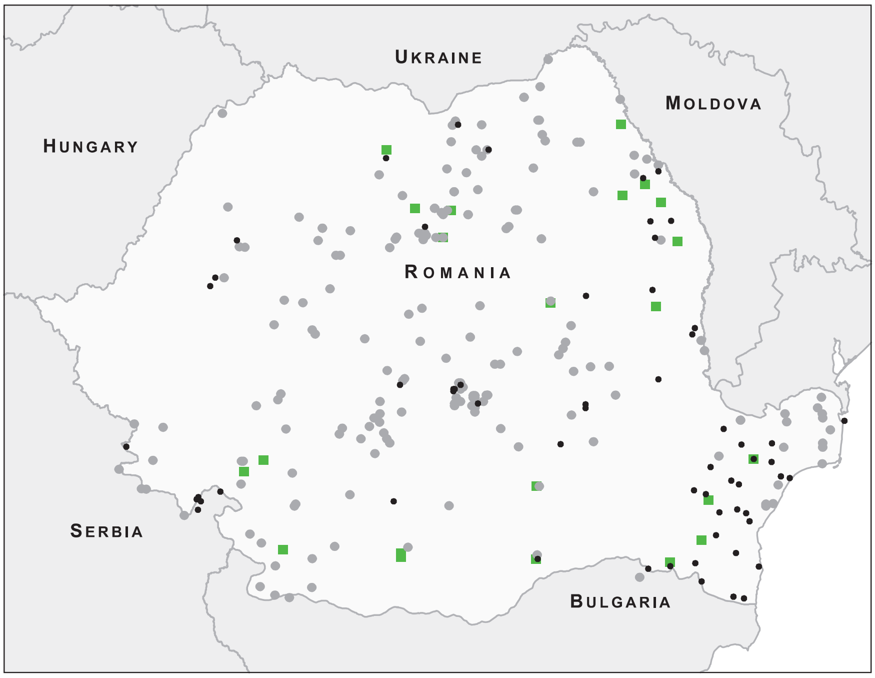
Coastal dune and sand habitats (EUNIS habitat B1): The characteristic species list for this habitat in Romania includes: *Crambe maritima*, *Lactuca tatrica*, *Argusia sibiri*, *Cakile maritime* ssp. *euxina*, *Glaucium falvum*, *Euphorbia peplis*, *Scolymus hipansicus* (Euxinic beach salty sand communities). Only four sites exist, therefore all four sites were selected as IPAs.

Dry grasslands (EUNIS E1): The species list for Romanian dry grasslands includes over 24 species from both dry pontic grasslands with xerophyllous species and from Dobrogea's dry-stoned grasslands with *Thymion zigioides.* These dry grassland habitats are very well represented in the southeast of Romania, particularly, but not exclusively in the Dobrogea region. 35 IPAs were selected in dry grassland habitats using criterion B, under the 10% threshold but judged to be of greatest international importance by the site selection team.

The Ministry of Environment is using the information collected about these sites to enlarge the Romanian protected areas network.

Box 8 cont.

Figure 7. **IPAs in Romania.** Green squares represent IPAs selected for botanical richness (equivalent to the KBA bioregionally restricted sub-criterion); black circles represent IPAs selected for botanical richness and the presence of either threatened species or threatened habitats; gray circles indicate IPAs selected under the other criteria. Data provided by the Romanian IPA team coordinated by Prof. Anca Sârbu of the Association of Botanic Gardens in Romania.



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5. Identifying and delineating Key Biodiversity Areas

This chapter provides practical guidelines for identifying and delineating KBAs, applying the criteria presented in Chapter 4. We provide details on data requirements and potential sources, application of the criteria, steps towards delineating KBAs, and approaches for gathering data, maintaining standards and developing consensus.

The criteria for KBAs, as presented in Chapter 4, are simple and robust, so as to be applied uniformly and cost-effectively. They yield a set of data-driven, quantifiable conservation targets at the site-level – traceable back to a data source and not solely dependent on expert opinion. More specifically, the data used to document the presence of a species at a KBA must be reliable enough to ensure transparency, so that conservation organizations and practitioners, including governments, can justify clearly to all stakeholders why they are working at and for a particular site, and so that a baseline can be established for monitoring. Complete datasets are not required to identify and delineate KBAs, since the method is based on individual biological values of particular sites and not on relative significance. Such information has to be generated by national and local organizations working on the ground. Finally, the process of identifying and delineating KBAs must be iterative, so that the networks of these globally important sites can be refined as additional data become available (for example, through site-level monitoring).

5.1 Data requirements and sources

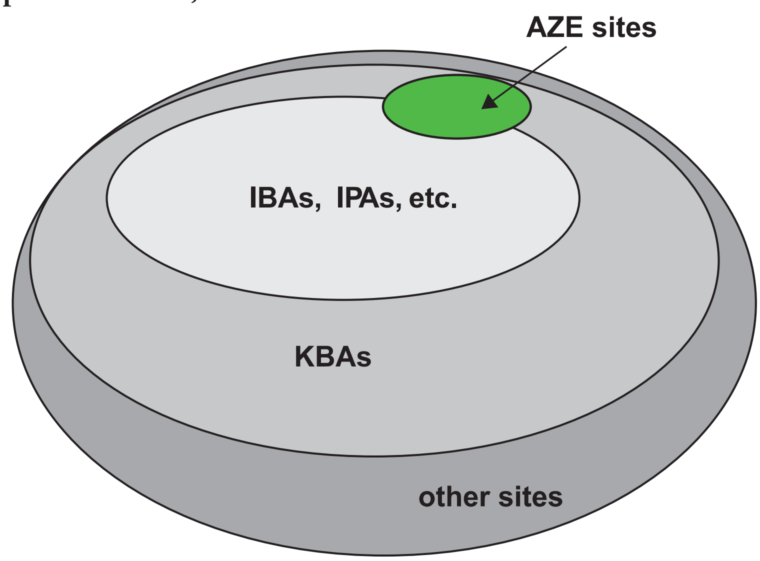
To identify and delineate KBAs, a number of datasets should be compiled, ideally in a geographic information system (GIS). These include existing site priorities, range maps and locality records of target species (i.e., species that trigger the KBA criteria), and contextual data layers such as topography, land-use, remaining habitat, and land management units (including existing protected areas).

5.1.1 Existing site-scale priorities

Alliance for Zero Extinction sites

Given that they are a subset of KBAs (Figure 8), Alliance for Zero Extinction (AZE) sites (Ricketts *et al.* 2005) should provide the starting point for identifying KBAs and be the first dataset incorporated into the process. An AZE site contains at least 95% of the known population of one or more Critically Endangered or Endangered species, and thus indicates where extinctions may be imminent. AZE sites have been identified globally for the world's most threatened species, including birds, mammals, amphibians, some reptile groups and conifers, and are freely available online.[6] Although AZE sites are being identified in a top-down process by the Alliance, with some national input, locally driven efforts to identify the full suite of KBAs will help refine the AZE sites by mobilizing regionally available data to improve site descriptions, ensure geographic

Figure 8. Relationship between IBAs, KBAs and AZE sites



[6] www.zeroextinction.org

accuracy, confirm species presence, and identify sites that should be added or dropped.

Important Bird Areas and Important Plant Areas

IBAs and IPAs are the next data sources to incorporate for identifying KBAs, if available. IBAs have been identified in most of the world's countries (Appendix 1), using criteria and thresholds almost identical to those for KBAs (Chapter 4). As such, IBAs are the avian subset of KBAs. The same is broadly true for IPAs, as most of the IPA criteria correspond to KBA criteria. In a number of countries, important areas have also been identified for other taxa using standard criteria (Eken *et al.* 2004), and these datasets should be acquired to inform KBA identification and delineation (Box 9).

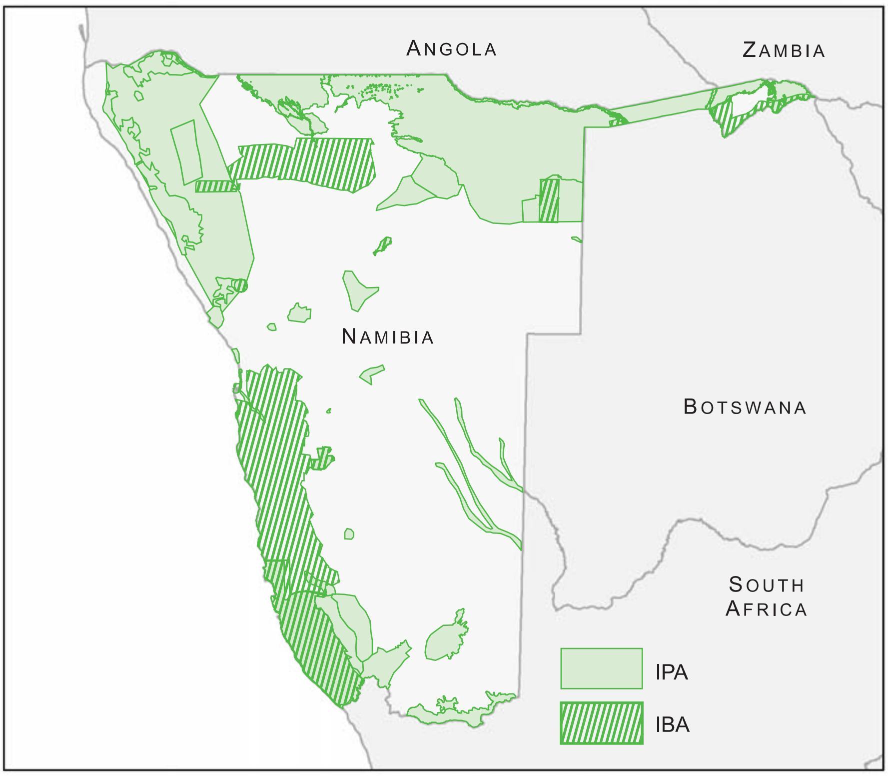
Box 9. Pulling taxonomic groups together: IPAs and IBAs in southern Africa

Assessing all major groups of organisms in the selection of KBAs will ensure a more comprehensive coverage of conservation priorities in a country or region. Omitting any particular group may result in important sites being overlooked. Complete assessments of all groups take valuable time and resources, so starting with manageable groups will allow conservation priorities to be more quickly addressed. The assessment of IPAs and IBAs in Namibia demonstrates the advantages of this approach.

Nineteen IBAs have been identified in Namibia (Simmons *et al.* 2001). A preliminary assessment of IPAs in Namibia (Hofmeyr 2004) identified forty sites of varying sizes. Eight IBAs and IPAs overlap (Figure 9) – 16% of the total of 51 sites.

Exceptional areas for plant diversity in Namibia include the Baines and Zebra mountains and the gravel plains in the northwest; the Omuramba Ovambo (central northeast); and the Auob, Olifants and Nossob rivers, the Karasberg mountains, Huns mountains and Ai Ais National Park, and the Orange river valley in the south. These areas were not selected as global IBAs. On the other hand, the Etosha salt pan, the eastern Caprivi wetlands and parts of the Erongo coast are sites of global importance for birds but not for plants. IPAs and IBAs overlap in areas such as the Nyae Nyae conservancy in the northeast, parts of the northwest, Naukluft Park, the Waterberg Escarpment in central Namibia, and Sperrgebiet in the south. Sperrgebiet is also believed to be important for its insect diversity.

Figure 9. IBAs and provisional IPAs of Namibia. IPA data supplied by Sonja Loots from the National Botanical Research Institute of Namibia following the SABONET IPA workshop, December 2004. IBA data from BirdLife International.



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Data from priority-setting workshops

The results of consensus-based expert workshops, which have been conducted in many regions of the world, can and do inform the identification of KBAs (Box 10). The output of these workshops is often a set of general areas (at the landscape/seascape level as well as the site level) that are priorities for conservation action. However, where workshop outputs are based on expert opinion, they need to be refined to determine whether the areas meet KBA criteria. The presence of target species in the area must be evaluated and documented (through the scientific literature, museum records, field survey, etc.), and the boundaries of the area refined to ensure that sites are manageable for conservation.

Box 10. Conservation priority-setting workshops

Conservation priority-setting workshops aim to develop consensus on areas of high importance for biodiversity conservation within a region, based on the best available information and expert opinion. The goal is to provide fast and credible baseline data from which immediate conservation actions and research needs can be determined. In the past, these workshops have identified subregional priorities and have employed slightly differing methodologies depending on regional and institutional context. Examples of workshops include a Congo Basin workshop led by WWF (Kamdem-Toham *et al.* 2003), and a Guayana Shield workshop led by Conservation International (Huber and Foster 2003; Figure 10). Workshops have typically involved partners from the government, academic and NGO sectors, and results have differed somewhat depending on which organization was leading the development of the methodology.

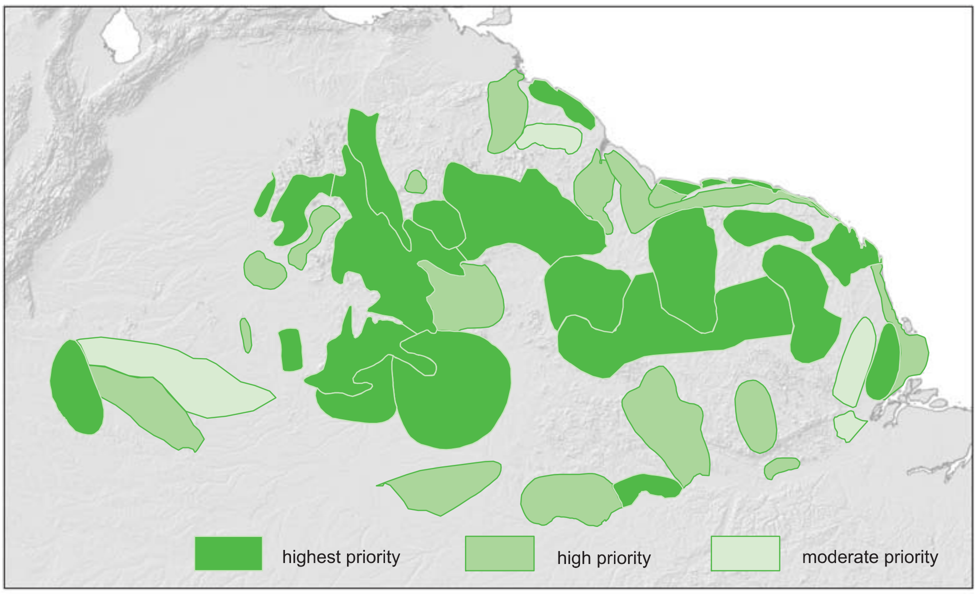
In advance of a workshop, geo-spatial and textual data are gathered on the distribution of biodiversity, bio-physical features (e.g., topography, forest cover), and socio-economic parameters (e.g., land use, population density). Workshops are typically divided into two distinct phases, a thematic working groups phase and an integrative working groups phase. During the thematic working groups phase, experts split into taxonomic groups to indicate on maps the areas most important for species in their taxon and to document the rationale for selection. Meanwhile, socio-economic working groups assess the region for areas of high threat and opportunity. During the integrative working group phase, the biodiversity scientists combine their knowledge and taxonomic maps to determine overall biological priorities while the social scientists combine their knowledge to determine overall areas of threat and opportunity. The resulting expert-based priorities vary from broad-scale areas to relatively discrete sites (Table 1, section 3.2).

Use of conservation priority-setting workshop data in the Key Biodiversity Area identification process

Data consolidated during workshop processes can and should be used to define KBAs, since much of the underlying biodiversity data is applicable. Workshop priority area polygons can also be used as an information layer in identifying KBAs, if the data related to each polygon are carefully reviewed. If properly documented, polygons whose rationale is consistent with KBA criteria should qualify as KBAs, while those workshop polygons with inconsistent rationale may still qualify if further research proves that the area meets KBA criteria.

Where point localities for globally threatened species are overlaid with workshop polygons, those polygons that are coincident with the globally threatened species points should qualify as KBAs, though the polygons themselves may need refinement in delineation.

Figure 10. Guayana Shield priority-setting workshop: final priorities map. Data from Conservation International.



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5.1.2 Species distributional data

A comprehensive synthesis of distributional data for species triggering the KBA criteria and thresholds is the crux of KBA identification. Species distributional data are available in several formats, most importantly as point occurrence data from the literature, from databases, museums and herbaria, and secondly, as geographic range maps in the form of polygon, atlas or grid data, representing the broader geographic area where a species occurs. These latter data are often more accessible than point data and are useful in the initial phase of identifying KBAs. Data quality clearly depends on data sources (Section 5.1.5).

Sources for point locality data

Compiling point locality data is an essential prerequisite for KBA identification. Ideally, these data should be spatially precise, delimiting known localities for each species on the basis of the best available scientific knowledge. In practice, however, they are often rather loosely geo-referenced data points. Sources for point locality data include:

- **Scientific literature**

The scientific literature, both primary and secondary, is an extremely important source of locality data for species. This includes peer-reviewed journal articles; regional monographs (which exist particularly for vertebrates); theses and dissertations; and books, such as the Centres of Plant Diversity series (WWF and IUCN 1994–97) for plants. These sources are found by using online databases, generalized search engines or library research, or by tracking back through citations. Monographs must often be located on a case-by case basis. Where the published literature does not contain the necessary data, gray literature with original source data (such as species checklists for protected areas or unpublished survey reports) should be checked. Researchers' unpublished data are also very valuable; by circulating first drafts of KBA datasets to specialists, you can sometimes acquire this input.

- **Museums and herbaria**

Where possible, specimen data should be traced back to the source in museum collections or herbaria. This helps to verify identification and locality attribute data against published records, which are often geographically imprecise, overlook subtle location details, or lack accurate geo-referencing from experienced sources. Original expedition journals are also often held in museums and herbaria. Many museums are digitizing their collections and making them available via the internet; if not, it may be necessary to visit the museum, time permitting. A few cautions: geo-referencing localities remains one of the greatest challenges for collections. In addition, older museum and herbarium records should be treated carefully, even when other data are lacking, because the area where the species was recorded may have been heavily transformed, affecting species occurrence, and because historical locality data are often imprecise, or incorrect. Additionally, taxonomic changes and the possible misidentification of specimens can cause inaccuracies in species data; data compilation from museums should be done by people with specialist expertise and resulting KBA data should be peer-reviewed (Section 5.1.5).

- **Online databases**

Online searchable databases can provide large quantities of secondary data for identifying KBAs, and many online initiatives provide a wide range of species data (Appendix 2). Online taxonomic databases can also resolve questions of taxonomy, and the Red List databases provide essential information on conservation status (Box 2). Of course, databases are only as reliable as the data entered into them, so original data sources should always be retained. Databases are particularly useful in pointing researchers toward original data sources, highlighting records they may have been unaware of, and facilitating preliminary KBA identification when time does not allow for checking of primary data.

- **Field surveys**

Ultimately, new information from targeted fieldwork is the best way to ensure the rigor of KBA identification and to supplement existing point locality data. It is also crucial for having accurate population data for species (5.1.3). New fieldwork has been effectively combined with IBA identification in Kenya (Bennun and Njoroge 1999) and elsewhere. First-hand knowledge of the sites themselves also greatly assists KBA delineation. Moreover, contrary to common misconceptions, fieldwork is actually economical and cost-efficient (Balmford and Gaston 1999) and will over time reduce the dependency on historical museum data.

There are two cautions, however. First, fieldwork takes time and requires specialist expertise, and may not be feasible if KBA identification and gap analysis must be conducted under tight deadlines. Second, it is important to recognize that the data underlying KBAs will never be perfectly comprehensive. Action to conserve species based on data in hand is better than allowing their possible extirpation while awaiting better and better data collection. This dilemma can also be resolved by subsequent monitoring (Chapter 8) to improve field data over time.

Clearly, the process of compiling locality data for species can be endless. If the data-gathering process begins to yield rapidly diminishing returns, data for poorly known species (i.e., species for which no locality data can be obtained even after intensive searching) can be incorporated into KBA identification at a later date. For speciose regions, prioritize gathering data for globally threatened species before tackling restricted-range, congregatory or bioregionally restricted species.

Species range maps

Maps that represent the global distribution or range of a species are available for many taxa, including mammals, amphibians[7] (Stuart *et al.* 2004, Box 2), and globally threatened birds (BirdLife International 2004a). The range maps are stored as ArcView shapefiles (a GIS file format) with an associated information table. These data are also used to evaluate species as having restricted ranges (Section 4.3.1). Compilation of range maps for reptiles, selected groups of plants, freshwater and marine species is also underway as part of the IUCN Red List global assessment. For some areas of the world where there are large communities of amateur naturalists, range maps and atlas data are available for other species groups as well.

A note of caution. Although some species range maps have fine resolutions, most are closer to representing extent of occurrence ("the area contained within the shortest continuous imaginary boundary which can be drawn to encompass all the known, inferred or projected sites of present occurrence of a taxon, excluding cases of vagrancy", IUCN 2001) rather than area of occupancy ("the area within a taxon's extent of occurrence which is occupied by a taxon, excluding cases of vagrancy", IUCN 2001). Thus, while these maps are useful starting points for poorly-known taxa and species restricted to a few isolated localities or a single site (Figure 13b), they must be used cautiously in identifying KBAs. A species may not necessarily occur regularly in significant numbers at any point within its extent of occurrence. Rather, more detailed locality data are generally needed to confirm a species' presence at a particular site.

5.1.3 Species population data

To rigorously apply the KBA criteria and thresholds (Sections 4.2 and 4.3), it is important to gather population data for species at sites in addition to locality data. For example, to know whether a site meets the KBA vulnerability criterion for a VU species, there should be reasonable evidence that the site supports at least 30 individuals or 10 pairs. Similarly, for sites thought to trigger the irreplaceability criterion, there should be evidence that the site supports 1% or 5% of the global population of the species (Section 4.3). Population data are generated through field surveys and monitoring. It is not uncommon for population data to be entirely lacking for a KBA trigger species, particularly those in poorly-known taxonomic groups or from under-surveyed regions. In these situations, population figures can be estimated based on the amount of total suitable habitat occurring at the site (as long as some known individuals of the species are present). These KBAs should be fairly high research priorities (Section 7.4).

5.1.4 Contextual data

A number of contextual datasets are useful for identifying and delineating KBAs. Arguably, the most important are spatial data on existing or planned protected areas. As mentioned in Section 3.1, many protected areas will be KBAs in their own right or at least will overlap with KBAs in some way. Below are a few examples of sources of contextual data:

- ***World Database on Protected Areas (WDPA)*** – A freely available data source (in GIS format) of the world's protected areas compiled by a consortium of organizations under the IUCN World Commission on Protected Areas (WDPA Consortium 2004).
- ***Detailed national protected area datasets*** – These can refine and supplement the WDPA. The natural resource agencies of many countries have datasets that are often mapped with greater accuracy and higher resolution, or contain categories of protected areas such as private nature reserves or conservation easements that might not be in the WDPA.
- ***Information on land cover derived from remote sensing and/or detailed field surveys of small areas*** – These maps are becoming increasingly available in digital format, as the conservation community and governments invest in monitoring remaining forest cover and fragmentation as well as other habitats.
- ***Landsat mosaics of surface vegetation*** – Often available free online.
- ***Vegetation, habitat-type and land-use maps*** – Useful for approximating remaining habitat in lieu of remote sensing or field surveys.
- ***Physical data layers*** – For example, data on topography (elevation, slope, bathymetry), hydrography (catchments, rivers, lakes), and geological features (caves, gorges, karst formations). These data are helpful in the absence of data on remaining habitat or on the area of occupancy of species within a particular area.
- ***Political boundaries and management units*** – These data, which include national, regional and local political boundaries, as well as management units such as existing protected areas, logging/mining concessions and privately owned areas, can help evaluate whether areas constitute a site that might be manageable for conservation.

5.1.5 Data challenges

Every data source has biases or limitations that must be considered. The age and reliability of datasets are important ones. The challenge is arguably most acute for species locality data, many of which are based on historical records, for example, specimens collected on nineteenth century expeditions. Such records should be treated with caution.

7 www.globalamphibians.org

How to deal with records of different age

To distinguish between reliable, current records (where we can be reasonably sure that a species still occurs at the site) and older records (which, while valid historically, may not indicate current presence of a species at a site), it may be necessary to set a cutoff date. Before this date, records must be backed up by a recent data source, such as (at a minimum) unpublished specialist knowledge. This cutoff date should correspond to the timescale, severity and type of threats in the region relative to the species concerned. For example, pre-1980s data would probably be useful for KBA identification in the Papua province of Indonesia, which remains largely forested; in contrast, species locality data should be compared with current habitat maps for forest species of the same age for Sumatra, which has experienced drastic deforestation in the past 25 years. Sites where only older records exist are priorities for urgent fieldwork and should not necessarily be considered for KBA status, but can be considered candidate KBAs (Section 5.2.4). The historical archive of satellite and aerial photography data is valuable here, although these data have not yet been analyzed to assess changes in habitat distribution for most regions of the world.

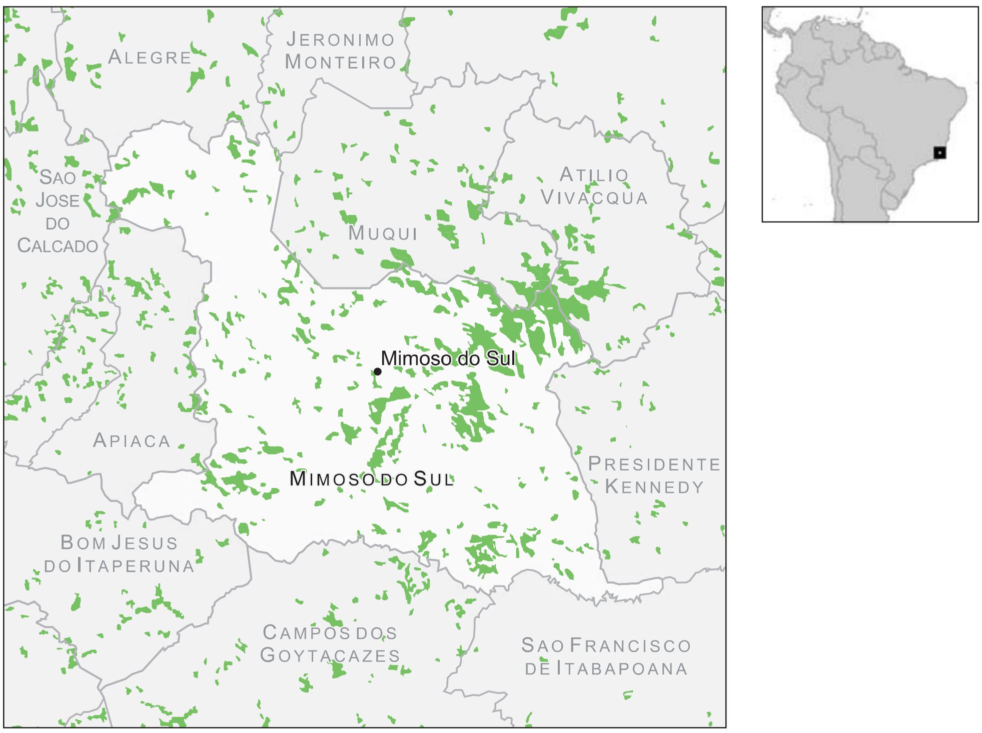
How to handle questions of taxonomic reliability and standards

Changes in taxonomy and nomenclature are important considerations for some species. Thus, it is advisable to engage specialists to help in evaluating records that may be questionable or outdated. Also, attention must be paid to what taxonomic standards to follow. Debates about varying species concepts (Collar 1996) and subspecies (Zink 2004) are intense and can appear daunting (Section 3.3). For higher taxa that have been comprehensively assessed for the IUCN Red List, the standard species-level taxonomies used as the basis for these assessments should be followed when applying the KBA criteria. For higher taxa that have yet to be comprehensively assessed, the taxonomy used by the IUCN Red List should also be followed for application of the vulnerability criterion, and the most appropriate consensus taxonomy for these species should be followed when applying the irreplaceability criterion.

How to handle coarse resolution data

In many regions, species localities are mapped to a scale larger than a site, such as the county or province level. These data can indicate the general area where a KBA may be identified for a species, but are typically not sufficient for documenting the presence of the species at a site (Figure 11). In this case, more precise locality data should be sought; sometimes, unpublished expert knowledge or targeted fieldwork is needed. If good data (not too coarse or too old) exist on the species' remaining habitat and habitat preferences, additional data collection can be focused on the species' presence within the larger-scale geographic unit.

Figure 11. Challenges in using coarse-scale species data to identify KBAs. The amphibian *Euparkerella robusta* (VU) is a forest-dependent species known only from Mimoso do Sul in the state of Espírito Santo, southeastern Brazil, at 70m above sea level (Izecksohn 1988). It also probably occurs in other localities. The coordinates given for the species' locality correspond to the main city of the Mimoso do Sul municipality. Without additional information, this "point locality" record cannot indicate in which of the forest fragments (mapped in green) within the municipality the species occurs; thus, it is of little value in identifying a KBA. Forest fragments data from Fundação SOS Mata Atlântica and INPE (2002).



Cautions with point locality data

Point locality data often do not represent precise locations where a species was observed or collected. In some point locality datasets, including those from museum and herbarium labels, geographic coordinates correspond to the capital city or center point of the county, island or province. Alternatively, they may represent the nearest town or village where the species was recorded, or (worst of all) a locality where a specimen was bought from trade or brought to the researchers, not from where it originated. They may also correspond to coarse approximations of real geographic coordinates, for example if data were recorded to the nearest degree rather than to degrees, minutes, seconds. Finally, in some cultures, settlements may move periodically, but retain their names. Thus, point locality data should be treated as if they are of coarse resolution, and additional data sources sought.

How to treat local reports

In much of the world, local communities retain detailed knowledge of their environment (Diamond 1966), and their reports of species presence are important considerations in KBA identification. However, such reports should always be treated judiciously in the absence of supporting evidence. Enthusiasm for providing reports may come at a cost to reliability, while local species classifications may vary widely.

How to handle taxonomic biases in species data

Not all species groups are studied with equal effort. Species locality data exist mainly for terrestrial vertebrates and some groups of plants, which have historically been easier to study because they are more conspicuous or of greater interest to researchers because of their economic importance. Invertebrates, aquatic biodiversity, and some plant groups are notoriously under-surveyed, although several current initiatives aim at closing this gap (Wheeler *et al.* 2004). Available data, regardless of taxonomic bias, should nevertheless be used. KBAs identified for particular species are conservation priorities in their own right, irrespective of whether they also qualify for other taxa. Identifying KBAs is an iterative process, and data on additional taxonomic groups should be incorporated as they become available.

Geographic biases in data: types of error

Geographic biases occur when the same places are surveyed frequently, while other areas remain poorly surveyed or not surveyed at all. Field studies conducted near easily accessible cities, roads or trails provide a classic example (Nelson *et al.* 1990). Omission errors can result from using point data, if a species is not recognised to be present in a given area due to lack of data (Section 3.5). Thus, the places where the species truly occurs in good populations may be lost, while a KBA that is less important for the species is the target of protection. However, rather than generate errors of commission by assuming a species is present at more sites than the locality data indicate (for example, through predictive modeling), KBAs should be identified for the species wherever the data support such conclusions, while additional field work should be prioritized in promising but un-surveyed areas (Section 7.4). KBA identification and delineation is a dynamic process; KBAs should be refined as new data become available and the conservation landscape or seascape changes. As with taxonomic biases, the best way to reduce geographic biases in datasets is through targeted survey effort.

5.2 How to identify KBAs

5.2.1 Determining confidence levels for KBAs

Presence of a species at a site should be confirmed before the site is eligible for consideration as a KBA. Knowing the degree of confidence by which the species is present at a site enables us to (1) set priorities for conservation by favoring places where we are most certain of the species' presence and potentially avoid wasting conservation effort at a site where a species no longer exists or has never existed; and (2) set priorities for research, as distinguished from priorities for site safeguard (Section 7.4).

How to establish confidence values in species' occurrence

Records of a species' presence at a site should be qualified by an evaluation of the degree of certainty that the species does indeed occur at the site. The following categories can be used to assess confidence in the species' occurrence at the site:

- ***Confirmed occurrence*** – the species record is based on sight records by a reliable observer, positive identifications of calls, or specimen records of known provenance. Older records should qualify only when the site has not faced significant threats since the record was obtained (Section 5.1.5).
- ***Suspected occurrence*** – this would include sight records by a reliable observer who noted uncertainty about the record, anecdotal reports from local people, historical records from sites known to have faced significant threats since the record was obtained, or prediction of presence based on species distributional modeling.
- ***Absent*** – the site does not contain sufficient area of appropriate habitat to support a population and/or exhaustive surveys have failed to record the species.

Where species can only be classified with suspected occurrence, the site should be classified as a candidate KBA (Section 5.2.4) and flagged as a priority for research. Peer review of the locality data used to confirm KBA status can help in evaluating confidence thresholds. This step ensures that subsequent studies (e.g., gap analysis) and conservation investment can be undertaken with confidence.

In general, all assumptions made during the KBA identification and delineation process should be well documented and stored with the KBA data themselves.

5.2.2 Identifying KBAs under the vulnerability criterion

Due to the urgent need to identify and safeguard sites where globally threatened species occur, the vulnerability criterion should be applied before the irreplaceability criterion when identifying KBAs.

5.2.2.1 Compiling the list of globally threatened "trigger" species for a region

The first task in identifying KBAs under the vulnerability criterion is to determine which globally threatened species occur in the country or region under consideration. Presence of threatened species by country can be derived directly from the IUCN Red List. Secondary databases such as WildFinder,[8] the Biodiversity Hotspots species database,[9] and national databases can supplement the IUCN Red List where species occurrence in a given region is not obvious (i.e., a region crosses national boundaries, for sub-national analyses, or for marine species), or if species distribution data are not up-to-date. It may also be necessary to research the primary literature or to consult directly with specialists.

Handling perceived mismatches between local and global conservation status

Several questions regularly arise regarding the application of the vulnerability criterion. The first is how to treat species classified as globally threatened but that are locally widespread and abundant. In this case, sites where the species is still abundant are the best places to invest in its conservation and should be identified as KBAs accordingly. On the other hand, where species are globally common but locally rare (e.g., Osprey *Pandion haliaetus* in the UK), such species are legitimately considered nationally threatened. However, the primary aim of KBAs is to identify globally important sites, and hence the appropriate trigger species are those that are globally threatened. Some countries may wish to identify nationally important KBAs for nationally threatened species, which is wholly appropriate as long as sites of global importance are prioritized.

Time lag in the IUCN Red List

Another question is how to treat species that are probably not globally threatened, although they are categorized as such in the IUCN Red List (i.e., more current data indicates that they should be down-listed). To ensure consistency amongst KBA classification worldwide, it is important to work with IUCN to update or correct the species' threat classification, rather than simply assuming the Red List to be wrong. A recommendation to down-list the species, accompanied by appropriate data, should therefore be sent to the IUCN Red List Authority for that taxonomic group. For species that are likely to be globally threatened but have not yet been assessed as such (i.e., national endemics that have been assessed as threatened in a regional application of the IUCN Red List criteria), the organizations conducting the KBA analysis should make every effort to ensure that the species is formally assessed for inclusion on the IUCN Red List and subsequently incorporated into KBA identification.

5.2.2.2 Incorporating sites already identified as KBAs: AZE sites, IBAs and IPAs

As described in Section 5.1.1, a set of sites that meet the KBA criteria have often already been identified in a country or region, which can provide a starting point for KBA identification. The first of these are AZE sites. Since they are triggered by the presence of Critically Endangered and Endangered species restricted to single sites, all AZE sites meet both the vulnerability and the irreplaceability criteria for KBAs. Secondly, IBAs have been identified for globally threatened bird species in many of the world's countries, and these sites can be directly incorporated as KBAs, assuming the sites and their trigger species are still present, and that the trigger species are still assessed as globally threatened. Finally, while identified in fewer countries, IPAs and important sites identified for threatened species of fish, butterflies or other single taxonomic groups should feed into the KBA process.

For these existing sites, the following steps should be undertaken during a KBA process:

- As far as possible, confirm that each site still exists (i.e., that it has not been recently converted to agriculture, human settlement, etc.) and that it still holds the globally threatened species for which it was identified as an important site.
- If there have been recent changes in knowledge of the distribution of a threatened species triggering an existing AZE site, IBA or IPA, such that it is now known to occur at additional sites, these sites should be identified within the KBA process. Changes in taxonomy and global threat status should also be addressed, such that KBAs are only identified under the vulnerability criterion for species recognised as threatened by the IUCN Red List.

These steps should be done in collaboration with the BirdLife International partner, Plantlife International partner, or other organization responsible for identifying the sites originally. At a minimum, data compiled on these existing sites during KBA identification should feed back

[8] www.wildfinder.org
[9] www.biodiversityhotspots.org

to these organizations for peer review and assimilation of results. It is particularly crucial that data on additional sites for AZE species, or conversely, on possible extinctions of AZE species, be reported back to the Alliance.

If the existing sites meeting KBA criteria have been identified recently using current data, the above steps may not be necessary. KBA identification should thus focus on the following:

- Determine whether globally threatened species in other taxonomic groups (i.e., those not represented by the IBA, IPA analysis) or that are not restricted to single sites (i.e., AZE species) occur within these existing KBAs. This involves synthesizing locality data to confirm the presence of these additional threatened species within existing sites, documenting their occurrence, and ensuring that the KBA criteria and thresholds are met (Section 4.2).
- Review site boundaries to make sure they are appropriate. In many cases, the existing site boundary will be appropriate and will capture the key habitat or localities of the additional threatened species found there. In other cases, modifications of the boundary may be necessary. KBA delineation is covered in detail in Section 5.3. It is important to note that AZE sites are currently only mapped as points. Additionally, some IBAs and IPAs have only been mapped as points with an associated estimate of their size, rather than as polygons with defined boundaries. The KBA process can usefully contribute to the delineation of existing sites that are only mapped as points; however, this should be done in collaboration with the relevant national partner of BirdLife International, Plantlife International or other organization responsible for the work originally. Delineations of AZE sites should feed back to the Alliance.

5.2.2.3 Identifying new KBAs

In most cases, the KBAs that have already been identified (i.e., AZE sites, IBAs or IPAs) will cover many, but not all, of the important localities of the globally threatened trigger species in a country or region. Thus, the next step in the KBA identification process is to evaluate the distributions of other threatened species to determine whether they require the designation of additional KBAs (Box 11). To do this, evaluate the locality data for each threatened species and document its presence at particular sites. It is important to work in a systematic fashion. KBA analysis can be done either by taxonomic group (i.e., working first through all threatened mammals, then amphibians, then reptiles, etc.), or by evaluating all Critically Endangered species first, then all Endangered species and finally all Vulnerable species across taxonomic groups. The sequence will be determined by data availability and the expertise of the team conducting the analysis. An argument for the latter approach is that it addresses the species requiring more urgent conservation first, regardless of their taxonomic group.

KBAs for Critically Endangered and Endangered species can be identified based on confirmed occurrence, while a population threshold exists for Vulnerable species (Section 4.2). Applying the threshold to Vulnerable species can be challenging because data are often lacking on the population sizes of a species at a given site. In these cases, consider average population densities for the species, which may have to be estimated based on encounter rates during field sampling and collecting or expert opinion, along with the size of the site. In the absence of any population data, a large area of suitable habitat in which there is a point locality record for a VU species may be inferred to hold the threshold number of individuals. All assumptions of this nature should be carefully documented.

Box 11. Using species data to identify KBAs in the Philippines

Conservation International's Philippines Regional Program initiated a KBA identification process in 2004, with support from the Critical Ecosystem Partnership Fund and in collaboration with the Haribon Foundation (the BirdLife partner in the Philippines). The 117 Important Bird Areas (IBAs) identified for the country by the Haribon Foundation (Mallari *et al.* 2001), and the 206 conservation priority areas (CPA) identified through the Philippine Biodiversity Conservation Priority setting Program (convened by Conservation International Philippines, Protected Areas and Wildlife Bureau of the Department and Environment and Natural Resources, and the University of the Philippines Center for Integrative and Development Studies) in 2002, served as the basis for KBA identification.

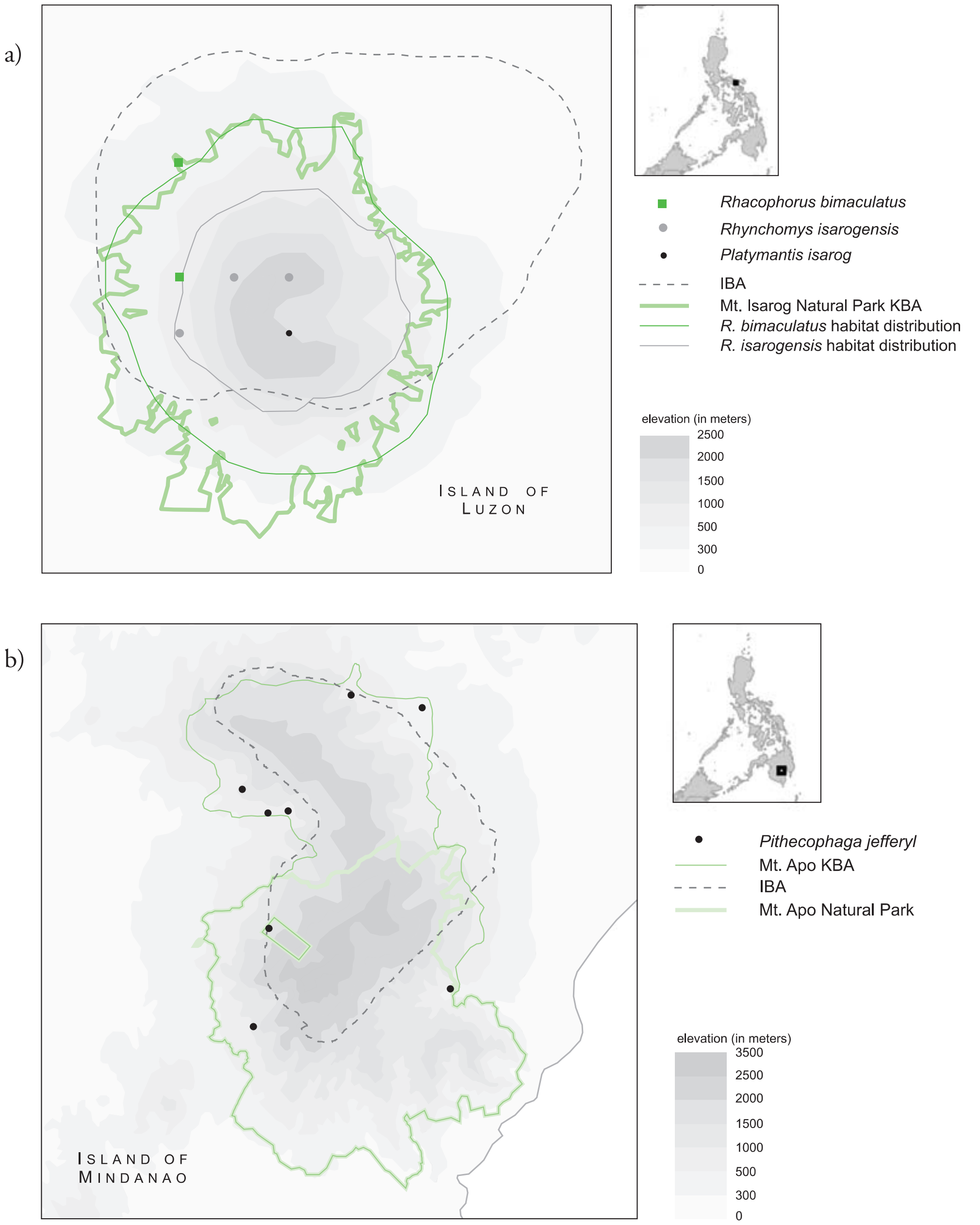
The main challenge in identifying KBAs was incorporating data for the threatened and restricted-range species of freshwater fish, amphibians, reptiles, birds and mammals to refine the results of the previous initiatives, specifically, to document presence of these species in existing sites and to identify new KBAs where needed. The IUCN Red List provided the list of threatened species for the Philippines, as well as data on conservation status, distribution, threats, key contacts and references. Additional data, especially point locality data, for each species were obtained from the published literature, scientists, and museum collections. A visit to the Field Museum of Natural History in Chicago provided data on mammals, reptiles and amphibians. Several scientists in the Philippines contributed a large amount of data. Further data were gathered from the National Museum of the Philippines, the American Museum of Natural History and the Utah Museum of Natural History.

Box 11 cont.

For the purposes of KBA delineation, point locality and distribution data for each species were compiled in a GIS. Other spatial data used in KBA delineation included the IBA and CPA polygons, information on habitat type and extent, settlement patterns, topography, and protected area (PA) boundaries. In some cases, existing IBA or PA boundaries did not have to be modified in delineating the KBAs, since the data for the trigger species fell within the boundaries of the IBA, CPA or PA (Figure 12a). In other cases, existing IBA or PA boundaries were modified as needed to incorporate nearby habitats of trigger species (Figure 12b). In still other cases, KBAs were delineated solely on the basis of data for the trigger species and habitat cover.

Experts reviewed the preliminary KBAs for threatened species during several informal meetings, and modifications to the boundaries were made as a result of their recommendations. Since the KBA identification and delineation is iterative, the boundaries can be modified and new KBAs added as new data become available.

Figure 12. KBAs in the Philippines: (a) In some situations, as with the Mt Isarog KBA, the KBA boundary is identical to the previously defined PA, since all point locality and distribution data for the trigger species fall within the PA. (b) In other cases, as with the Mt Apo KBA, the inclusion of new data on Philippine Eagle *Pithecophaga jefferyi* nesting site and sightings resulted in the expansion of the KBA beyond the boundaries of the existing IBA and PA. Data compiled by Conservation International-Philippines and the Haribon Foundation.



Grace Ambal and Liza Duya, Conservation International-Philippines

5.2.2.4 Considerations in application

Threatened species for which KBAs cannot currently be identified

When there is a total lack of recent or reliable data on one or more threatened species, the best course of action is to determine where these species are likely to occur and to flag these sites as extremely high research priorities – candidate KBAs (section 5.2.4) – rather than to identify them as KBAs. Even if already identified as KBAs for other species, such sites are still research priorities for the unconfirmed species. Once more data are available, the information on species occurring in those KBAs can be updated or new KBAs can be identified if appropriate.

Populations of threatened species for which KBAs do not need to be identified

In theory, some very low density Vulnerable species with broad geographic ranges could fail to trigger the threshold for KBA identification (although if they are widespread, they will likely occur at KBAs identified for other species). In practice, we suspect that the provisional threshold for Vulnerable species is low enough that all threatened species will trigger at least a few KBAs. Even if not, this is appropriate since widespread, low-density threatened species often require conservation attention at the landscape or seascape level, instead of or in addition to site conservation, to ensure their persistence. Criteria for defining such area-demanding species are under development.

5.2.3 Identifying KBAs under the irreplaceability criterion

As outlined in Section 4.3, KBAs are identified under the irreplaceability criterion because they hold significant proportions of the global population of one or more species. The provisional threshold for significance is 1% or 5% of the species' global population at a particular site (Section 4.3). While this is different from the vulnerability criterion, many of the steps necessary to identify KBAs as described in the previous section also apply to the application of the irreplaceability criterion. The general process is the same: 1) compile the list of species that will likely trigger this criterion, 2) evaluate existing sites identified under irreplaceability criteria (e.g., IBAs, IPAs) and feed these sites into the KBA process, 3) document the occurrence of additional trigger species at these sites, and 4) identify new KBAs for trigger species not fully captured by sites identified for other taxa. This section will therefore focus on specific guidelines for applying the irreplaceability sub-criteria.

5.2.3.1 Restricted-range species

Compiling the list of restricted-range species

Restricted-range species have limited global distributions, meaning that they occur in a relatively small geographic area. The proposed threshold for defining terrestrial vertebrate species as restricted-range is a breeding Extent of Occurrence of less than 50,000 km^2 (Section 4.3.1). Research is underway to test appropriate restricted-range thresholds for freshwater and marine species (Boxes 3 and 5), and similar efforts are needed for plants and terrestrial invertebrates.

To apply this sub-criterion, determine which species have restricted ranges and make a list of those species for which this criterion will be evaluated. For mammals and amphibians, maps of global ranges are available through the IUCN Global Species Assessments. If species ranges have been mapped, selecting species whose range polygons are less than 50,000 km^2 can be done in a GIS. This information was analysed for all bird species (Stattersfield *et al.* 1998), and incorporated into IBA identification worldwide. Assessing the global distributions of species other than birds, mammals and amphibians, will require searching the literature and consulting with specialists.

Clearly, many globally threatened species (for example, all AZE species and all species listed under the B and D2 criteria of the IUCN Red List) also have restricted ranges. If KBAs have already been identified for these species under the vulnerability criterion, the next step would be to indicate for which sites these species meet the threshold for the restricted-range sub-criterion as well (i.e., at least 5% of the species' global population occurs at the site).

Applying the population threshold to identify KBAs for restricted-range species

Determining whether a population of restricted-range species meets the 5% threshold at a site (as defined in Section 4.3) can be challenging, due to lack of data for many species. Wherever possible, population data should be synthesized from the literature or recent field surveys to evaluate whether this threshold has been met. Where global population data are lacking, estimates can be made from the extent of remaining habitat at the site and the average population densities of the species. Barring any population data, for restricted-range species with clumped distributions, KBAs can be triggered when 5% of total suitable habitat and some known individuals are present at a site. KBAs should generally not be identified for restricted-range species widely distributed across their range and with poor data on population size, as the sites where they occur are unlikely to meet the threshold for global significance. However, it is very likely that these species would be captured in KBAs identified for other species.

All assumptions made regarding population size of restricted-range species triggering KBAs should be well documented.

5.2.3.2 Congregations

Congregatory species are those that gather in globally significant numbers at a particular site at a particular time in their life cycle for feeding, breeding or resting (during migration). This definition applies to some species of birds (e.g., waterbirds, colonial nesters), mammals (e.g., bats, whales), fish (e.g., spawning aggregations), butterflies (e.g., monarchs), some marine invertebrates, and possibly some species of amphibians (Mittermeier *et al.* 2003). Few restricted-range species will be congregatory, but a number of globally threatened species do congregate in globally significant numbers. Thus, applying the vulnerability criterion should pick up KBA sites for some congregatory species. These sites should be documented as meeting the congregations sub-criterion as well as the vulnerability criterion.

Applying the population threshold to identify KBAs for congregatory species

As with restricted-range species, determining which species are congregatory is the first step in applying the congregations sub-criterion and is usually fairly straightforward. Plants are sessile and do not congregate, so this criterion need only be applied to animal taxa (see definition above). IBAs have already been identified for congregatory birds in many countries. The key challenge is to determine whether the congregations of non-bird species are globally significant. In other words, do they trigger the threshold of 1% proposed in Section 4.3.3? While we may be able to estimate the number of individuals congregating at a site, we may not know the species' global population sizes. In this case, a review of the literature and consultation with specialists can guide the decision about the applicability of this criterion to a particular taxa (Box 12), as well as whether a trigger species meets the threshold at a particular site.

5.2.3.3 Identifying KBAs for other species meeting the irreplaceability criterion

Bioregionally restricted species and assemblages

The bioregionally restricted assemblages sub-criterion is in more formative stages of development than the other irreplaceability sub-criteria due to the challenges outlined in Section 4.3.5. Both BirdLife International and Plantlife International have nonetheless tested this criterion in many countries. It is used to identify sites that hold a significant component of the group of species that possess distributions largely or wholly confined to individual biomes (Bennun and Njoroge 1999, Fishpool and Evans 2001) or habitats (Anderson 2002) (Boxes 8 and 13).

Other species

Restricted-range, congregatory and bioregionally restricted species, because they are concentrated in space, will trigger the majority of KBAs under the irreplaceability criterion. There may be a few additional species, such as those that are widespread but have highly clumped distributions such that >5% of their global population occurs at a site or sites (Section 4.3.2), and those with source populations on which a significant proportion (>1%) of the species' global population depends (Section 4.3.4). These sites should be identified as KBAs, following compilation of data indicating that the population threshold has been met.

Box 12. Applying the congregations sub-criterion to bat populations – a case study in Turkey

Turkey is amongst the few countries that has completed the selection of KBAs at a national scale. Taxonomic groups covered by the Turkish KBA program include birds, mammals, herpetofauna, freshwater fish, butterflies and dragonflies. Within these groups, bats are an example of a taxonomic group for which one must apply the congregations sub-criterion in identifying a network of KBAs. Most bat species depend on caves for their summer and winter roosts; many of these caves are irreplaceable and if not properly conserved will have a great impact on the overall status of the bat populations in the region. In Turkey, caves are widespread along the Black Sea coast and in the Mediterranean. Caves are used either for summer or for winter roosts – sometimes for both. Of the 37 bat species in Turkey, 33 species regularly congregate in large numbers in caves, and thus, potentially trigger the congregations sub-criterion.

No global population estimates exist for bat species in Turkey, making it difficult to select globally irreplaceable KBAs for bats. To highlight sites that likely hold more than 1% of the global population of a particular bat species, information on the population sizes in sites was combined with expert opinion on the order of magnitude of global populations. Using this method, three sites were considered KBAs based on the congregations sub-criterion. A typical example is the Istranca Mountains, which comprise several winter and summer roosts and crucial feeding areas for bats. The Dupnisa cave in these mountains regularly holds at least 60,000 bats. Among these, four species (*Miniopterus schreibersii, Myotis myotis, Myotis blythii* and *Rhinolophus ferrumequinum)* are thought to trigger the congregations sub-criterion for KBAs.

Although this process is partly led by expert judgment, it is a practical and sound way of identifying caves of global importance for bats. Forming an international working group for selecting KBAs for bats would further improve the objectivity of this process.

Ahmet Karataş, Niğde Üniversitesi and Güven Eken, Doğa Derneği

Box 13. Identifying KBAs for bioregionally restricted birds: case study of IBAs in Paraguay

Assemblages of species endemic to specific biomes form one component of irreplaceable biodiversity, and as such need to be contemplated when planning protected areas networks. One criterion for identifying KBAs that has been used by BirdLife International and partners is the presence of a significant proportion of the group of species whose distributions are restricted to a bioregion. In Paraguay, application of the bioregionally restricted criterion has been tested for birds as part of the national IBA program. Two sub-criteria have been applied: first, all bioregionally-restricted species must be represented in at least one site in the country; and second, all sites holding 25% or more of the total species globally confined to a given bioregion were considered as potential IBAs.

For the Neotropics, the Americas IBA program has taken the broad zoogeographic regions and their lists of endemic bird species as defined by Parker *et al.* (1996) to be equivalent to bioregions and bioregionally-restricted assemblages. However, in Paraguay it has proved more effective to use specific avian biogeographic studies that are more closely aligned with the global bioregion classification developed by the World Wildlife Fund (Olson *et al.* 2001). Although this was initially more time-consuming, it confined the analysis to those species truly restricted to the bioregions in question.

Many species that trigger the recognition of IBAs under the globally threatened, restricted-range and congregatory criteria are also restricted to one bioregion. Thus, in practice it proved most efficient to first select sites under these three criteria and then to apply the bioregionally restricted criterion once the resulting gaps in species and geographic coverage were analyzed. For example, of 19 IBAs in the Paraguayan Atlantic Forest, 18 were triggered by application of the globally threatened species criterion; 12 of these also met the 25% threshold level for the bioregionally restricted criterion. Just one IBA was added through application of the bioregionally restricted criterion alone.

Application of the 25% threshold level for other bioregions in Paraguay proved less effective at identifying IBAs. Within the Cerrado, no sites met the threshold level. In contrast, virtually any site in the Chaco with avian inventory data surpassed the threshold. By raising the threshold level to 50%, we identified nine IBAs, which, when considered together, included all Chaco bioregionally restricted species in the country. As the Chaco holds few globally threatened and no range-restricted species, applying the bioregionally restricted criterion in this region was especially important. Of the nine IBAs, just four were also identified using the other three criteria. Nationally, no sites were chosen for the presence of just one or a few bioregionally restricted species, as all such species were well-represented in the sites identified using the other three criteria plus the percentage threshold level sub-criterion for bioregionally-restricted species.

In summary, the following conclusions can be drawn from experiences in Paraguay:

1. Application of the bioregionally restricted criterion is most efficient once gaps in species coverage and geographical spread that result from the application of the other criteria have been analyzed.

2. Use of this criterion is most important in bioregions that hold few globally-threatened and/or range-restricted species (such as the Chaco and many other Wilderness areas).

3. We recommend using a variable threshold level, perhaps correlated with the conservation status of each bioregion, with 25% (of the total species globally confined to a given bioregion) the minimum that should be applied.

4. To maximize the likelihood of encompassing viable populations of bioregionally restricted species, we recommend selecting large sites that reflect the distribution of the bioregion across the country, and suggest that the existing protected areas network be a pragmatic starting point for choosing sites.

Rob P. Clay, BirdLife International-Americas Division

5.2.4 Candidate KBAs

How should we deal with areas that are suspected to be important, but for which no conclusive data exist that demonstrate one or more KBA trigger species is present in the site? These include sites that may be suitable for a trigger species because the right habitat is present (but they have not yet been surveyed), or areas where distributional modeling indicates that the species is likely to occur. These areas may be considered 'candidate KBAs'. Such candidate KBAs are high priorities for field research, as opposed to true KBAs which are high priorities for conservation. Modeled data can be very useful in identifying candidate KBAs and support the use of a precautionary management approach in some areas (e.g., prohibition of development or logging) to prevent risk until further data become available. It is often desirable to include candidate sites on the map of KBAs identified for a region, indicated with different symbols, to flag areas that are high priorities for research (Section 7.5).

Candidate KBAs that are priorities for research, as described above, should be distinguished from sites that do not yet qualify as KBAs because they hold nationally threatened endemics that have not yet been assessed using the IUCN Red

List guidelines (Standards and Petitions Working Group 2006) for inclusion on the Red List. While also technically 'candidate KBAs', a separate term may be warranted to describe these sites (e.g., provisional KBAs) to avoid confusion.

5.3 KBA delineation

Although KBAs are identified using objective and quantitative criteria, their transparency and conservation utility depend on how they are delineated. To delineate IBAs, BirdLife International and partners have used three main guidelines: "the sites should, as far as possible,

1. be different in character or habitat or ornithological importance from the surrounding area;
2. exist as an actual or potential protected area, or be an area which can be managed in some way for nature conservation; and
3. alone or with other sites, be a self-sufficient area which provides all the requirements of the birds (that it is important for) which use it during the time they are present" (Grimmett and Jones 1989).

These guidelines have yielded, for the most part, biologically meaningful IBAs based on practical considerations for site conservation. Extending this approach beyond birds, the objective of KBA delineation is also to identify ecologically derived sites that are currently or can potentially be managed for conservation (Eken *et al.* 2004). We should emphasise that we use the word "delineation" in a data management sense to mean "drawing a line around." Whether or not a KBA will be delineated on the ground (or in the water) will depend on the particular management regime in place.

In practice, this has meant that the existing protected area network is often the starting point for defining and delineating IBAs (and hence KBAs), as many (but not all) protected areas have been designated for biodiversity conservation. Sites outside the existing protected area network that qualify as KBAs are subsequently identified and delineated, as necessary (Figure 14).

Two main concerns are often raised with this approach to delineation, which incorporates land management units and other broad-scale socio-economic information from the start. The first is that the repeatability of the KBA approach may be compromised because KBA delineation will vary around the world, depending on the land management context in a country or region and the type and resolution of management data used for delineation; the assumption is that KBAs would be more consistent if defined purely on biological criteria. Second, KBAs delineated with respect to management units may emerge as less important for the species for which they were identified, for example, if the important habitat for a KBA trigger species was somehow split into two (or more) management (or manageable) units.

The response to both of these concerns is the same:

1. The choice between biological and management units for KBA identification is a false one, because there are no "biological units". Species have unique habitat requirements, some of which overlap in space. Because this overlap is not perfect, the appropriate habitat for all KBA trigger species covers the entire world. In other words, where to make the boundaries of a "biological unit" is not at all clear.
2. While KBA delineation should ensure that the boundaries of each site are as biologically sensible as possible, they must also be practical to maximize the prospects for conservation of the trigger species. Thus, pragmatic incorporation of land management data is essential to enable the safeguarding of globally important sites.
3. Tackling delineation pragmatically will yield KBA boundaries that vary from place to place, because site conservation will always vary based on the national or local conservation context. This variation is not a problem *per se*; much more important is to ensure that a given KBA would be delineated in the same way by different assessors, or by the same assessor over time.
4. While any given KBA is by definition necessary for the persistence of the species for which it is identified, it is not necessarily sufficient. Some species that face specific threats such as hunting may also need conservation targeted at mitigating these pressures directly. Others will require conservation in multiple KBAs managed as a network, while still others need action at the landscape or seascape scale in addition to site conservation. Thus, while KBAs should be as biologically sensible as possible, they must first and foremost be pragmatic in allowing management for conservation.

There are no fixed size limits for KBAs. They can range from very small to very large, depending on the distribution of species and the management context in a particular area. As sites that are currently, or can potentially be, managed for conservation, KBAs generally exclude areas that have been converted to human use such as cities, large-scale agricultural areas, and transportation corridors.

The guidelines in this section are most relevant for terrestrial biomes. Delineation of KBAs in aquatic systems will be straightforward in some instances (e.g., small lakes) but much harder in rivers and ocean systems. Research that will guide the identification and delineation of KBAs in both marine and freshwater systems is underway.

5.3.1 Delineation with respect to existing KBAs

As described in Section 5.2, a set of existing globally important sites – such as IBAs, IPAs, and AZE sites – can provide the starting point for KBA identification in a country or region. Where these sites have been delineated, the task is, first, to evaluate data for additional KBA trigger species to determine whether they occur within these existing sites, and, second, to ensure that the boundaries of the existing sites make sense for the additional trigger species. Where IBAs or IPAs have been delineated only on paper maps, it will be necessary to digitize and spatially geo-reference these data in a GIS before commencing with KBA delineation.

The delineation of existing KBAs will generally fall into one of two categories: 1) their boundaries correspond to an existing land management unit, such as a protected area, or 2) their boundaries follow biological or physical features on the landscape because no useful land management unit exists in the area. These two scenarios, which apply to KBAs generally, are covered in detail in the following two sections, respectively.

In many cases, despite the incorporation of data on additional trigger species, the boundary of an existing KBA does not require modification (Box 11; Figure 12a). Sometimes, however, the boundaries of an existing KBA must be modified to incorporate adjacent habitat required for other species (Box 11; Figure 12b), or if this is not possible, identification and delineation of a second KBA is required. This situation is covered in detail in Section 5.3.4.3.

5.3.2 Delineation with respect to existing management units

As far as possible, KBAs should include habitat that is important for their trigger species. This means that KBA delineation usually requires not just a confirmed locality but also an understanding of the habitat affinities of each species. While these data are lacking for a number of species, particularly in lesser known taxonomic groups, an effort should be made to obtain, map and store this information for as many KBA trigger species as possible. This information can assist with KBA delineation and in later management of the species and/or site.

Because KBA boundaries should yield sites that can realistically be managed for conservation, existing land management units are obvious starting points for KBA delineation (Figure 13). Many existing protected areas will be directly equivalent to KBAs (Box 14). This is particularly true in situations where protected areas were established for their biodiversity values and contain suitable habitat for species that would trigger a KBA, and where the protected areas contain most of the remaining habitat in a country or region. Moreover, because of uneven sampling, well-known sites such as existing protected areas often emerge quickly in a KBA analysis. It is sensible to use the boundaries of these existing management units as a starting point for KBA delineation. Other land management units may include private properties, forestry concessions, indigenous territories, and government land holdings.

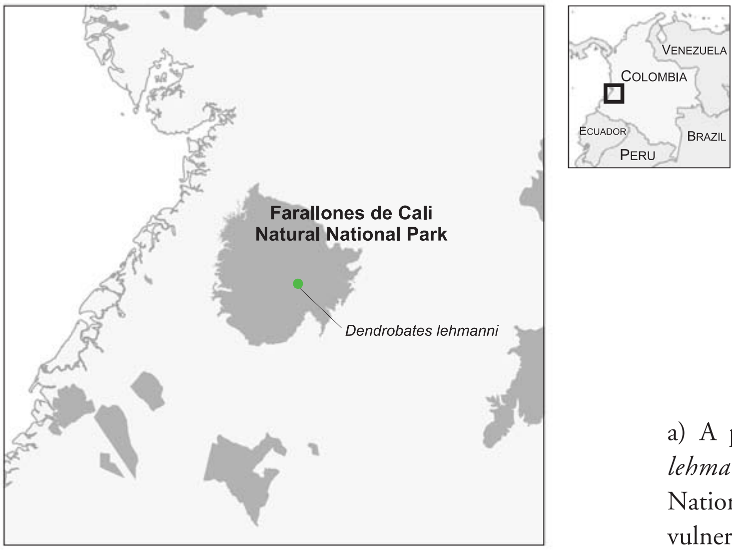
Occasionally, we have sufficient data on the habitat requirements of a KBA trigger species to conclude that the boundaries of an existing land management unit are not sensible. This could happen, for example, when the habitat for a particular trigger species falls partly within, but mostly adjacent to (and outside of) an existing protected area or other land management unit. Guidance for dealing with this and similar scenarios is given in Section 5.3.4.1.

When land management data do not exist or are too coarse

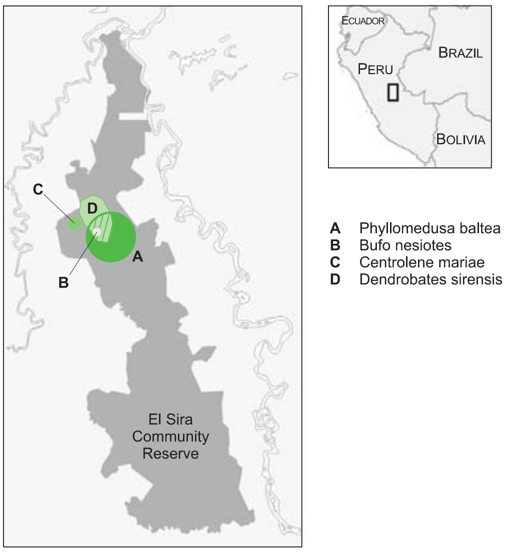
Occasionally, it may be difficult to obtain appropriate land management data for a country or region to aid in KBA delineation. (What is "appropriate" will depend on the local context. For example, in some countries, very large areas can be manageable for conservation, and thus, the data required can be coarser.) This is often the case where finer-scale management units have not been digitized or made available, or when land is split into many private and public land management units. A significant effort should be made to obtain data on existing land management units during a KBA process; at a minimum, protected area boundaries can be obtained for most countries from the WDPA. If, however, there are insufficient data on management units to delineate KBAs, there are a couple of options. The first is to draw a rough boundary following biological or physical features (Section 5.3.3), and the second is to leave the site as a point and wait to delineate the boundaries at a later stage, when detailed planning for conservation implementation begins. In either case, and particularly for the former, it is important to indicate the need for refinement of the boundary on any maps that are produced (Section 5.3.5).

In some countries, land management takes place at an extremely fine scale, such that the resulting management "units" are very small. This situation often arises in regions of customary land tenure, such as in Melanesia, where a number of villages or communities own and manage the land (Box 15). It is generally not desirable to have many small KBAs that correspond to individual customary land units, as these would often fail to meet the criteria and thresholds for KBA status. Instead, it may be preferable for the KBA boundary to follow biological or physical features; in this situation, information on the finer-scale units (i.e., different groups holding land tenure within the KBA) should be recorded to aid in later conservation management. If a KBA ends up being split or the boundary refined significantly following more detailed socio-economic analysis or stakeholder consultation that accompanies site management planning, an analysis must be done to ensure that the resulting sites independently meet the KBA criteria. Common sense should be used in deciding how finely to split KBAs based on management units.

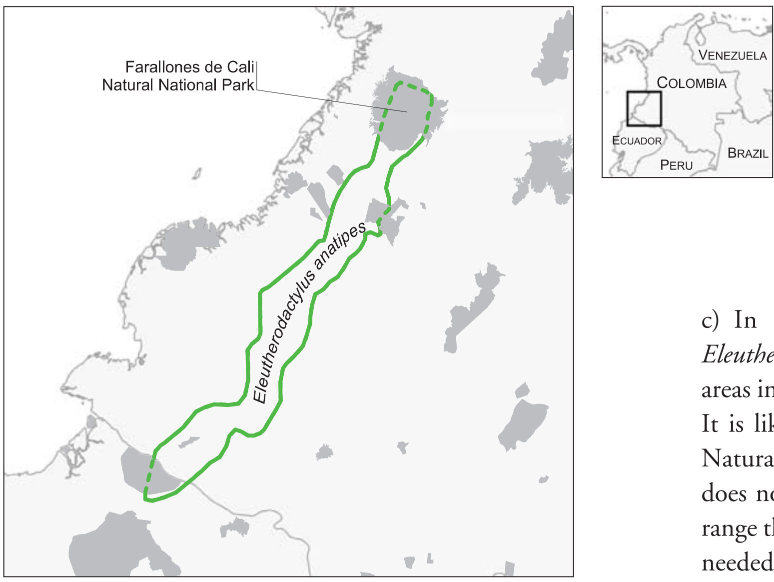
Figure 13. Aggregation of species data to protected areas to identify KBAs. Amphibian distribution data from the Global Amphibian Assessment (IUCN *et al.* 2004); Protected area data from the WDPA (WDPA Consortium 2004).



a) A point locality for the amphibian species *Dendrobates lehmanni* (CR) falls within Farallones de Cali Natural National Park in Colombia, making the site a KBA under the vulnerability criterion.



b) The Reserva Comunal El Sira in Peru contains the entire global distributions of four Endangered species: *Bufo nesiotes, Dendrobates sirensis, Phyllomedusa baltea, Centrolene mariae*. In this rare situation, the Extent of Occurrence range maps for these species are entirely sufficient to identify this site as a KBA.



c) In contrast, the Extent of Occurrence map for *Eleutherodactylus anatipes* (VU) overlaps at least two protected areas in Colombia, and extends way beyond to the southwest. It is likely that the species occurs in the Farallones de Cali Natural National Park to the north, but in general, the map does not give enough information to know where within its range the species actually occurs. More detailed locality data is needed for this species to identify KBAs for it.

Box 14. Delineation of KBAs in Indochina

During 2003, 438 KBAs were identified in the Indochina Region (comprising Cambodia, Laos, Myanmar, Thailand, Vietnam and parts of southern China). This work was conducted by BirdLife International, with technical support from CI and contributions from in-region experts, as part of the preparation of the Critical Ecosystem Partnership Fund (CEPF) Ecosystem Profile for the region.

The starting point for KBA identification in this region was the network of IBAs defined by BirdLife International and its partners. Based on these IBAs, 282 KBAs were identified, comprising 64% of the total list of KBAs identified in the Indochina Region. In most cases, when the IBAs were overlaid with point locality data for other taxonomic groups (mammals, reptiles, amphibians, freshwater fish and plants), the existing IBA boundaries could be adopted as KBA boundaries without any adjustment. In a few cases, the IBA did not contain sufficient area of suitable habitat to support all the species from other taxonomic groups (mainly large, wide-ranging mammals, such as Tiger *Panthera tigris* and Asian Elephant *Elephas maximus*). In these cases, the KBA boundaries were enlarged by incorporating contiguous areas of suitable habitat outside of the IBA.

Another issue was that the resolution of distributional data for birds was greater than that for other taxonomic groups. In a number of cases, this greater resolution led to the identification of several IBAs within a single large protected area (>*c*.1,000 km^2), because different parts of the protected area differed ornithologically. In such cases, however, the available published data on the distribution of other taxonomic groups was often limited to presence or absence within the protected area as a whole. Consequently, the available data did not permit assessment of whether the individual IBAs qualified as KBAs for other taxonomic groups. With more time, it may have been possible to obtain more detailed data on species distribution within protected areas; given the time constraints, however, these situations were resolved by delineating a single KBA that comprised the whole protected area and all IBAs within it.

It was then necessary to add additional KBAs for other taxonomic groups that did not qualify as IBAs. In many cases, it was both desirable (for future management) and pragmatic (because of data availability) to delineate KBA boundaries following the boundaries of existing protected areas. In most cases, existing protected areas were considered to form biologically sensible units, containing sufficient suitable habitat to support the species that they are important for. In these cases, each protected area was delineated as a separate KBA. If two or more contiguous protected areas were not considered to be individually large enough to form biologically sensible units, or (very rarely) if disaggregated species locality data were unavailable, the areas were delineated as a single KBA. Eighty-nine KBAs were delineated based on existing protected areas, comprising 20% of the total list of KBAs identified in the Indochina Region.

The remaining 67 KBAs (comprising 15% of the total) were delineated outside both IBAs and existing protected areas. To define these KBAs, point locality data were overlaid onto land cover data and hydrological data (river systems, wetlands, etc.), and biologically sensible units were delineated based on a consideration of the ecological requirements of the trigger species. In most cases, it was relatively straightforward to reconcile the ecological requirements of different species, because the KBAs identified outside both IBAs and existing protected areas were defined for relatively few species each (a mean of three species per site, compared with a mean of seven species per site for the full list of KBAs). After biologically sensible units had been delineated, these were reviewed against administrative/land management data to ensure that the areas delineated were manageable units (i.e., did not contain multiple land-uses and did not overlap international boundaries or, in the case of countries where protected area management is decentralized, provincial boundaries). In many cases, it was not necessary to further refine the KBA boundaries. In some cases, the site had been proposed as a protected area by a government agency or conservation NGO, and it was possible to simply delineate the KBA following the proposed protected area boundary.

Andrew Tordoff, BirdLife International

5.3.3 Delineation outside existing management units

Delineating KBAs where there are no useful land management units, or where the boundaries of existing land management units are unknown or ambiguous, can be challenging. This is particularly true in areas of low habitat heterogeneity and where there is little fine-scale endemism. In some cases, the habitat preferences of trigger species are known and the data exist to estimate and map habitat extent. In other cases, the habitat preferences of trigger species are either not known, or the relevant data may not be available to map habitat preferences to aid in KBA delineation.

When data on species' habitat preferences exist and can be mapped

Data on the Area of Occupancy of KBA trigger species can be very useful for KBA delineation. If these data exist and can be mapped, an initial boundary for a KBA can emerge by overlaying this finer-scale distributional data for each KBA trigger species. A boundary that includes all, or the majority, of the habitat for the set of trigger species around known point localities would be sensible, assuming that the resulting site could still potentially be managed for conservation and human-dominated areas are excluded. As described in section 5.3, very large

KBAs will be appropriate in some areas (e.g., the Amazon), because such sites can practically be managed for conservation. In other regions, however, delineating a KBA that fully encompasses the Areas of Occupancy of a set of trigger species will not be possible, and the boundaries will need to be refined using biophysical data (e.g., elevation, streams) to yield manageable sites.

Given that Area of Occupancy data exist for relatively few species, this can be estimated if something about the species' ecological requirements are known. This would include information on suitable habitat (e.g., montane forest, wetland), unsuitable habitat (e.g., secondary forest), altitudinal range, environmental preferences (e.g., steep slopes, low rainfall), food preferences, population density, and home range size. This information can often be obtained from the scientific literature, online species databases, and specialist opinion (Section 5.1.2). All life stages of the species that occur in the area should be considered.

Once information on species' habitat and ecological needs has been compiled, the next step is to map the habitat preferences of species using available data. This can be done using a range of methods, from simple GIS overlays to sophisticated species distribution models. It will typically involve acquiring (or digitizing) spatial data on vegetation type and extent, elevation, topographic position (e.g., ridges, aspect), land use (e.g., for excluding areas that have been converted or heavily impacted), and hydrography, as well as climatic variables (e.g., rainfall) and soil type for some species. Once the maps of suitable habitat have been generated, they can be overlaid with the known point localities and initial boundaries drawn such that the important habitat for each KBA trigger species is included (Figure 14c). Again, practical management of the site for conservation should be considered when overlaying the habitat preferences of more than one species to delineate a single KBA.

When species habitat preferences are unknown or relevant habitat data do not exist

Often data on the habitat preferences of KBA trigger species are lacking, particularly for lesser known taxonomic groups. If a KBA has been identified for a species of bird and a species of amphibian, for example, and there is sufficient data to delineate the site based on the habitat preferences for the bird but not the amphibian, KBA delineation should proceed but with an indication that the boundary may need to be refined once more information on the other KBA trigger species becomes available.

In cases where a) there is no habitat information for any KBA trigger species, b) data are not available to map the species' habitat preferences in a GIS, or c) the ecological requirements of several species overlap in discordant ways, biophysical data can be used to delineate site boundaries. Maps of remaining vegetation or forest cover are very helpful for KBA delineation, particularly in regions that have been considerably fragmented; in these cases, delineation will often follow the boundaries of the remaining forest cover or other vegetation type (Figure 14a). When data on remaining vegetation do not exist, or it is patchily or oddly configured (e.g., a narrow strip of habitat along a river or mountain ridge), biophysical data layers such as digital maps of elevation, streams and topographic features can be overlaid with species localities to derive boundaries that approximate habitat discontinuities for the KBA trigger species (Figure 14b). It is generally sensible to aggregate species locality points to the largest possible site that can be potentially managed for conservation, to ensure that important habitat for each species is included.

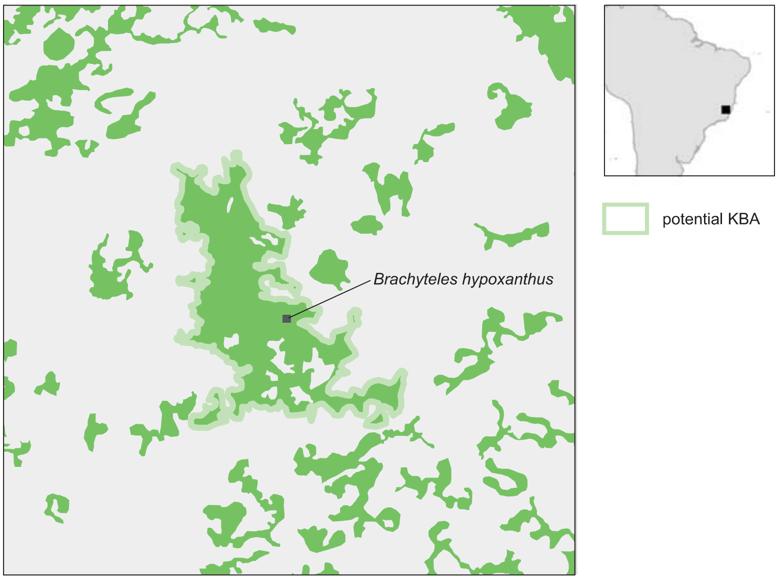
In contrast to highly fragmented areas, KBA delineation in areas of continuous habitat, such as wilderness areas (Mittermeier *et al.* 2003), will be more difficult. Data on remaining habitat are of little use, because much of the habitat is still remaining. Also, in some regions such as the Amazon, there are vast tracts of continuous habitat with relatively little environmental diversity. The challenge becomes how to parcel this continuous habitat into discrete KBAs. To compound the difficulty, data on species distributions are often lacking. The site boundaries will generally align with natural features, such as inter-riverine areas or mountains (Figure 14b). There may be fewer, larger KBAs in wilderness areas than in more highly fragmented systems, and these will likely be identified where restricted-range species occur (e.g., in centers of endemism), or where species congregate in significant numbers (e.g., migratory stop-over sites). Generating detailed maps of species distributions (e.g., through habitat modeling that is validated by additional surveys) is possibly the best course of action for refining KBA delineation in wilderness areas over the longer term (Figure 14c).

Where there are no habitat data for any KBA trigger species at a particular site, and if there are no useful environmental features on which to base the boundaries, the KBA can remain mapped as a point and delineation can be completed when more information becomes available (Section 5.3.4.4).

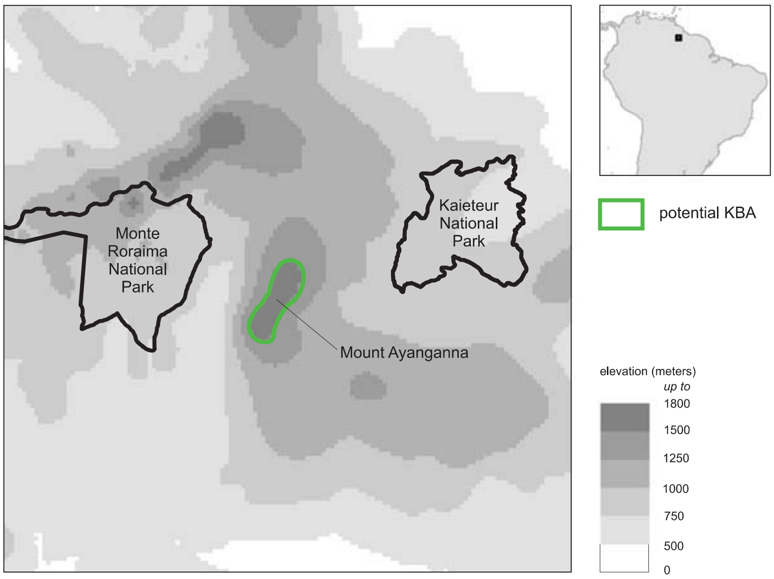
5.3.4 Tackling delineation challenges

Although it is tempting to argue for hard and fast ecological rules (e.g., setting a threshold size, or requiring that KBA boundaries follow watersheds) to make the process of delineating KBAs maximally objective and repeatable, no set of rules would be adequate for all KBAs across all countries because the management context is so variable. Instead, it is preferable to provide guidelines for handling the most frequent challenges faced in delineating KBAs as sites that can be managed for conservation.

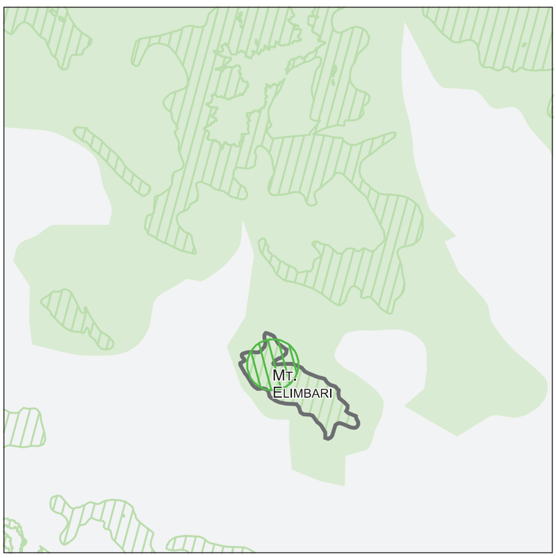
Figure 14. Delineation of KBAs outside of protected areas

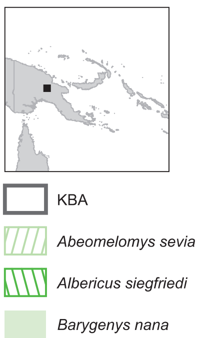


a) In highly fragmented areas, such as the Atlantic Forest of Brazil, delineation of KBAs outside existing management units will often follow the remaining forest or habitat cover. Here, a point locality for Northern Muriqui *Brachyteles hypoxanthus* (black square) falls within a patch of forest, so the KBA can take the shape of the forest fragment (light green line). Forest fragments data from Fundação SOS Mata Atlântica and INPE (2002).



b) Delineating KBAs in intact, continuous habitat can be significantly more challenging. When virtually nothing of the species' ecology or habitat requirements is known, topographic features such as elevation, rivers and geological features can be used. In this example from the Guianan Amazon, three species of Vulnerable, restricted-range amphibians (*Stephania coxi, S. ackawaio, S. ayangannae*) are found only on Mount Ayanganna at an elevation above 1,490m (Macculloch and Lathrop 2002). Thus, the 1,490m contour line in a digital elevation model or topographic map can provide a sensible KBA boundary for these species, assuming the resulting site could potentially be managed for conservation. Protected areas data from WDPA (WDPA Consortium 2004); Elevation = GTOPO30, USGS.

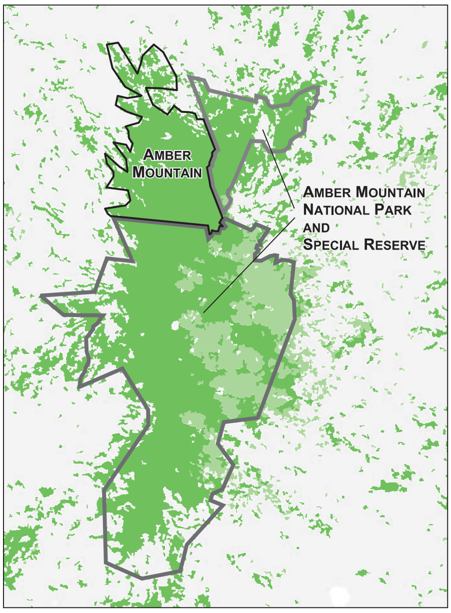


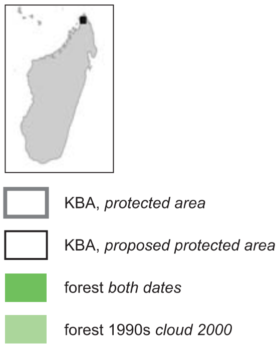


c) Species habitat requirements, if known, can be mapped in a GIS to derive an approximation of Area of Occupancy around one or more known locality points, to assist with KBA delineation outside the protected area network. In the following example from the highlands of New Guinea, the habitat preferences for the Critically Endangered frog species *Albericus siegfriedi* and two restricted-range species – the frog *Barygenys nana* and the mammal *Abeomelomys sevia* – were researched in the literature and mapped using data on vegetation type and elevation. *A. siegfriedi*, an AZE species, is only known to occur near the summit of Mt Elimbari. The mountain is also one of the few known collection sites for the two restricted range species. All three species are found in montane forest, so the boundary of the KBA was drawn to include the remaining forest habitat at the summit of Mt Elimbari. The result provides a sensible initial delineation of the KBA for these species. Data provided by the Melanesia Center for Biodiversity Conservation, Conservation International.

Figure 15. Resolving mismatches between an existing management unit and the habitat of KBA trigger species.

a) When habitat important for the KBA trigger species occurs outside a protected area (or other management unit), and including this habitat within the KBA would not compromise the manageability of the area, the KBA can be delineated to include both the protected area and the adjacent habitat. This would yield a partially protected KBA where the recommendation would be to expand the protected area. An example of this situation is the Sipurak Hook area of Sumatra, where the Kerinci Seblat National Park has been designated as a KBA. A relatively large lowland forest block east of the park still contains a significant area of unlogged forest and is important for several species of large mammals found within the KBA. Local conservation organizations are proposing that this area, which is covered by a logging concession, be repatriated to the national park. Source: Anon. 2002. Fauna and flora in Kerinci Seblat National Park Buffer Zone: results and recommendations from biodiversity surveys in logging concession areas. Technical Report 15, ICDP-Kerinci Seblat National Park Component C1. Jaako Poyry Consulting and Tritunggal Konsultan, Jakarta.





b) When adjacent habitat important for the KBA trigger species is in a different management unit, or when expanding the existing protected area would not be politically feasible, two KBAs should be delineated, assuming both portions meet the KBA criteria (if data do not exist to support the identification of the second site as a KBA, it would qualify as a candidate KBA). The recommendation would thus be to change the management of the second KBA such that its trigger species were safeguarded. An example of this situation is the Amber Mountain National Park and Special Reserve in northeast Madagascar, where the adjacent habitat important for the trigger species occurs in a different management unit which is not currently managed for conservation. Thus, an additional KBA (Amber Mountain) was delineated to indicate the difference in management structures in these KBAs. Data provided by Madagascar Center for Biodiversity Conservation, Conservation International.

5.3.4.1 Mismatches between an existing land management unit and habitat of KBA trigger species

The boundaries of some protected areas or other land management units may not yield sensible KBA boundaries, for example, if the habitat of one or more trigger species extends partly or mostly beyond the site's existing boundary. There are two main ways of handling this type of situation. The first option is to delineate the KBA as the entire protected area plus the adjacent area of suitable habitat (Figure 15a), effectively expanding the boundary of the existing site. The second option is to delineate a second, adjacent KBA (Figure 15b), effectively creating two separate sites, assuming both meet the KBA criteria. The correct choice will depend on the local management context. Whichever situation increases the potential for the site(s) to be managed for conservation should be followed. In some countries, protected areas are often expanded and so delineating a KBA that does not align perfectly with current management boundaries would not jeopardize the manageability of the site for conservation. In other cases, it is more common for new protected areas to be created rather than an existing one expanded, and including an unprotected portion into an existing protected KBA means that the unprotected portion will be effectively ignored. Similarly, it is often necessary to split what would otherwise be a single KBA into two sites, because the management regimes of the two portions are considerably different and incompatible (e.g., a protected area and a logging concession).

If delineation yields a partially protected KBA, this information should be included in the standard documentation of each site (Section 5.4), as it is relevant for gap analysis, site-scale planning and implementation.

5.3.4.2 Multiple or overlapping management units

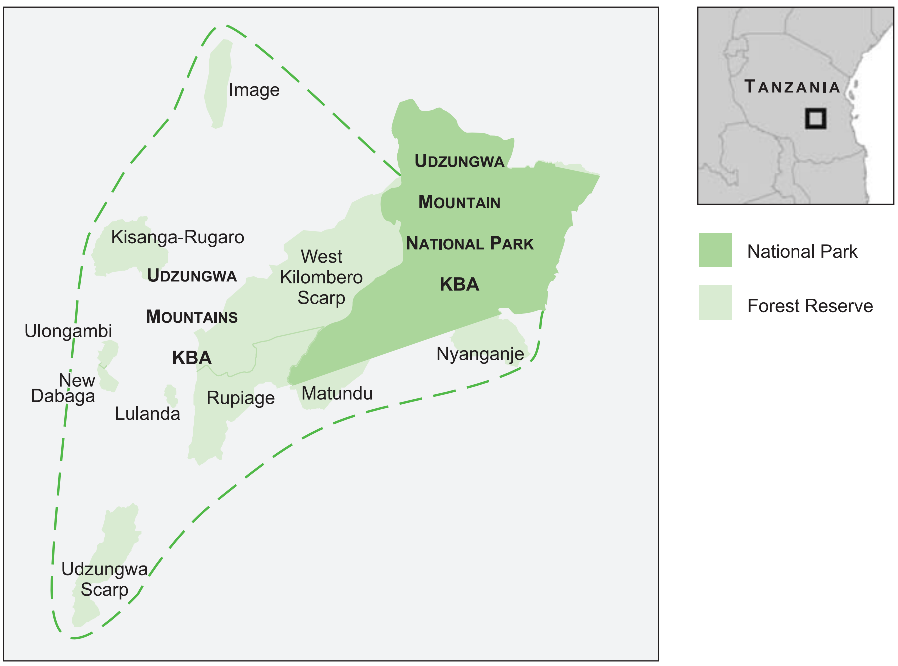
Technically, it is possible to have a KBA covered by more than one protected area or management unit when the different management units are effectively working toward the same goal of safeguarding the KBA (Figure 16). Having multiple management regimes (e.g., a state protected area and a national park) within a KBA requires special considerations when planning or implementing conservation. In these situations, it would be desirable to develop a coordinated management plan for the entire KBA. If the KBA is comprised of different management units, this should be documented in both the textual data and on resulting maps.

Occasionally, land tenure will be overlapping or ambiguous. This may happen, for example, when a protected area overlaps with a forestry concession, or when land is managed communally (Box 15). In these situations, an initial KBA boundary can be generated based on the habitat requirements of the trigger species or biophysical features, and detailed delineation of boundaries can happen once conservation implementation is being planned for the area (and presumably more information becomes available). It is important to show the preliminary nature of these boundaries when mapping KBAs (Section 5.3.5).

5.3.4.3 Mismatches between an existing KBA and habitat of additional KBA trigger species

As described in Section 5.3.1, the boundaries of an existing KBA – such as an IBA or IPA – sometimes do not capture the habitat or known localities of additional trigger species. If the KBA in question is an existing protected area or other land management unit, the guidance given in Section 5.3.4.1 for handling mismatches between an existing land management unit and the habitat of KBA trigger species should be followed. If the existing KBA does not correspond to a management unit (because there are no useful land management units in the area), and instead was delineated based on the habitat preferences of the initial KBA trigger species or along biophysical features, then the site should generally be expanded to capture the habitat or point localities of the additional species. Refinement of existing KBA boundaries, upon incorporation of new taxonomic groups, should be done in consultation, and ideally in collaboration, with the relevant BirdLife International partner, Plantlife International partner, or other organization.

Figure 16. Example of a KBA containing multiple management units. The Udzungwa Mountain National Park comprises one KBA while all of the major forest blocks outside the national park make up a second, Udzungwa Mountains KBA. The latter is an example of a KBA containing multiple management units. Several of the mountainous forest reserves have adjacent boundaries (e.g. West Kilombero Scarp, Rupiage and Matundu Forest Reserves), while others are separated by degraded grassland or farmland. Management of the reserves is controlled by individual reserve managers, thus technically they represent different management units. However, locally these 10 forest reserves are treated as one manageable unit, while the national park is treated as a second manageable unit. Data provided by Nature Kenya and Wildlife Conservation Society of Tanzania.



5.3.4.4 No data on species needs, habitat discontinuities, or land management units

The most challenging delineation situation arises when there are no data on the KBA trigger species' habitat preferences, no existing land management units and no habitat discontinuities such as mountain tops, habitat fragmentation or vegetation type that could yield even provisional site boundaries. This basically equates to a situation where one or more species localities falls in a large region of continuous, homogenous habitat. The best advice in this situation is to leave the KBAs as points and wait until more information becomes available to delineate the sites. It is important to cluster adjacent species point localities that are likely referring to the same site, such that as far as possible, each KBA point represents a distinct site. Otherwise, if each species locality is treated as a separate site, a country or region will have an anomalously large number of KBAs.

5.3.5 KBA delineation as an iterative process

Ideally, the delineation of KBAs would be very detailed in the first iteration, starting with the mapping of species point localities and habitat needs, moving all the way to the fine-scale incorporation of socio-economic information to derive highly refined boundaries for conservation implementation. However, this is usually not

Box 15. Socio-political factors impacting delineation of KBAs in Melanesia and China

The Melanesia region is home to extraordinarily rich cultural and biological diversity. While this diversity of species and cultures is the region's most valuable asset, it can also provide challenges to the identification and delineation of KBAs.

Among the most significant challenges in KBA delineation is the fluid nature of socio-political boundaries within the region. If a KBA is considered a "single management unit", then the complexity of unregistered customary land tenure and lack of a nationally-sustained model for effective protected area management means that tribal land units are the only pragmatic management units in Melanesia. For example, the Solomon Islands are home to 74 language groups and numerous culturally distinct tribes; however, political boundaries between tribes are poorly defined. Debates on extent do not usually arise until one tribal group appears to be benefiting from a land-use that neighboring land groups would like to benefit from also.

Thus, while tribes are the relevant management units, delineating KBAs according to tribal boundaries would be extremely complicated. In addition, this could lead to parcels of land that are far too small to support populations of threatened species. In an area where tribes are at war (as in parts of the New Guinea highlands), or are otherwise unable to cooperate, it may not be feasible to define a single KBA that straddles tribal boundaries. In most other cases, KBAs in Melanesia are delineated first with respect to the habitat requirements of trigger species; management needs are not accounted for at this stage.

Experience in Melanesia suggests that community engagement projects aiming to conserve a large or biologically diverse area must start small with one or two tribal groups. To ensure that scarce resources are first invested in the most important part of the KBA, a "bulls-eye" approach is used to delineate KBAs in Melanesia. The bulls-eye combines 'core' areas of known or highly likely habitat of KBA trigger species. Areas surrounding the core habitat are included in the KBA as ecological buffers to help dissipate the impact of known threats such as wildfire incursion and bush meat hunting. Once the biological criteria have been defined, socio-political and cultural boundaries are overlain. If the KBA occurs within a high-level political grouping (e.g., country or province or state), cultural boundaries such as language groups may be used as an initial indicator of management zones or units (Figure 17a). These zones or subunits within the KBA are delineated at this stage to flag the implementation strategy for engaging communities in conservation. If the KBA straddles a country, province or state, separate KBAs rather than management zones within a single KBA are more likely to be delineated. By incorporating socio-economic layers at an early stage in KBA definition, we avoid the common problem of working at a small scale in areas that may be adjacent, but are not crucial, to threatened species conservation. KBA delineation teams typically include members experienced in conservation implementation and are thus able to make recommendations for site delineation that may be refined later with local politicians and community stakeholders. While biological criteria are the focus for KBA delineation in Melanesia, teams make conservative decisions about internal delineation or subdivision depending upon knowledge available at the time.

At the opposite end of the spectrum lies China, where political boundaries can be extremely rigid, such that even minor political units function in some degree of isolation. Thus, protected areas managed by entities other than the national government are generally delineated along county boundaries. Where there is overlap, the different counties sometimes set up their own system of management within a single protected area. Where these regimes are essentially the same, or are highly complementary, this does not present a problem for KBA delineation. Good examples are the very large nature reserves in Tibet and Qinghai, such as Changtang Nature Reserve, Linzhi Nature Reserve, and Three River Source Nature Reserve, which cover many counties and are managed as a single unit, or else co-managed by both their nature reserve headquarters and counties.

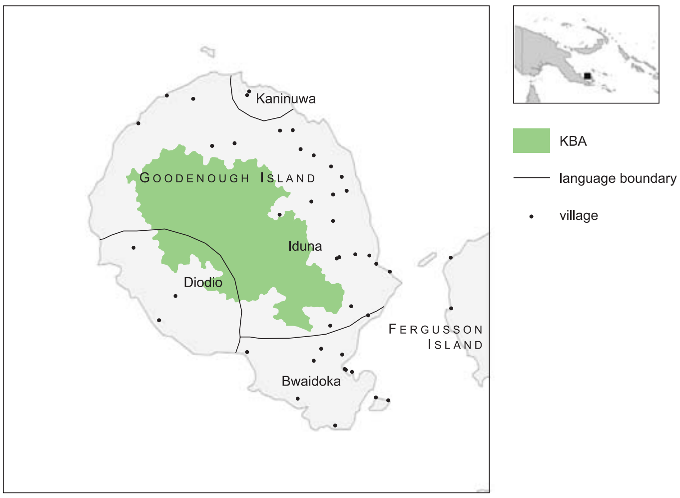
Where differences in management are extreme, the protected area is essentially split into more than one unit based on county boundaries. This scenario can present challenges for KBA delineation, since it is generally not possible to predict whether two or more counties will cooperate in the management of a single KBA, or whether the KBA will be designated as a national-level protected area. For example, an ongoing KBA analysis in the Mountains of Southwest China yielded preliminary KBAs delineated primarily on biological data. However, given that management is generally at the county level, most of

Box 15 cont.

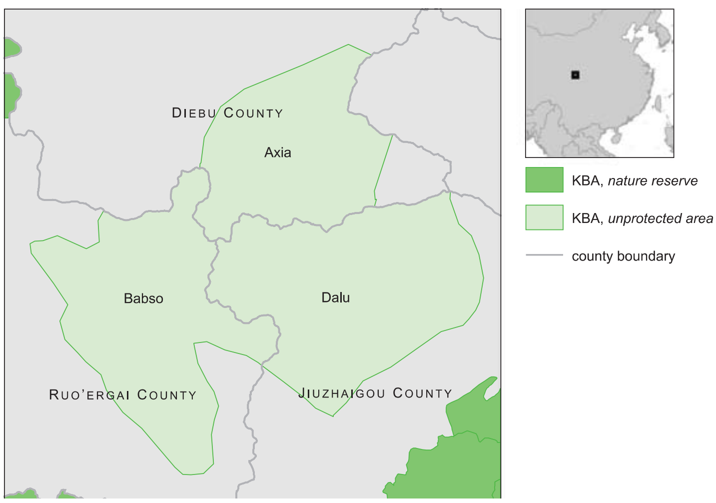
these preliminary KBAs have been split by the underlying county boundaries (Figure 17b). As a result, each county will be able to make independent decisions regarding the portion of their territory that most urgently requires conservation. Where counties decide to cooperatively manage adjacent KBAs, or where a national level protected area is designated that overlaps two or more counties, the individual KBAs can be merged.

Figure 17. How land tenure impacts the use of management data to delineate KBAs in New Guinea and China.

a) The following example from Goodenough Island in Milne Bay Province, Papua New Guinea, shows a single KBA delineated for three globally threatened species that are endemic to the island: Black Dorcopsis Wallaby *Dorcopsis atrata* (EN), an AZE species; Loud Big-eyed Treefrog *Nyctimystes avocalis* (VU); and Milne Bay Mehely Frog *Copiula minor* (VU). The KBA boundary was derived from mapping and overlaying the habitat preferences for these species (around known point localities). Also shown on the map are boundaries of language groups and villages, which will be used for zoning within the KBA and implementation of conservation on the ground. In this case, the boundaries of the KBA will be refined using more detailed socio-political data during the process of planning for conservation implementation. Data compiled by the Melanesia Center for Biodiversity Conservation, Conservation International.



b) In this example from the mountains of Southwest China, the remaining habitat for a number of globally threatened species (including the Giant Panda *Ailuropoda melanoleuca* (EN), and the birds *Perisoreus internigrans* (VU), *Haliaeetus leucoryphus* (VU), and *Lophophorus lhuysii* (VU)) is essentially contiguous within three counties. However, splitting this area into three KBAs was considered to be preferable over retaining it as a single site, due to the strong management that occurs at the county level in China. Each of the three sites independently meets the KBA criteria for at least one species. Thus, the three resulting KBAs are considered to be more likely to be manageable for conservation than a single site would have been. Data compiled by Conservation International-China.



Roger James, Melanesia Center for Biodiversity Conservation, Conservation International; Kristen Williams, Commonwealth Science and Industrial Research Organization (CSIRO); Wang Hao, Peking University and Conservation International-China

possible, given that KBA identification is conducted at the national or regional scale. This means that boundaries will typically follow existing land management units (for which data are available at the national or regional level), and outside these units, their boundaries will follow coarse-scale maps of species' habitat preferences and biophysical features. Undertaking a very fine-scale analysis of KBA boundaries for every site is a major effort and will necessarily involve local stakeholders in the conservation and use of that particular site.

At the initial stage, new KBAs are often mapped as points. Where these fall within existing protected areas and other clear land management units, these boundaries allow initial delineation. Beyond existing land management units, the boundaries of the site will begin to take shape as the Areas of Occupancy (or approximations thereof) of each of the trigger species are synthesized and analyzed (Figure 14). These boundaries can be refined using biophysical features when site boundaries are not obvious based on remaining habitat. If and when other land-use and management data become available, more detailed boundaries can be drawn.

While it may be tempting to postpone KBA delineation to the site-planning stage (leaving them mapped as points until conservation of the site is planned), rough boundaries, at least, are necessary to conduct subsequent prioritization and gap analysis of KBAs (Chapters 6 and 7). They are also needed to determine which species require urgent conservation action at the landscape or seascape scale, because site conservation is not sufficient to ensure their persistence in the short term. Because KBA delineation is an iterative process, new information is incorporated as it becomes available, to improve site boundaries or as new taxonomic groups are considered in the KBA process. However, it is important to remember that, even if final boundaries have not yet been precisely defined, conservation actions can be directed towards a KBA.

Documenting and displaying a range of delineation states

In practice, KBA boundaries will have a range of detail and confidence values. At one end of the spectrum will be KBAs with precisely mapped, undisputed boundaries such as many protected areas. In the middle of the spectrum are sites that have been delineated as rough polygons, based on species' habitat requirements or biophysical features. At the opposite end of the spectrum are sites that could only be mapped as points because no data exist to aid their delineation. It is very important to document the status of, and confidence level in, the delineation of each KBA's boundary in the textual data underlying the KBA analysis. We also recommend using different symbology on KBA maps to distinguish between the different types of boundaries (e.g., confirmed, provisional, etc.).

5.4 Maintaining standards, developing consensus and managing data

Maintaining standards

The following are crucial for helping to maintain standards in KBA datasets:

- ***Clear responsibility*** – A single national entity (either a single organization, or a consortium of partner agencies) should lead the process of identifying and delineating KBAs to ensure that the quality of data and synthesis is maintained and that the KBA process is dynamic and iterative. Typically, a first cut of KBAs is defined based on the best immediately available biological data. These are then shared with stakeholders through publications, workshops and/or databases.
- ***KBA identification should be iterative*** – Because our knowledge of biodiversity is dynamic, the KBA process is too. KBAs should be updated as often as data and institutional capacity allow. Financially, this will probably require one full-time position, on average – so a small cost compared to the benefit of having a living dataset. Although some may fear that an unstable KBA list will be hard to advocate for politically, the KBA list will probably plateau quickly as new data are incorporated (especially following the addition of aquatic species); thus, even the addition of many species to a KBA plan will add relatively few sites to the list.
- ***Expert review*** – The importance of engaging experts in the KBA identification and delineation process cannot be overstated. It ensures that KBA sites are globally important, scientifically credible and backed up by solid data. At the least, input data (e.g., point locality data per taxonomic group), and, more importantly, output data (i.e., KBA polygons, species-site combinations, and associated information) should be peer-reviewed.

Building consensus

Ideally, KBAs are identified and delineated through a locally-led process, generally driven from the national level. Thus, the KBA identification process is an invaluable tool for bringing together stakeholders (often for the first time) to discuss conservation priorities and for better involving specialists in the development of national conservation policy and processes. Developing consensus around the KBAs is essential in maximizing buy-in from government and donors. Below are a few tips for building consensus:

- While agreements for data sharing and participation in a KBA process can often be informal, formal agreements (such as Memoranda of Understanding) may sometimes be desirable, particularly when large amounts of data are provided by a single organization or institution not responsible for managing the process of KBA identification, or when analyses and/or publications are being produced jointly.

- Workshops, in which experts can review the KBA data and methodology, are often the best way to bring specialists and stakeholders together. In other cases the process will require several bilateral meetings.
- Given that KBAs are identified through a data-driven process, and that data speak for themselves as to whether thresholds are met, consensus on the global importance of a particular site is often not difficult to obtain. It is often harder to achieve consensus on the exact boundaries of the site, or on the conservation actions that should be implemented there.
- Expert review of data (see above) can go a long way towards building consensus for the sites identified, especially if representatives from relevant government agencies (at all levels) are involved in the process. Expert review is perhaps most efficiently accomplished through workshops. Compile as many data as possible and identify preliminary KBAs beforehand.

Managing data

Clear documentation and the ability to make revisions as more information becomes available require good data management and are crucial to the overall process of identifying, prioritizing and safeguarding KBAs. Identifying and delineating KBAs is a data intensive process that requires specialist knowledge of species in a number of taxonomic groups, as well as analytical and data management skills. Below are some tips for managing data in a KBA exercise:

- Maintaining data standards is best accomplished when the project is run by well-trained biologists with field experience and experience working with species data.
- It helps to have GIS capacity within the team to enable mapping of species distributions, point locality data and contextual data layers. The team that conducts the KBA analysis should also have project management, communication and fundraising skills.
- Lay out in advance: 1) which data are available for the species and region being evaluated; 2) which additional data are needed; 3) how these data will be obtained; and 4) who will help evaluate their quality. An informal advisory group, comprised of specialists from the scientific community, is often a good strategy for ensuring data standards.
- Textual or tabular data generated for each KBA should include the site's name, geographic location, physical and biological characteristics (e.g., elevation, habitat type and land use), protection status and level of effective management, threats, and other descriptive information. Additionally, it should indicate the criteria under which the KBA was identified; the trigger species that are found at the site; the dates of and confidence in these records; and the key references used to define the site as a KBA.
- Spatial data comprising the boundaries of the KBAs should be linked to the textual data on KBAs, so that attributes for each KBA polygon (e.g., site name, protected status, trigger species) are readily available. This will greatly enhance the usability of the data, for example for conducting gap analyses (Chapter 6). Other spatial data layers should be managed in a similar format accompanied by standardized metadata.
- To ensure data standards, accessibility and transparency, the data compiled for the identification of KBAs should be housed in a database, ideally standardized at the global level. A global umbrella for KBAs is clearly needed to make global standardization possible (Section 8.1). The goal should be to make the data publicly available, for example through the internet.

Section 7.1 describes in detail the type of information that should be recorded for each KBA, to allow prioritization of conservation action at KBAs.

Products and publication

Several products should result from the identification and delineation of KBAs:

- A fully documented database of KBAs and their associated species, as described above.
- A national inventory of KBAs (in the national language) that includes a map displaying the results of KBA identification and prioritization; a strategy and set of recommendations for their conservation; an assessment of how the action needed can be integrated within existing national, regional and global conservation initiatives; and where renewed effort for conservation is needed to ensure site protection.
- The results of KBA identification and delineation (and prioritization) should be published in some form in the peer-reviewed literature (including regional journals), on the internet, and/or in the informal literature.

5.5 Existing KBA directories, lists and processes

In many countries, local or national organizations are expanding beyond IBAs, IPAs and AZE sites to identify the full suite of KBAs in a region, considering all taxonomic groups for which appropriate data are available. In most countries, the effort to identify KBAs does not need to start from scratch. Previous and ongoing efforts to identify KBAs are summarized in Appendix 1.

Increasingly, KBAs are being incorporated into national gap analyses, National Biodiversity Strategy and Action Plan (NBSAP) priorities, and the investment strategies of donors (such as the Critical Ecosystem Partnership Fund and the Global Conservation Fund). In all cases, the emphasis is on developing a locally owned, dynamic process for identifying, safeguarding and monitoring KBAs, which can provide a solid backbone for national or regional-scale conservation planning and prioritization.

6. Key Biodiversity Areas as a basis for gap analyses

This chapter explains the theoretical considerations involved in undertaking a national or regional gap analysis of KBAs at the site scale. It expands the concept of gap analysis beyond the traditional "analysis of gaps in protected areas" to the core component of an integrated strategy for developing comprehensive, representative and effectively managed networks of protected areas. We explain the concepts of complementarity, irreplaceability and vulnerability that underlay the selection of priority areas for conservation action, setting the stage for the practical application of these principles in the next chapter.

All KBAs are, by definition, global priorities for conservation. By focusing on those species most in need of conservation action at the site scale, and by pinpointing the sites where such investment is appropriate, KBAs become targets for conservation action. Given scarce conservation resources, it is not possible to invest in the conservation of all KBAs simultaneously. Nor would one want to: KBAs do not all make equal contributions to comprehensive and effective networks of conservation areas. Deciding which KBAs are most in need of conservation action is, therefore, a fundamental component of any gap analysis.

Concept of gap analysis in this document

These guidelines are aimed at meeting the international commitment to "significantly reduce the rate of biodiversity loss by 2010" and align directly with Goal 1.1 of the CBD Programme of Work on Protected Areas: "To establish and strengthen national and regional systems of protected areas integrated into a global network as a contribution to globally agreed goals" (Box 1). Gap analysis is interpreted here as a strategy for achieving comprehensive, representative and effectively managed networks of protected areas. They accomplish this through identifying priorities for:

a) strategic expansion of existing protected area networks;

b) strengthening and consolidation of existing protected area networks;

c) filling the gaps in information required to inform (a) and (b).

As with the application of KBA criteria and thresholds, the prioritization methodology outlined here requires testing across a range of environments and data situations.

6.1 Concept and purpose of gap analysis

Over the last couple of decades, two distinct strands of 'gap analysis' have emerged in the literature and in practice. The first, institutionalized by the US Gap Analysis Program (Scott *et al.* 1993, Jennings 2000), assesses coverage of existing protected areas by comparing maps of land classes (e.g., Strittholt and Boerner 1995, Scott *et al.* 2001) and/or of (frequently modeled) species distributions (e.g., Peterson and Kluza 2003) with maps of land stewardship and management status. Percentage-based representation targets (e.g., 25% in Strittholt and Boerner 1995; 10% in Scott *et al.* 2001) are used to assess extent of coverage for each land class or species within existing protected areas.

The second strand of gap analysis has been largely driven through the Australian, South African and European systematic conservation planning literature (Pressey *et al.* 1993, Margules and Pressey 2000). It assesses priorities for establishing new protected areas that best complement existing networks. Explicit representation targets are established for the features that will be analyzed, then the existing protected areas are reviewed to assess how well they meet those targets; finally priorities for expanding the protected area network are identified to achieve the targets for all features. Priorities are established based on the principles of irreplaceability and vulnerability.

The framework for gap analyses presented in these guidelines has deep roots in both of these approaches, as described below. However, our framework has been developed to deal with the practical constraints in which most national and regional gap analyses take place (Box 16).

Box 16. Global gap analysis: an illustration of the risks in the assumptions made in 'classical' gap analyses

With so many published examples of gap analyses, it is reasonable to ask: is it worth developing and applying a new methodology? Here we use the recently published global gap analysis (Rodrigues *et al*. 2004a) to illustrate the oversimplified assumptions and risks inherent to most gap analyses.

Global gap analysis overview (for more details, see Rodrigues et al*. 2004a)*

The objective of the global gap analysis was to assess how well the global network of protected areas covered terrestrial vertebrate species, and to highlight priority regions for expanding the global network. The data used included GIS maps of protected areas and maps of extent of occurrence of vertebrate species.

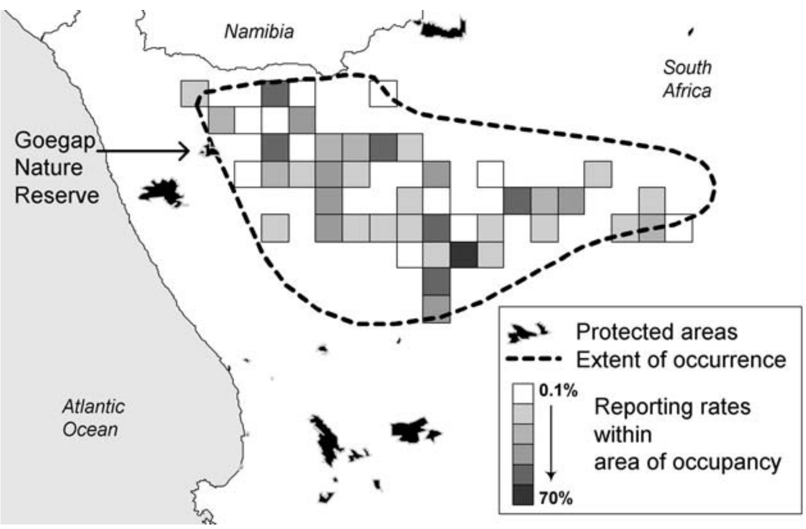
The first step of the methodology was to assess species coverage in the existing protected area network. Representation targets were defined for each species as the percentage of their range that must overlap with protected areas. The representation target varied between 100% (for species with very small ranges, < 1,000 km^2) and 10% (for widespread species, with ranges > 250,000 km^2). Species whose representation target was met by the existing protected area network were considered 'covered'; species that overlapped with no protected areas were considered 'gap species,' and species that overlapped with some protected areas but did not meet their targets were considered 'partial gaps.'

The second step was to identify priority regions for expanding the protected area network. The world's land area outside protected areas was divided into half-degree cells. The irreplaceability value of each of these cells was calculated (using the C-PLAN software) as the probability that the cell would be required as part of a final network in which all species meet their representation targets (Ferrier *et al.* 2000). The threat value of each unit was calculated as the weighted sum of the IUCN Red List categories of each species at each site (giving greater weight to more highly threatened species). Sites of simultaneously very high irreplaceability and very high threat were identified as priorities for expanding the global network of protected areas.

Why not use the results of the global gap analysis to provide guidance at the national/regional scale?

The global gap analysis is based on very simplified data for both protected areas and species, because these were the only data available at the global scale. It assumes a binary distinction between 'protected' and 'unprotected' areas: all areas mapped as protected are presumed effectively managed for conservation, such that all species are 'safe' inside them, while species are presumed to be at equal risk of loss in any region outside protected areas. In addition, species are presumed to be present throughout their mapped ranges and uniformly distributed such that they can be effectively protected in any section of their range.

Figure 18. The broad range polygon (extent of occurrence) mapped for the Red Lark (*Certhilauda burra*, VU) compared to field records across quarter-degree grid (area of occupancy; Harrison *et al.* 1997). Reporting rates correspond to the percentage of visits to each cell in which the species was seen, a proxy for relative abundance (Robertson *et al.* 1995). This reveals that the species is absent from a large part of its extent of occurrence, and that its abundance varies significantly among the quarter-degree cells where it does occur. Figure reproduced with permission from Rodrigues *et al.* 2004a. Copyright, American Institute of Biological Sciences.



Box 16 cont.

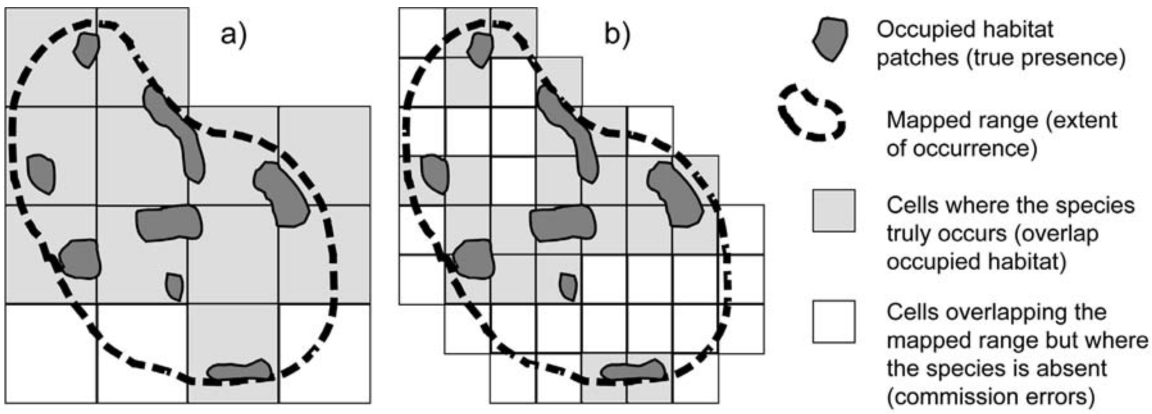
Reality is much more complex. Protected areas vary in their degree of legal protection, effective reinforcement, ongoing threats and pressures, and biological composition, and thus in their capacity to effectively protect the species that they hold (e.g., Singh 1999, WWF 2004). Unprotected areas also vary widely in the degree to which species in them are secure or at risk. Species are frequently absent from large parts within their mapped range, and within the areas where they do occur, they tend to vary significantly in abundance (Brown *et al.* 1995, Gaston 2003) (Figure 18).

Recognizing these limitations, the global gap analysis was developed to be meaningful at a coarse scale, useful in highlighting broad regions (e.g., Atlantic Forest, Western Ghats, etc.) as priorities for expanding the global protected area network, but not to provide guidance for the establishment of individual protected areas. Also, the results assumedly underestimate the extent of gaps in coverage, as a result of the data coarseness. Hence, it is not appropriate to 'zoom' into the results of this analysis to recommend site-level decisions.

What if a smaller spatial unit (e.g., 10 km cells) had been used instead of the half-degree cells?

Smaller spatial units would only make the results even less suitable for use at a local level. The coarse half-degree grid was selected to match the coarseness of the species data. When sub-dividing a generalized map of extent of occurrence into units, the odds are that the species will be absent from some of those units. These result in commission errors: places where the species is assumed to be when it is in fact absent. The finer the units used, the greater ratio of units where the species is absent, and hence the higher the level of commission errors made in recommending areas for conservation (Figure 19).

Figure 19. Effects of grid resolution in commission errors, when overlapping with a broad map of extent of occurrence. Without knowing where the species truly occurs, we assume species to be present at any cell overlapping the mapped range. The coarser the cell, the more likely that is to be true and the lower the frequency of commission errors. Hence, in (a) 3 out of 14 cells (21%) are commission errors, compared to 23 out of 48 cells (48%) in (b).



Why not simply improve the data and apply the same methodology to a national or regional gap analysis?

No matter how refined or reliable the data, the methodology of the global gap analysis still requires a binary distinction between protected and unprotected areas, and between places where the species is present and places where the species is absent; thus, it would still oversimplify the reality of conservation efforts and needs in any country or region. For example, many species would appear to be adequately protected even if they were only present in protected areas containing marginal habitat or in protected areas that are not effectively managed. Other species would appear to be major gaps even if they benefited from adequate conservation efforts outside official protected areas (e.g., in private reserves).

An additional concern with applying this methodology to any scale other than global is that it would not intrinsically take endemism into account and thus would not distinguish between local and global irreplaceability (Rodrigues and Gaston 2002). Software like C-PLAN (NSW NPWS 2001) or MARXAN (Ball and Possingham 2000, Possingham *et al.* 2000) would, by default, treat a site containing the single worldwide population of a species and a site containing a globally widespread species confined to a single site in the region as equally irreplaceable. Yet, the former is a much higher priority for conservation action than the latter.

Ana S.L. Rodrigues, Cambridge University

Benefits of a KBA-based gap analysis

- A KBA-based gap analysis starts with reliable data on species occurrence at sites, rather than broad generalizations (e.g., broad polygons of extent of occurrence or mapping across arbitrary grid cells) or inferred distribution (e.g., modeled data). This minimizes commission errors, where species are presumed protected in places where they do not occur.
- KBAs focus on those species that are most likely to need conservation investment: globally threatened species; species with restricted ranges; species that congregate; and bioregionally restricted species.
- KBA-based gap analysis encourages the use of the best information available (even if not in a standardized format) to prioritize those sites where conservation is likely to be more effective (i.e., sites with larger populations, higher abundance, better habitat, etc. for the trigger species).
- KBA-based gap analysis does not presume a binary distinction between protected and unprotected sites. Instead, it encourages the use of the best available information to understand the variations in site-based vulnerability (i.e., the probability that species will persist at a site). Conservation priorities are not defined simply as the sites that should receive legal protection but, more broadly, as the sites that require conservation action that best complements ongoing efforts (including reinforcing existing protected areas).
- KBA-based gap analysis explicitly recognizes that data are not perfect and will be continually improved. Rather than oversimplifying the data to the lowest common denominator (e.g., by using broad generalizations of species presence or protected area status), it clearly distinguishes between what is known and what is presumed, striving to make the best use of the available information, while highlighting priorities for improving it strategically.

Beyond a binary distinction between protected and unprotected sites

A straightforward overlay between KBAs and legally designated protected areas provides useful information as a first cut to a national or regional gap analysis (Box 17). However, the binary distinction between (legally) protected and unprotected areas assumed by most gap analyses is an oversimplification of conservation effort in any given region, and such an analysis is likely to overestimate the true degree of species representation and protection (Rodrigues *et al.* 2004a,b). Indeed, existing protected areas have been placed under a wide diversity of management regimes, from strict protection to multiple-use (IUCN and WCMC 1994, but see Locke and Dearden 2005). Irrespective of legal status, such protection often has little or no correspondence on the ground (Brandon *et al.* 1998). In contrast, some sites that are not legally considered part of a protected area network have a high level of effective protection (Bhagwat *et al.* 2005). Acknowledging this complexity, the framework proposed in these guidelines does not simply focus on expanding networks of legally protected areas but also on defining priorities to strengthen and consolidate existing networks. The term 'protected area' in these guidelines is not used in the narrow sense of a legally protected site, but in the broader one, defined by IUCN (1994), as "an area of land and/or sea especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means." This definition recognizes a diversity of tools for the *in situ* conservation of species, going beyond protected areas in the classical sense, to include other approaches, such as protection of sites by local and indigenous communities. Therefore, this framework does not assume that all KBAs should necessarily become protected areas in the strict sense but, rather, that appropriate site-level conservation measures should be put in place most urgently for the highest priority KBAs.

6.2 Basic principles behind the prioritization of KBAs for conservation action

While all KBAs are, by definition, global priorities for conservation action, not all KBAs are the same; some require conservation action more urgently than others. As explained in Chapter 3, prioritization is about deciding where conservation should be targeted *first*, and not which targets are dispensable. This section explains the main considerations for conducting a KBA-based gap analysis (expanding on the information already provided in Chapter 3). These include the principle of *complementarity*, on which gap analysis is intrinsically based, and the principles of *irreplaceability* and *vulnerability*, which underlie how we prioritize KBAs. The section also explains why it is necessary to distinguish between *site-based* and *species-based vulnerability* for prioritization purposes. Finally, it then considers how these principles interact with each other and with *conservation cost and opportunity* to determine what makes one KBA a more urgent priority for conservation action than another.

6.2.1 Complementarity

The complementarity principle has become a keystone of systematic conservation planning (e.g., Pressey *et al.* 1993, Margules and Pressey 2000). It determines the importance of a given site by the contribution it makes to a network. Following this principle, therefore, conservation decisions need to be made in the context of networks, rather than considering each site in isolation.

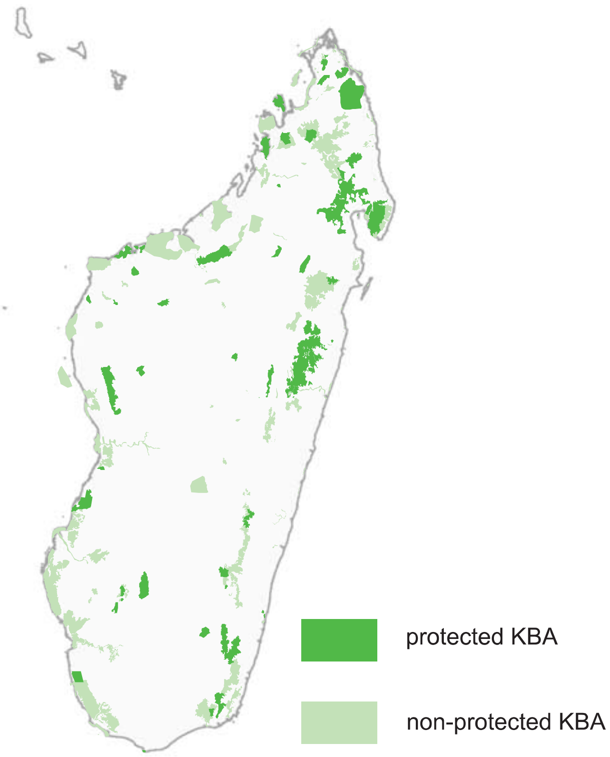
Box 17. Using KBAs to identify gaps in the protected area network of Madagascar

Building upon the previous work from priority-setting exercises (Hannah *et al.* 1998) and, more recently, the Important Bird Areas identified by the BirdLife International Madagascar program (Project ZICOMA 1999), Conservation International and other partners expanded this work in 2005 to identify KBAs across Madagascar. Using distributional data on globally threatened species of birds, mammals, amphibians, freshwater fish, reptiles and plants, 164 KBAs were identified, 50 of which were formally protected (Figure 20). The 50 KBAs held 290 out of 376 threatened species, leaving 86 threatened species existing wholly outside of formal protected areas.

During the Fifth World Parks Congress, the president of Madagascar, Marc Ravalomanana, made a declaration to increase the national protected area network from 1.7 million hectares to 6 million hectares. Based on this declaration, international experts, and national and governmental conservationists identified proposed conservation sites for these new protected areas.

Using the new proposed conservation sites and the existing protected areas, the analysis of KBAs and threatened species was updated, and concluded that 60 out of 86 previously unprotected, threatened species will likely be protected within 95 KBAs safeguarded by the creation of new protected areas. However, the remaining 26 threatened species have ranges across 19 KBAs outside of both existing and proposed protected areas. These species, mainly freshwater fish and amphibians, will require additional conservation attention, if they are to be formally protected.

Figure 20. Protected status of KBAs in Madagascar. Data provided by Madagascar Center for Biodiversity Conservation, Conservation International.



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Complementarity in ensuring representativeness

The complementarity principle was first applied to gap analyses to ensure that the sites selected to expand an existing protected area network best increased its overall representativeness. Hence, all else being equal, a site holding a species not yet represented in the network is considered to be a higher priority than a site holding species already covered. Measures of irreplaceability (see below) quantify the likelihood that a given site will help achieve a representative network (Pressey *et al.* 1994, Ferrier *et al.* 2000).

Complementarity in the timing of conservation actions

Because developing a comprehensive and effective protected area network takes time, and some sites and species have a higher probability of being lost before that process is finalized, it is not enough to consider only the relative species composition of each KBA. Species and site vulnerability (see below) must also be considered, along with irreplaceability, to guide the scheduling of conservation actions (Pressey and Taffs 2001).

Thus, to attain a representative network, gap analysis must incorporate information on both spatial options (i.e., irreplaceability) and temporal ones (i.e., vulnerability) for the conservation of each species.

Complementarity in relation to existing conservation efforts

Traditional gap analyses assume that all existing protected areas effectively safeguard the species they hold, and that building a network that complements existing conservation investment is simply a matter of identifying those sites that most urgently need to be declared protected as well. Reality is much more complex. Rather than assuming all protected areas as 'protected' and all other sites as 'unprotected', these guidelines propose that each KBA be analyzed individually to assess the level of effective conservation afforded to the species for which it was defined (i.e., the trigger species). Given that is a daunting task, we recommend that such assessment be done first for the KBAs of highest conservation urgency (Section 7.2), and that conservation action is implemented in these accordingly (Section 7.3).

Gap analyses as iterative processes

When the complementarity principle is applied to gap analyses, the relative priority of a given KBA can change depending on what happens to other KBAs. For example, a KBA will become a higher priority for conservation action if other populations of one of its trigger species were lost elsewhere (see discussion on irreplaceability, below). The relative priority of a KBA can also change depending on how much is known about other sites (e.g., if additional KBAs are defined for species they hold, a previously identified KBA may become a lower priority). Thus, a gap analysis based on complementarity needs to be iterative: the priorities should be updated as better information becomes available and as conditions change (Section 7.6). While complementarity is not explicitly incorporated into the guidelines for prioritization, it is implicitly included through the measurement of irreplaceability.

6.2.2 Irreplaceability

The concept of irreplaceability has already been described in Chapter 3, because it is intrinsic to the definition of KBAs. Nevertheless, it is reiterated here, because of its crucial role in gap analyses. The irreplaceability (or uniqueness) of a site is the degree to which spatial options for conservation are lost if the site and its biodiversity are lost (Pressey *et al.* 1994). Irreplaceability is based on a site's biological composition in relation to the biological composition of other sites.

High irreplaceability = few spatial options

A KBA has extreme irreplaceability if one or more of its species are totally confined to it and thus the KBA is the only option for protecting this species. For example, the Zapata Swamp in Cuba is the only known location for Cuban Crocodile *Crocodylus rhombifer* (EN; Ross 1998) and is therefore a site of extreme irreplaceability. The more options that exist for conserving a species, the lower the irreplaceability of the sites at which it occurs. All else being equal, a site with high irreplaceability is a higher priority for conservation action than one with lower irreplaceability.

Different importance of sites for species

KBA irreplaceability is estimated by a matrix of species presence or absence at each site. However, more precise information about the relative importance of each site for the conservation of each species can influence the relative value of KBA irreplaceability. For example, Tristan Albatross *Diomedea dabbenena* (EN) breeds on Gough and Inaccessible Islands, both Dependencies of the British Overseas Territory of St Helena (BirdLife International 2004a). These two islands would be considered equally irreplaceable for the conservation of this species if only presence data were available. However, 1,500 to 2,400 pairs breed annually on Gough, compared with only two or three pairs on Inaccessible. This information makes it obvious that the former site is much more irreplaceable than the latter, and, therefore, a higher conservation priority for Tristan Albatross.

'Temporary' irreplaceability

Some sites may be determined as irreplaceable because they hold a significant fraction of one or more species' entire population for a given duration rather than permanently. This includes not only species' congregations (e.g., for roosting or breeding) but also bottleneck sites, where a large fraction of the population may pass through (e.g., along a migratory route) over a relatively short period, even if few individuals co-occur at the site at any one time.

Irreplaceability value in relation to the rest of the world

The irreplaceability of a site for a species should be assessed in a global context, not simply in relation to a given country or region. Consider a species that occurs at only one KBA in the country or region of analysis. If the species is endemic to the country or region, this is a case of extreme irreplaceability: the loss of that single KBA would result in the global extinction of the species. If the species is widespread outside of the region, this is a case of national or regional rarity but low irreplaceability: there exist many options for conservation of the species outside the country or region.

6.2.3 Vulnerability

Vulnerability can be viewed as a measure of irreplaceability on a temporal (rather than a spatial) scale. High vulnerability means that conservation actions must happen quickly ("it's now or never") in order to be effective. Low vulnerability translates into plenty of time to implement a particular conservation action. Vulnerability interacts in a complex way with irreplaceability to define conservation priorities (see below). This is because there are, in fact, two types of vulnerability: *species-based* and *site-based* (which often, but not always, coincide):

- ***Species-based vulnerability*** is the probability that trigger species will become globally extinct. This type of vulnerability is frequently assessed using information on species' threat levels (e.g., Dobson *et al.* 1997b, Lombard *et al.* 1999), typically based on the global threat assessment (IUCN 2006) of the species.
- ***Site-based vulnerability*** is the probability that the population of a trigger species at a site will become extinct at a KBA. Strictly speaking, site-based vulnerability should be assessed for each species for which the KBA was defined (i.e., the trigger species), given that different species frequently have different likelihoods of local extinction within the same site (e.g., species may be differently targeted by hunting; Peres 2000). Frequently, however, site-based vulnerability is assumed to be similar for all species at each site (e.g., low at a site with intact habitat, high at a site with little natural habitat remaining), and assessed using variables of habitat loss, such as deforestation (Myers *et al.* 2000) or other measures of intensity of human pressure, such as human population density, or presence of roads (Sanderson *et al.* 2002). Also, it is frequently assumed that legally protected areas have low site-based vulnerability, although this is not necessarily so. These guidelines propose using more detailed information on threats to trigger species to assess site-based vulnerability at each KBA (Box 18).

These two measures of vulnerability may not always coincide. Indeed, a non-threatened species may have sites within its range where it is highly vulnerable to local extinction (i.e., low species-based vulnerability but high site-based vulnerability), while, conversely, a highly threatened species may have sites within its range where it is reasonably secure (i.e., high species-based vulnerability but low site-based vulnerability). It is important to distinguish between these two measures because they have different implications for conservation prioritization, particularly related to conservation cost and opportunity.

Conservation cost and opportunity

The cost of conserving a KBA is a measure of the difficulty of effectively ensuring the long-term persistence of the species that triggered its designation. Benefits that derive from conservation should also be taken into account (net benefits are benefits minus costs). 'Cost' is used here in a broad sense, to include the following aspects: a) financial costs/benefits, such as land value (some sites are more expensive than others; e.g., Ando *et al.* 1998) and income from park entrance fees; b) economic costs/benefits related to services and externalities, such as benefits of ecotourism development or the economic costs of higher human-wildlife conflict; c) economic opportunity costs/benefits, such as the opportunity cost of foregone land use if set aside for conservation; and d) social and political costs/benefits, such as the higher social conflict that may arise from the protection of some sites (Williams *et al.* 2003).

Conservation costs are determined by diverse factors and tend to vary widely across sites and regions (Balmford *et al.* 2003, Bruner *et al.* 2004). Furthermore, it is inversely related to opportunity: inexpensive places are typically easier to conserve. Pragmatic conservation is highly influenced by cost and opportunity. While this is unavoidable, these considerations should not be the main drivers of conservation action, as it would ultimately compromise the main objective of biodiversity conservation (Pressey *et al.* 1994). For example, an opportunity-driven approach is largely responsible for the current biases in protected area networks towards remote and infertile regions (e.g., Scott *et al.* 2001, Pressey *et al.* 2002), which are typically the easiest to protect but often not the most valuable from a biodiversity perspective (Balmford *et al.* 2001).

High site-based vulnerability is typically associated with high conservation cost

High site-based vulnerability is frequently associated with high conservation cost within a given region. For example, it is more difficult to create a protected area if land is highly valued for other uses such as agriculture or forestry (Pressey and Taffs 2001), or if local threats are expensive to mitigate (e.g., invasive species; Courchamp *et al.* 2003). But there are exceptions to this overall pattern, particularly when differences between countries are accounted for. For example, an area with low site-based vulnerability in a high-income country (say, a well protected meadow in England), is often more expensive to conserve than a high vulnerability area in a low-income country (e.g., a forest patch in Madagascar). Additionally, a site may currently have low site-based vulnerability because of a previous high investment in protection, but maintaining this favorable conservation status may be costly. For example, while the population of Hawaiian Goose *Branta sandvicensis* (VU) at Crater Hill, Kaua'i, is currently in good condition, its persistence depends on an ongoing program of control of invasive predators (USFWS 2004). Overall, though, within a particular region, there is typically a correspondence between high conservation costs and high site-based vulnerability.

High species-based vulnerability is not necessarily associated with high conservation cost

For species-based vulnerability, the relationship with cost is not straightforward. This is because the intensity of local threat often varies substantially across a species' range. At larger scales, it is still frequently the case that regions with more threatened species tend to be those more expensive to conserve. For example, the region of Brazil with the highest concentration of threatened species is the Atlantic Forest, where most of the country's human population lives and where land prices are the highest. However, prices of land are likely to vary substantially within each species' range, and sometimes the last areas where a species persists are less desirable for other forms of human use. For example, most remaining patches of Brazilian Atlantic Forest are in areas of steep slopes unsuitable for agriculture. Thus, some KBAs containing highly threatened species (high species-based vulnerability) may be areas under relatively lower threat (lower site-based vulnerability and lower conservation cost).

Higher species-based vulnerability corresponds to higher priority

Species at high risk of extinction have often already suffered extensive declines and should not be allowed to lose any more populations. This is particularly true of species with the higher threat levels (Critically Endangered [CR], followed by Endangered [EN], followed by Vulnerable [VU]). All else being equal, a site with higher species-based vulnerability is a higher priority for conservation action than a site with lower species-based vulnerability, because species with higher threat levels have fewer temporal options for their conservation.

Higher site-based vulnerability corresponds to higher priority only in the case of highly irreplaceable sites

While high irreplaceability and high species-based vulnerability both correspond to high priority for conservation action, high site-based vulnerability does not necessarily do so. Its effect on a site's conservation priority *depends* on whether there are other options for the protection of the trigger species, that is, on the site's irreplaceability. Where no or few spatial options exist, and all else is equal, conservation action is more urgently required for those sites with high site-based vulnerability, even if their protection is not easy. For example, a site that holds the last population of a species is a more urgent priority if it is about to be destroyed than if it is reasonably safe, even if in the former situation it is more expensive to protect.

Where numerous spatial options exist for the conservation of a species, but it is considered impossible to conserve all these sites, it will be best to focus on those that can be conserved at relatively low cost. For political or social reasons, lower conservation cost will often (though not always) correspond to lower site-based vulnerability.

Why different standards for site-based vulnerability and species-based vulnerability? Because a site can potentially be replaced with another site, but a species cannot be replaced by another species. If the conservation of a site comes at a high cost (land purchase value, human conflict, etc.) *and* if there is an option for protecting the same set of species at another site of lower cost, then it is a better strategy to take advantage of the opportunity provided by the site of lower cost.

6.3 Proposed guidelines for setting priorities for conservation action based on irreplaceability, species-based vulnerability, site-based vulnerability and conservation cost/opportunity

The criteria used in prioritization depend significantly on the purpose of the exercise (i.e., on what one is prioritizing for). In these guidelines, the aim of prioritization is to identify globally important sites where conservation action, broadly defined, is most urgently needed, to strengthen the ability of networks of protected areas to secure the long-term persistence of species. The overall goal, therefore, is to minimize species extinctions: other conservation aims are possible and would require different prioritization systems. As outlined above, conservation action becomes more urgent and has less scope for compromise and flexibility when there are fewer spatial and/or temporal options. When there are alternatives, however, these should be explored, to avoid high conservation costs and conflicts and make the best use of opportunities.

The different factors that should be considered are broadly hierarchical in how they should be applied. However, the order in which they should be applied differs depending on whether sites have high or low irreplaceability. The first factor to consider is *irreplaceability*: sites of high irreplaceability are typically higher priorities than sites of low irreplaceability, because there are fewer spatial options for conserving their trigger species. Second, *species-based vulnerability* should be considered. Sites of high species-based vulnerability should be considered higher priorities than sites of low species-based vulnerability, because species that are more highly threatened need conservation action more urgently (i.e., there are fewer temporal options). Third, *consider site-based vulnerability*. Sites of high site-based vulnerability should be considered before sites with low site-based vulnerability, because such sites require urgent conservation action to prevent the irreversible loss of irreplaceable biodiversity elements. *Conservation cost* should be the last factor considered when prioritizing among sites of high irreplaceability. If several sites have equally high irreplaceability and equivalent species-based and site-based vulnerability, the site with the lowest conservation cost (or highest opportunity) should be the highest priority for conservation action.

Among KBAs of lower irreplaceability, site-based vulnerability is much less important. Where there are many spatial options for conserving the KBA trigger species, conservation cost and opportunity become more important factors to consider.

Sites that have either extremely high or extremely low values for all three criteria of irreplaceability, site-based vulnerability and species-based vulnerability are straightforward to prioritize (they fit into the highest and lowest priority levels, respectively). However, prioritizing sites that have intermediate values is more challenging. The next chapter provides practical guidance for prioritizing sites in a KBA-based gap analysis.

7. Conducting a KBA-based gap analysis and prioritization

This chapter presents a practical method for defining levels of priorities among KBAs in a given country or region, based on the principles of irreplaceability and vulnerability. It also discusses the main types of conservation action that can be recommended through a gap analysis followed by a discussion of how research priorities can be integrated into the gap analysis framework. Finally, it makes recommendations for organizing the information produced from a gap analysis into outputs to guide decision-making.

As explained in section 6.1, these guidelines present gap analysis as a strategy for achieving comprehensive, representative and effectively managed networks of protected areas by identifying priorities for a) strategic expansion of existing protected area networks; b) strengthening and consolidation of existing protected area networks; and c) filling the gaps in information required to inform a) and b).

In practice, this is done in a three-step process:

1. KBAs are assigned to different priority levels for action, on the basis of irreplaceability, species vulnerability and site vulnerability.
2. Within each priority level, the existing protection status of KBAs (legal as well as practical) is analyzed to determine what conservation measures are the most appropriate.
3. Research priorities for filling in the most important gaps in knowledge are identified.

Other factors or criteria may need to be incorporated into a KBA prioritization exercise, if the goals vary from those outlined above.

7.1 Data requirements for KBA-based gap analysis

Dealing with data of variable quality

These guidelines acknowledge that data quality is highly variable, not only across regions but also between sites and species within given regions. Requiring data to be of consistently good quality would make any guidelines inapplicable to most regions in the world, including most regions where conservation action is most urgent. On the other hand, requiring data to be harmonized by simplifying it to the lowest common denominator would mean disregarding better data where they do exist and would produce lower-quality results. Instead, these guidelines were developed to be applied with limited data, but to make use of better quality data wherever and whenever they become available.

Dealing with incomplete knowledge

These guidelines also explicitly acknowledge that, while we lack complete information on biodiversity distribution, status and conservation needs, conservation decisions must be made urgently. They thus aim to use existing knowledge to set clear priorities for conservation action, at the same time prioritizing research efforts to fill gaps in knowledge, and iteratively integrate new information into priority-setting for conservation action. Because the guidelines propose explicit criteria for assigning sites to different priority levels, the results can easily be updated on a site-by-site basis, as new information is obtained.

This section presents the data requirements necessary to apply the guidelines for prioritizing KBAs outlined in Section 6.2. Below, the 'ideal dataset' is compared with a likely 'real life dataset'. The former is presented as a standard that conservationists should ultimately try to obtain. The latter illustrates the data typically available, how they relate to the ideal dataset, the assumptions made when using them, and how they can be improved.

In order for the guidelines to be widely applicable and to allow for the integration of changing knowledge, the guidelines extend beyond more simplified approaches to gap analysis. The guidelines require a good understanding of the data used for gap analysis, of the assumptions that need to be made whenever data are not ideal, and of the implications of such assumptions for informing conservation practice.

7.1.1 The 'ideal' dataset and the 'real-life' dataset

This section outlines the dataset that should be compiled for a KBA-based gap analysis.

1. Documented occurrence of species per KBA

- ***Ideal:*** Reliable knowledge of where each KBA trigger species occurs and where it does not. This is important for understanding site irreplaceability: the spatial options for the conservation of each species.
- ***Real-life:*** Best-available knowledge of where each species occurs. In a real-life dataset, two types of error may occur in this information: species listed in places

where they do not truly occur (i.e., commission errors); and species not yet reported from sites where they actually occur (i.e., omission errors). Rigorous application of the KBA criteria, which require confirmed rather than suspected presence of trigger species (Section 5.2.1), should minimize commission errors. In the short term, minimizing omission errors requires compiling the most reliable knowledge available. In the longer term, strategic fieldwork may be required to fill the gaps in knowledge (Section 7.4).

2. KBA delineation

- ***Ideal:*** Delineated boundaries for all KBAs.
- ***Real-life:*** Delineated boundaries for most, if not all, KBAs.

3. Relative importance of each site for the species

- ***Ideal:*** A quantification of the relative importance of each site for the conservation of each species. This is likely obtained from information on the total population size of each species at each site, as well as habitat suitability and extent. This information would enable a better understanding of site irreplaceability.
- ***Real-life:*** Information on the relative value of sites for species. If the only data available are on species presence at each KBA, assume that all sites where a species occurs are equally valuable for its conservation. In some cases, this may be reasonable, while in others it may fail to recognize the disproportionate importance of particular sites for a species, and, thereby, distort assessment of irreplaceability. One or both of the following approaches can be used to obtain information on the relative value of sites for a species:
    - KBA size – Assume that larger KBAs support larger populations of a given species and, hence, are more important for its conservation.
    - Local abundance – Evaluate at which sites species are likely to be more abundant. Frequently, species are distributed across their range in such a way that they have peaks of abundance at a few sites but are relatively rare at most others (Brown *et al.* 1995, Gaston 2003). Protecting those peaks of abundance increases the species' probability of persistence over time (Rodrigues *et al.* 2000). Ideally, use field information on species' relative abundance at different sites. In some cases, population censuses are available, particularly for congregatory species (e.g., Perez-Arteaga *et al.* 2002). Other sources of information are reporting rates (e.g., Harrison *et al.* 1997); habitat modeling, which may predict abundance in poorly known areas (e.g., Hansen and Rotella 2002); and finally, a qualitative assessment based on the field experience of experts.

4. Site-based vulnerability

- ***Ideal:*** An estimate of the likelihood of persistence of each species at each site or, conversely, the probability of local extinction of each species at each site. This would require an assessment of current and future threats to each site and how they interact with existing management effectiveness and with each species' ecological requirements. Ideally, assessments of the probability of local extinction of each population at each site under the current or predicted future management regime would be available (e.g., Ball *et al.* 2003). This information would provide an estimate of site-based vulnerability and, hence, an understanding of the temporal options for the conservation of the species at each site.
- ***Real-life:*** Protected status of KBAs (e.g., using the World Database on Protected Areas; WDPA Consortium 2004). If this is the only information available, one must assume that species are well protected (high probability of long-term persistence) in KBAs that are covered by existing protected areas and badly protected otherwise. This binary distinction risks misrepresenting the true picture of site-based vulnerability. Simple methodologies for assessing site-based vulnerability are already in use (see e.g. Box 18) and can be helpful in ranking sites. Where it is not possible to apply a consistent framework like the one in Box 18, relative site-based vulnerability could still be assessed via:
    - Information on existing pressures at each site, for example ongoing deforestation rates or human density inside and around the site (again, satellite imagery may prove useful; e.g., Bruner *et al.* 2001, Saatchi *et al.* 2001).
    - Projected pressures, for example due to predicted road construction (e.g., Laurance *et al.* 2001), agriculture/forestry suitability (e.g., Pressey and Taffs 2001), or mining concessions.
    - The main ecosystem at the site. This can be a good proxy for site-based vulnerability, because certain ecosystems (e.g., coastal, riverine, lowland evergreen forest, etc.) are typically more suitable for human activities and conversion to other land-uses, and thus tend to face higher threats, than others (e.g., montane forest, alpine habitats, etc.). Data on rates of decline of different ecosystems may be available, or could be derived, to help provide an objective basis for such an assessment.
    - Information on the degree of legal protection (strict protection vs. multiple use, what type of

activities are authorized, etc.), and management effectiveness (e.g., existence of management plans, staff, budget; Ferreira *et al.* 1999).

- Information on ongoing conservation action at the site and/or for individual species (e.g., conservation projects by local NGOs).

5. Species-based vulnerability

- ***Ideal:*** A quantification of the overall extinction risk of each species according to the IUCN Red list, through the combination of information on existing population levels, trends, threats, ongoing conservation action, and ecological characteristics and requirements. This would provide information on species-based vulnerability and, hence, an understanding of the temporal options for the conservation of each species. Accurate quantitative assessments of species' viability typically require much more detailed information on demographic, ecological and behavioral data on each species (e.g., Sommer *et al.* 2002).
- ***Real-life:*** The conservation status of species. The IUCN Red List provides information on species' threat level (a broad categorization of extinction risk), the criteria used to assign this threat level (declining population, small range size, etc.), population trends, and main threats to the species.

6. Proportion of species' population in country or region

- ***Ideal:*** An assessment of the proportion of each species' population in the country or region of analysis. This is important to access the irreplaceability of each KBA at the global level, distinguishing between species that are locally rare but globally common and species that are globally rare.
- ***Real-life:*** Endemism of the species or the fraction of each species' range inside the country or region being analyzed. This can be used as an approximation of the fraction of the global population in the country or region. For many terrestrial vertebrate species, this is relatively easy to estimate using information on global distributions (e.g., Ridgley *et al.* 2003, Patterson *et al.* 2003). For other species, a coarse distinction between species that are endemic, species that are not endemic but mainly restricted to the country or region of analysis, and species that occur mainly outside the country or region can be made.

7. Conservation costs

- ***Ideal:*** An estimate of the costs of conservation action at each site. Costs should be defined broadly, to take into account direct financial costs (e.g., costs of land acquisition, establishment of management structures, etc.), opportunity costs (e.g., economic costs incurred through not developing the site for alternative uses, such as forestry, agriculture, mining, etc.) and social/political considerations (e.g., potential for higher social conflict, depletion of political capital for future conservation initiatives, etc.).
- ***Real-life:*** Expert opinion on conservation costs at each site. Synthesising information on financial costs, opportunity costs and, in particular, social/political considerations at each site can be challenging, but in many cases, local conservationists will have an opinion (based on personal experience or anecdotal information) on how difficult or easy it is to work in certain areas, and why. Capturing this information in some qualitative way (high, medium and low conservation cost) may prove useful in establishing priorities for conservation action across sites.

As with KBA identification, all assumptions should be clearly documented.

7.1.2 Organizing the data for a gap analysis

The basic data needed for a gap analysis can be organized into a data matrix in the following way (Appendix 3):

a) Start with an initial matrix of trigger species per KBA using a spreadsheet or relational database. Candidate KBAs (those sites for which there is low confidence that any trigger species is present; Section 5.2.1) should be excluded. At very least, code each species-site combination with 1/0, to indicate presence/absence. However, use more precise codes if more information is available (see example in Appendix 3), such as:
   - Data on the population of each species at each site (e.g., if it is known that, for a given species, 200 individuals congregate at one site and 10 at another). If information on the global population is available or can be estimated, indicate the percentage of each species' global population at each site.
   - If population data are not available, data on the extent and condition of suitable habitat for species across sites can be used to estimate the percentage of the global population of each species at each site, using the following broad categories: < 1%; 1–10%; 10–95%; and ≥95%.
   - For the least-known species, distinguish, if possible, the sites where the species is 'present' from those where it is 'probably present'.

b) For each species in the data matrix, indicate:
   - The IUCN Red List category (this corresponds to the categories of extreme, high, medium and low species-based vulnerability in Table 4).

- The number of KBAs where it occurs in the country or region of analysis.
- The degree to which the species is restricted to the country or region of analysis. At a minimum, distinguish between endemic and non-endemic species; if possible, indicate the proportion of the species' global range, or preferably, its global population that falls inside the country or region of analysis.

c) For each KBA in the data matrix, indicate:

- An estimate of site-based vulnerability. At very least, distinguish between whether each site has legal protection or not. If possible, give more specific information on site-based vulnerability, even if only on a qualitative scale (e.g., low, medium and high vulnerability). Ideally, more detailed information on site-based vulnerability per species should be recorded, indicating the degree of site-based vulnerability for each species (Box 18).
- Indicate conservation cost for each site, at least qualitatively, if possible (e.g., low, medium and high cost). Ideally, finer information on conservation cost per species at each site should be recorded.

With these data, one can assign each KBA to a priority level as defined in the following section, as well as determine which sites within each level require most urgent conservation action. Appendix 3 illustrates a way to organize the information in order to facilitate assigning KBAs to priority levels. For a relatively small dataset, the analysis can be done by hand, but for a larger dataset it may be useful to use queries in a relational database (e.g., through MS Access). For a really large dataset, the help of an expert in database management may be in order.

7.2 Proposed framework for assigning KBAs to different levels of priority for conservation action in gap analyses

This section proposes a five-level classification for defining priority levels among KBAs for conservation action. KBAs assigned to the highest level (1) are the most urgent priorities, while KBAs with successively lower priority levels (2 to 5) are successively less urgent priorities. It is important not to forget that this is an exercise in prioritization among priorities: KBAs are already a set of globally important sites that have been selected because of their irreplaceability and/or species-based vulnerability. This approach builds conceptually on the methodology developed by the BirdLife partnership in Africa to set priorities for action among IBAs (Bennun and Njoroge 1999, Ngeh 2002), in which sites are prioritized based on the importance of the site for biodiversity (a combination of irreplaceability and species-based vulnerability) and the level of threat at each site (equivalent to site-based vulnerability in these guidelines).

This framework requires testing in a range of habitats and across biomes (i.e., terrestrial, freshwater, marine). The prioritization guidelines will doubtlessly be refined as experience in applying them in a range of situations is obtained.

General rationale for the priority levels

The general rationale for the priority levels defined is that the highest priority corresponds to the extremes of high irreplaceability, high species-based vulnerability and high site-based vulnerability (i.e., sites supporting species with the fewest spatial and temporal options for their conservation). Progressively lower priorities are assigned for combinations of intermediate levels of irreplaceability and/or species-based vulnerability, and lowest priorities are assigned to sites with relatively low irreplaceability and species-based vulnerability (i.e., sites supporting species with the most spatial and temporal options for their conservation). As discussed in Section 6.3, site-based vulnerability is only incorporated into prioritization before opportunity and cost for highly irreplaceable sites. The criteria proposed for allocating a site to a particular priority level are such that they are scale-independent and globally consistent: given the same data, KBAs would be assigned to the same priority levels in a gap analysis at the global, regional, national or sub-national scale.

Prioritization should be sequential

Assigning sites to a particular priority level, as described below, should be done sequentially: sites should be assigned to the highest level they trigger. For example, if a site has an endemic CR species that occurs nowhere else and is highly vulnerable at the site (triggering Priority Level 1), then the site will remain Priority Level 1 regardless of any other species that occur at the site that may trigger a lower priority level. This can be thought of as a multiple-threshold approach: all sites are first subjected to a higher threshold (more demanding criteria) to assess if they fit within Priority Level 1; they are then subjected to progressively lower thresholds to evaluate to which priority levels they belong. This type of approach (similar to that applied by the IUCN Red List of Threatened Species), while employing similar criteria, is different from the BirdLife scoring approach mentioned above, in which each site is given points based on a set of criteria, all points are added, and sites are then ordered according to their overall cumulative score (e.g., Bennun and Njoroge 1999).

The boundaries between levels are subjective but the highest conservation priorities are frequently obvious

Although it is easy to distinguish the highest priorities for conservation action (such as sites with highly threatened single-site endemics) from lower level priorities (sites with relatively widespread, non-threatened species), ranking sites of intermediate levels of irreplaceability and vulnerability becomes a matter of judgement. For example, it is not obvious whether sites of very high irreplaceability but medium species-based vulnerability should be of higher, lower or equal priority compared with sites of medium irreplaceability but high species-based vulnerability. Difficulty in defining clear boundaries for lower-level priorities should not prevent the identification of (and conservation action for) the highest priority sites.

Species' levels of endemism

As discussed above, it is critical to distinguish species that are endemic to the country or region where the gap analysis is being undertaken from those that are not. The conservation of the former must be ensured in that particular country or region, while there are other spatial options for the conservation of the latter. In these guidelines, an explicit distinction is made between species considered 'endemic' (≥ 95% of their global range inside the country or region of analysis) and those that are not.

Variable distribution across a species' life history

All criteria defined below apply to any of the stages of a species' life history. For highly mobile species (e.g. those with distinct ranges for breeding and non-breeding periods, or for juveniles and adults), the definition of endemism applies to any segment of their life history. Thus, for these purposes, Baikal Teal *Anas formosa* (VU) is considered endemic as a breeding species to Russia, since it nests solely in Siberia, even though it has a non-breeding range that includes areas of Mongolia, North Korea, South Korea, Japan and China (BirdLife International 2004a).

7.2.1 Criteria for assigning KBAs to different priority levels

KBAs are assigned to different priority levels based on criteria of irreplaceability, species-based vulnerability and site-based vulnerability. These criteria are applied to each species-site combination (i.e., to each trigger species at each site); and each site is assigned to the highest priority level it triggers. This is broken down into four steps, as outlined below, for each species-site combination: 1) assign an irreplaceability score, 2) assign a species-based vulnerability score, 3) assign a site-based vulnerability score, and 4) assign a priority level. Details on how to apply the criteria using the data matrices are given in Appendix 3.

Step One: Assign an irreplaceability score

Each species-site combination is assigned an irreplaceability score, ranging from 'low' to 'extreme'. However, it should be noted that 'low' in this context is a relative term. A site can qualify as a KBA under the irreplaceability criterion (i.e., because it holds 1% of the global population of a species) but fall into the 'low' irreplaceability category for prioritization purposes. It is important to stress that this is an exercise in prioritizing among sites that are global priorities for conservation. Assigning KBAs to different irreplaceability scores simply recognizes that there are fewer spatial options for conserving some species than others.

The criteria used to assign irreplaceability scores for prioritization purposes depend upon whether data on the proportion of the global population are available for the species at the site ('population data' scenario) or only data on presence/absence ('no population data' scenario; Table 3).

Table 3. Criteria used to assign irreplaceability scores to species-site combinations. Note that for a particular region or country, one is likely to have a 'no population data' scenario for some species and sites and a 'population data' scenario for others.

Irreplaceability score	'Population data' scenario	'No population data' scenario
Extreme	Sites known or inferred to hold ≥ 95% of the global population of a species	Sites holding a species endemic to the country/region that is not known to occur at any other site
High	Sites known or inferred to hold ≥ 10% but < 95% of the global population of a species	Sites holding a species endemic to the country/region that is only known to occur at 2–10 sites OR Sites holding a species that globally is only known to occur at 2–10 sites
Medium	Sites known or inferred to hold ≥ 1% but < 10% of the global population of a species	Sites holding a species endemic to the country/region that is only known to occur at 11–100 sites OR Sites holding a species that globally is only known to occur at 11–100 sites
Low	Sites known or inferred to hold < 1% of the global population of a species	Sites holding a species endemic to the country/region that occurs at more than 100 sites OR Sites holding a species that globally is known to occur at more than 100 sites

Table 4. Criteria used to assign species-based vulnerability scores to species-site combinations.

Species-based vulnerability score*	Global threat status
Extreme	Critically Endangered (CR)
High	Endangered (EN)
Medium	Vulnerable (VU)
Low	Near Threatened (NT), Least Concern (LC)

*Data Deficient (DD) species are excluded because, by definition, their threat status is unknown. DD species are research priorities rather than conservation priorities.

Step Two: Assign a species-based vulnerability score

Next, each species-site combination is assigned a species-based vulnerability score, based on the global threat status of the species, following the IUCN Red List (Table 4).

Step Three: Assign a site-based vulnerability score

Next, each species-site combination is assigned a site-based vulnerability score of 'high', 'medium' or 'low' based on the risk of the species being extirpated from the site. If information is available, a separate site-based vulnerability score should be assigned to each species at each site. If only a general assessment of site-based vulnerability is available, the score for the site as a whole should be assigned to each species-site combination. If no information on site-based vulnerability is available, each species-site combination should be assigned a site-based vulnerability score of 'medium'.

Box 18 outlines one methodology for evaluating site-based vulnerability of KBAs, based on the work of the BirdLife Partnership in Africa, which relies on a site-by-site assessment of the timing, scope and severity of current threats. Current site-based threats can also be assessed by analyzing trends in satellite imagery which, by using a systematic and objective process across a country or region, can reveal extent and rate of habitat loss within KBAs. For other threats such as invasive species and hunting, however, it may be more difficult to measure them consistently at a national or regional scale. Future site-based vulnerability can be estimated by determining relationships between current threats and the direct and indirect drivers of those threats (e.g., demographic changes, infrastructure development), which may be best accomplished through modeling of potential future scenarios (Noss *et al.* 2002, Carroll *et al.* 2003).

Box 18. Methodology for assessing site-based vulnerability for IBAs

BirdLife International has developed a standard methodology for assessing site-based vulnerability at Important Bird Areas (IBAs) refined through experience gained by IBA monitoring initiatives in Africa and elsewhere (BirdLife International 2006). The methodology also adopts a refined list of threat classes, simplified from the IUCN Threats Authority File used in Red List assessments of pressures affecting species, in order to harmonize the two systems.

Threat classes

For each IBA, the first step is to identify all threats affecting the trigger species and/or their habitats. Threats are selected from the following list of standard threat classes:

Agricultural expansion and intensification
Annual crops
– Shifting agriculture
– Small-holder farming
– Agro-industry farming
Perennial non-timber crops
– Small-holder plantations
– Agro-industry plantations
Wood and pulp plantations
– Small-holder plantations
– Agro-industry plantations
Livestock farming and ranching
– Nomadic grazing
– Small-holder grazing, ranching or farming
– Agro-industry grazing, ranching or farming
Marine and freshwater aquaculture
– Subsistence/artisanal aquaculture
– Industrial aquaculture

Residential and commercial development
Housing and urban areas
Commercial and industrial areas
Tourism and recreation areas

Energy production and mining
Oil and gas drilling
Mining and quarrying
Renewable energy

Transportation and service corridors
Roads and railroads
Utility and service lines
Shipping lanes
Flight paths

Over-exploitation, persecution and control of species
Direct mortality of 'trigger' species
– hunting and trapping
– persecution/control

Box 18 cont.

Indirect mortality (bycatch) of 'trigger' species
- hunting
- fishing

Habitat effects
- hunting and trapping
- gathering plants
- logging
- fishing and harvesting aquatic resources

Human intrusions and disturbance
Recreational activities
War, civil unrest and military exercises
Work and other activities
Natural system modifications
Fire and fire suppression
Dams and water management/use
Other ecosystem modifications
Invasive and other problematic species and genes
Invasive alien species
Problematic native species
Introduced genetic material
Pollution
Domestic and urban waste water
Industrial and military effluents
Agricultural and forestry effluents and practices
Garbage and solid waste
Air-borne pollutants
Noise pollution
Thermal pollution
Light pollution
Geological events
Volcanic eruptions
Earthquakes/tsunamis
Avalanches/landslides
Climate change and severe weather
Habitat shifting and alteration
Drought
Temperature extremes
Storms and floods
Other

Threat status

The next step is to assess the severity of each threat class at each KBA. Each threat is assigned an impact score derived from assessments of its timing, scope and severity. Where information allows, this process may be applied to each trigger species separately, in order to produce separate assessments of site-based vulnerability for individual species-site combinations.

Scores for timing, scope and severity are as follows; in most cases these scores will be based on informed estimates, rather than quantitative data:

Timing of selected threat

3 Happening now
2 Likely in short term (within four years)
1 Likely in longer term (beyond four years)
0 Past (and unlikely to return) and no longer limiting

Scope of selected threat

3 Whole population/area (> 90%)
2 Most of population/area (50–90%)
1 Some of population/area (10–49%)
0 Few individuals/small area (< 10%)

Severity of selected threat

3 Rapid deterioration (> 30% over ten years or three generations, whichever is longer)
2 Moderate deterioration (10–30% over ten years or three generations)
1 Slow deterioration (1–10% over ten years or three generations) or large fluctuations
0 No or imperceptible deterioration (< 1% over ten years)

Scores are then summed to calculate the impact score (i.e., impact = timing + scope + severity). However, any threat for which the timing, scope and/or severity score is 0 is assigned an impact score of 0. This means that the impact score never has the value 1 or 2. The threat with the highest impact score, whether to the site, or to trigger species if individually assessed, is taken as the impact score for the site/species (applying the 'weakest link' approach).

The impact score can be converted to an assessment of site-base vulnerability as follows:

Impact score	***Site-based vulnerability***
8–9	High
6–7	Medium
0–5	Low

Lincoln Fishpool and Leon Bennun, BirdLife International

Step Four: Assign a priority level to each species-site combination

Finally, a priority score is assigned to each species-site combination based on the three criteria, and each site is assigned to the highest priority level it triggers (Table 5). Guidelines for analyzing the species-site matrix, in order to determine which priority level a given site falls into, are given in Appendix 3.

The criteria of conservation cost, benefits and opportunities have not been used to define the priority levels, and hence are not incorporated into Table 5, because these will be determined by the type of conservation action required or recommended for the site. Costs and benefits obviously depend on the type of conservation action proposed; for example, the cost of monitoring a site is likely to be very different from the cost of strengthening conservation at a site. Once sites are allocated to priority levels, the next step is to identify what conservation actions are needed and estimate their costs/benefits and opportunities (Section 7.3). This information can then be used to prioritize KBAs within priority levels (Section 7.2.3).

Sites with extreme irreplaceability for CR or EN species are the highest priorities for conservation action; identification and protection of these sites is the aim of the Alliance for Zero Extinction (Box 19).

Provided that global threat assessments have been conducted for most trigger species, the following combinations of criteria are very unlikely to arise:

- ***Extreme irreplaceability–low species-based vulnerability–high site-based vulnerability***: Any species restricted to a single site globally (extreme irreplaceability) and facing a high risk of extirpation from that site (high site-based vulnerability) would qualify as globally threatened (medium species-based vulnerability or higher), based on IUCN Red List Criterion B. These situations most likely reflect a time-lag in uplisting the species to a higher threat category.
- ***Extreme irreplaceability–extreme (or high) species-based vulnerability–low site-based vulnerability***: Any CR or EN species (extreme or high species-based vulnerability) restricted to a single site globally (extreme irreplaceability) would be expected, on the basis of its global threat status, to be facing a high risk of extirpation from the site (high site-based vulnerability). The few exceptions to this rule are discussed further below.

Table 5. Matrix used to assign priority scores to species-site combinations. The numbers in the table correspond to priority level, with 1 indicating highest priority.

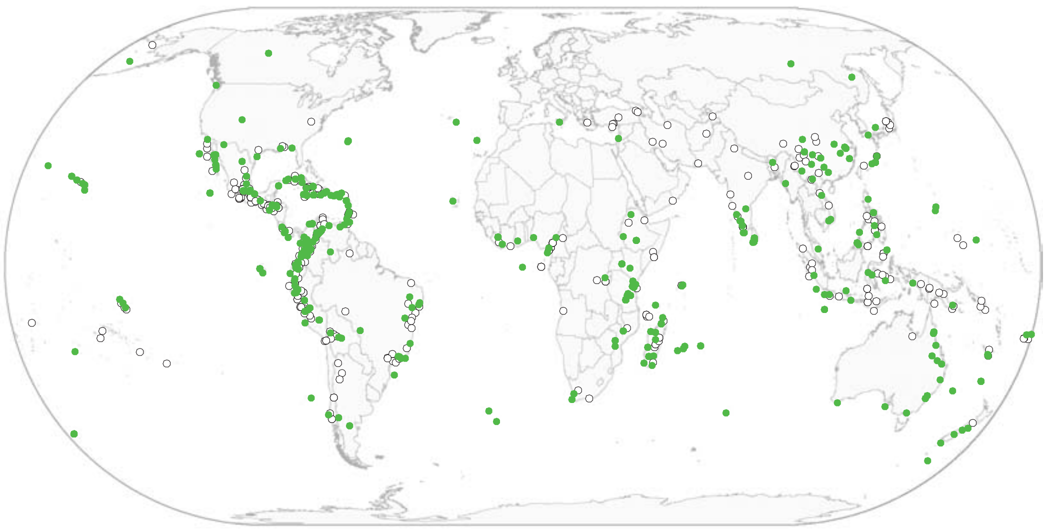
Irreplaceability	Species-based vulnerability	Site-based vulnerability		
		High	Medium	Low
Extreme	Extreme	1	1	1
	High	1	1	1
	Medium	2	3	4
	Low	3	4	5
High	Extreme	2	2	3
	High	2	3	4
	Medium	3	4	5
	Low	4	5	5
Medium	Extreme	3		
	High	4		
	Medium	5		
	Low	5		
Low	Extreme	4		
	High	5		
	Medium	5		
	Low	5		

Box 19. Alliance for Zero Extinction sites

Within the broader set of KBAs, there exists a particularly sensitive subset of sites: those known to hold the remaining populations of CR or EN species. These sites, where policy-makers and managers must take immediate action to conserve threatened and irreplaceable biodiversity, represent the most urgent site-scale priorities. The identification and conservation of these sites are the goals of the Alliance for Zero Extinction (AZE), a partnership of more than 60 international, regional, national and local non-governmental conservation organizations. Vulnerability, irreplaceability and the discreteness of site boundaries have to be strictly incorporated to pinpoint these sites where imminent species extinctions may occur if action is not taken now.

To date, AZE has identified close to 600 sites globally for birds, amphibians, reptiles, mammals and conifers (Ricketts *et al.* 2005; Figure 21). To help target sites requiring immediate attention, AZE has assessed the protection status of these sites, revealing that many are unprotected or have only partial protection. The overwhelming message of AZE is one of urgency: these sites are not the only places where action is needed to conserve biodiversity but they are the first places where conservationists need to act to prevent impending global extinctions - the tip of the iceberg for the global extinction crisis.

Figure 21. Map of the 595 AZE sites, the single remaining locations for species at risk of imminent extinction. Sites depicted as solid circles are either fully or partially contained within declared protected areas (n = 204 and 86, respectively), while sites shown as open circles are completely unprotected or have unknown protection status (n = 257 and 48, respectively). In areas of overlap, unprotected sites are mapped above protected sites, to highlight the more urgent conservation priorities. Data provided by the Alliance for Zero Extinction.



AZE is open to any non-governmental group that has biodiversity conservation as a primary mission. The members of AZE call on the global conservation community to work in partnership to protect Earth's species, and stress that one important way to prevent imminent extinctions is to fully safeguard all AZE sites as rapidly as possible.

Michael Parr, American Bird Conservancy

7.2.2 Summary of priority levels

This section summarizes the priority levels depicted in Table 5 and provides their rationale.

Priority Level 1 sites

The extreme irreplaceability of these sites means that their loss would be expected to result in the global extinction of at least one species. Their extreme or high species-based vulnerability indicates that these sites hold species that are already under great threat and with a very high probability of extinction. As described in the KBA prioritization framework (Section 6.3), site-based vulnerability translates into higher conservation priority for sites of higher irreplaceability. For Priority Level 1, however, an explicit departure from this framework is being made, to place all AZE sites (Box 19) exclusively in Priority Level 1, regardless of their site vulnerability. This is being done for two main reasons:

- The combination of extreme irreplaceability, extreme (or high) species-based vulnerability, and low or medium site-based vulnerability necessarily represent a small fraction of sites. Most sites of extreme irreplaceability for CR or EN species will likely have high site-based vulnerability; otherwise, the species restricted to them would not be listed as highly threatened. Without appropriate action, extinction of these species is imminent. The few exceptions are likely to result from the following:

a) The CR or EN species is listed as threatened because of an extremely small population size (50 or 250 total individuals, respectively) with no apparent threats to the site, triggering the D criterion of the IUCN Red List only. As these guidelines promote an expanded definition of conservation action appropriate for KBAs (Section 7.3), a site holding the global population of a species comprising only 50 or 250 individuals is arguably an urgent global conservation priority for monitoring (at least), to determine whether the species indeed begins to decline.

b) The species is restricted to a well-protected site but is suffering from a threat not impacting the site itself (e.g., amphibian species threatened by chytrid fungus). These sites would also be urgent priorities for monitoring, to determine whether the species is declining to the point of requiring captive breeding.

c) The primary threats occur away from the site (e.g., seabirds threatened by long-line fisheries while foraging at sea) or at a site important for a different life-history stage of the species (e.g., migratory species threatened in their wintering grounds). As these species are suffering severe threats elsewhere, ensuring the effective conservation of their breeding grounds is fundamental to their persistence.

- Because these situations are perceived to be very rare and represent urgent conservation priorities in their own right, these guidelines take a precautionary approach by placing them in a higher priority level than a strict application of the prioritization criteria would ordinarily do.

Priority Level 2 sites

Sites assigned to Priority Level 2 have slightly less extreme combinations of irreplaceability, species-based vulnerability, and site-based vulnerability than those assigned to Priority Level 1. They include sites with extreme irreplaceability, medium species-based vulnerability and high site-based vulnerability. Loss of these sites would most likely result in the global extinction of at least one species but, because the species in question has lower species-based vulnerability (i.e., more temporal options for its conservation), the urgency of conservation action is, again, slightly lower than it would be for a Priority Level 1 site. Sites assigned to Priority Level 2 also include ones with high irreplaceability, extreme species-based vulnerability and high or medium site-based vulnerability, as well as sites with high irreplaceability, high species-based vulnerability and high site-based vulnerability. Extirpation of the species from these sites is imminent but, because of lower irreplaceability (i.e., more spatial options), one local extirpation would not immediately result in the global extinction of the species. Consequently, the urgency of conservation action is, once again, slightly lower than it would be for a Priority Level 1 site.

Priority Level 3 sites

The rationale for the criteria used to assign sites to Priority Level 3 is similar to that followed for Priority Level 2, but with sites having slightly lower combinations of irreplaceability, species-based vulnerability and site-based vulnerability. For sites with extreme species-based vulnerability but medium irreplaceability, all sites were assigned to Priority Level 3, regardless of their site-based vulnerability scores. The site-based vulnerability criterion was not used because, as discussed in Section 6.3, higher site-based vulnerability only corresponds to higher priority for highly irreplaceable sites.

Priority Level 4 sites

The rationale for the criteria used to assign sites to Priority Level 4 is similar to that followed for Priority Levels 2 and 3, but with sites having slightly lower combinations of irreplaceability, species-based vulnerability and site-based vulnerability. For sites with extreme species-based vulnerability but low irreplaceability, and high species-based vulnerability but medium irreplaceability, all sites were assigned to Priority Level 4, regardless of their site-based vulnerability scores. The site-based vulnerability criterion was not used because, as mentioned above, higher site-based vulnerability only corresponds to higher priority for highly irreplaceable sites.

Priority Level 5 sites

Priority Level 5 sites comprise all KBAs that do not meet the criteria for Priority Levels 1 to 4. These KBAs have relatively lower combinations of irreplaceability and species-based vulnerability. However, as stated above, all KBAs are global conservation priorities, and that remains true of those assigned to Priority Level 5.

7.2.3 Prioritizing within priority levels

The priority levels recommended in the previous section are broad bands or categories that can be helpful in distinguishing sites where conservation action is needed most urgently. Depending on the country or region, tens or hundreds of KBAs could fall into a given priority level. It is important to realize that even within each of the priority levels, not all sites are the same and within-tier prioritization may be needed. Where several sites are assigned to the same priority level, priority for conservation action should, all else being equal, be given to KBAs with higher irreplaceability, that is, sites having a score of 'extreme' or 'high' irreplaceability for larger numbers of species. For example, the Massif de la Hotte, in Haiti, which is the single location for 12 CR and one EN species (Ricketts *et al.* 2005), should be considered a higher priority for conservation action than Bali Barat, in Indonesia, with 'only' one CR species restricted to the site: Bali Starling *Leucopsar rothschildi* (BirdLife International 2004c).

The other prioritization criteria should also be used to prioritize sites within priority levels. For example, among sites of roughly equivalent irreplaceability, higher priority should, all else being equal, be given to KBAs with higher species-based vulnerability, or larger numbers of globally threatened species. For sites of higher irreplaceability, those with higher site vulnerability should, all else being equal, be considered as more urgent priorities for action. This is not to say that conservationists should not take the best advantage of opportunities as they arise – they most certainly should. However, conservation action at Priority Level 1 and 2 sites simply cannot wait for opportunities to arise, as many species would be lost meanwhile. Instead, conservationists should strive to create opportunities for conservation where they are currently lacking.

Once these factors have been considered, and particularly for sites of lower irreplaceability, conservation cost and opportunity can be very important in helping to prioritize KBAs within priority levels. This requires an evaluation of which conservation action is needed at each KBA, so that costs/benefits and opportunities can be estimated relatively accurately.

7.2.4 Guidance for situations where most or all KBAs fall into lower priority levels

The prioritization guidelines in this document are globally applicable. They should give consistent results wherever they are applied, and at whatever scale.

Some countries or regions have few globally threatened species or few highly irreplaceable sites. In such cases, most or all sites may fall into Priority Levels 4 or 5. While this result may accurately reflect the sites' global priority for action, it is not helpful in guiding priorities at the national or regional scale.

The perception that, for example, all of a country's sites are 'low' priority (even though this is a relative ranking among global priorities) may also be unhelpful. To be effective, priority-setting exercises must often consider the process as well as the results. It is important to ensure that those who will implement the priorities take part in setting them, and gain some ownership over the outcomes. These considerations may require some adjustment of the process.

Some possible approaches to this particular problem include:

- ***Re-label the priority levels.*** If all of the KBAs fall into Priority Levels 4 and 5, these categories could be relabeled to something meaningful for the country or region in question, such as 'very high' and 'high'.
- ***Increase the number of priority levels.*** Priority Levels 4 and 5 can be broken down into more levels by adding conservation cost and opportunity explicitly into the prioritization criteria. Among sites of lower irreplaceability, higher priority would be given to those with low conservation cost or high opportunity.
- ***Use an additive approach to prioritize KBAs within priority levels.*** The approach above uses a 'weakest link' mechanism: the most threatened or most irreplaceable species determines the overall rank of the site. This takes no regard of the relative value of the site to other species. *Within* priority levels, however, an additive approach can be used to rank KBAs as priorities for action. All else being equal, a KBA that meets the criteria for a particular priority level for multiple species is a higher priority than a KBA that meets these criteria for a single species. For IBAs, an additive approach has been used for setting national priorities for action in Africa and South America (see, e.g., Bennun and Njoroge 1999): a similar method could be applied here. Note that this rule should only be used to prioritize KBAs *within* priority levels: a site with a single species that meets the criteria for Priority Level 4 is *always* a higher priority than a Priority Level 5 site, no matter how many species trigger the criteria for this priority level.

7.3 Recommending conservation actions for KBAs

Over and above assigning priority levels to KBAs, a gap analysis should provide guidance on what needs to be done at each site. Broadly speaking, four types of conservation action can be recommended for a KBA: restore the site/reinforce species' populations; strengthen conservation efforts; continue ongoing efforts; or monitor the site but take no further action.

Recommendations for conservation action should be strategically defined to complement most effectively ongoing conservation efforts in ensuring the species' persistence at KBAs over time. The *type* of conservation action(s) recommended depends on the degree of site-based vulnerability and the specific threats to the site, as the purpose is ultimately to reduce such vulnerability to levels consistent with the species' persistence. The *urgency* with which the recommended actions should be implemented is determined by the site's priority level. The *way* in which conservation actions are implemented will be greatly affected by opportunity (e.g., political will making it possible to designate a new protected area or interest by a private foundation leading to the designation of a private reserve). Finally, given that safeguarding KBAs is necessary but generally not sufficient to ensure the persistence of their trigger species, conservation action at the site scale will need to be complemented by sea/landscape-scale or species-specific interventions when appropriate.

Recommendation: restore habitats/reinforce species' populations

In some cases, it is crucial to go beyond mitigating or compensating ongoing threats and actively restore habitats or reinforce species' populations at a site. This is a special case of the recommendation for strengthening conservation efforts. For example, at some sites, habitat may have been so seriously reduced that even an effective ban on all destructive activities may not be sufficient to ensure the long-term viability of species populations there. In such cases, preventing further habitat loss may need to be complemented by habitat restoration (Dobson *et al.* 1997a).

Example: Intensive habitat restoration and management was key in the recovery of Kirtland's Warbler *Dendroica kirtlandii* (currently VU) from a global population of 200 in 1997 to more than 1,000 today (Probst *et al.* 2003). Population reinforcement from captively bred or artificially propagated populations may also prove key in supplementing depleted populations. This was the case, for example, with Golden Lion Tamarin *Leontopithecus rosalia* (currently EN) at the Poço das Antas Biological Reserve, Brazil (Rylands *et al.* 2002).

Recommendations should initially be considered for each trigger species in each site, but subsequently consolidated in the most useful way to guide implementation. For example, the consolidated set of recommendations for a particular KBA may be an urgent ban on primate hunting, the continued protection of forest habitat as per the existing protected area management plan, and monitoring of amphibian populations for potential emergence of chytrid fungus.

Recommendation: strengthen conservation efforts

Most KBAs will require additional conservation efforts to mitigate ongoing threats and thereby reduce site-based vulnerability. In some cases, no conservation action is taking place at the site, and the recommendation is, thus, to initiate appropriate action, such as establish a new protected area or to initiate new efforts. In other cases, conservation action is already underway but is insufficient to ensure species' long-term persistence; thus, the recommendation is to add to these existing efforts by, for example, improving the management of existing protected areas.

The specific recommendations for conservation action at each KBA will depend on the threats to the species or the site (e.g., habitat loss, invasive species, overexploitation, disease, etc.), the species' ecological requirements (e.g., habitat and area requirements), the characteristics of the site (e.g., isolated or well connected to other sites, small or large, etc.) and the ongoing conservation efforts there (e.g., hunting ban already well reinforced, logging still unabated, etc.). The purpose of making recommendations should not be to prepare a detailed management plan for each site during the gap analysis phase (although this may be desired/appropriate in some cases) but to summarize required conservation measures for conservation planning. Valuable sources of recommended actions for species and sites include: the IUCN Red List, BirdLife International,[10] the Global Amphibian Assessment, and species' action plans.[11]

Recommendation: continue ongoing efforts

Species may be currently quite secure at particular KBAs (i.e., they have low site-based vulnerability) not because threats do not exist at the site level but because they are mitigated or compensated for by ongoing conservation efforts. In this case, the recommendation would be to continue these efforts. This recommendation differs from the following one in that it involves the investment of conservation resources at the site in addition to simply monitoring. However, it differs from the two previous recommendations in that there is no need for *additional* investment over and above maintaining current levels.

Example: Black Toad *Bufo exsul* is endemic to a few freshwater springs and oases in Deep Springs Valley, USA. At present, this species does not seem to be highly threatened, being classified as VU because of its small area of occupancy. However, its current (relatively favorable) threat status is ensured by habitat protection, including a fenced area to exclude livestock and manipulation of irrigation water to minimize impacts on breeding toads, eggs and larvae (Murphy *et al.* 2003). While this protection is so far proving adequate, the species would likely become more seriously threatened if such measures were removed. The recommendation for this species is, therefore, to continue with current protection efforts.

Recommendation: monitor the site

Ideally, a KBA would require no active conservation management. Although an uncommon situation, this may nevertheless happen if site-based vulnerability is low, with no serious ongoing threats. In general, this is the result of 'natural' protection provided by site remoteness. For sites with low site-based vulnerability, the only action required is to monitor them, to provide early warning of emerging threats that could quickly affect their species-based and site-based vulnerability and, hence, priority level.

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10 www.birdlife.org/datazone
11 www.iucn.org/themes/ssc/pubs/sscapts.htm

Example: Several species of frogs endemic to the Tepuis region of Venezuela (including *Oreophrynella nigra*, *O. vasquezi* and *Metaphryniscus sosae*) were classified as VU based on their very small ranges but are currently not known to face serious threats (IUCN *et al.* 2004). KBAs in the Tepuis region containing the only populations of VU species would be assigned to Priority Level 4, but ought to be monitored regularly to ensure that the species remain in good condition (e.g., that they are not being affected by chytrid fungus).

7.4 Research priorities

Priorities for conservation action vs. priorities for research

Conservation planners face a dilemma between protecting sites of known importance now and waiting for more data to become available. However, waiting for the perfect dataset is not an option, so conservation has to proceed based on the best available data. Of course, those parts of the world where conservation action is most urgently needed are often the regions where the least is known about species' conservation status, distributions, threats, and appropriate conservation measures. Threatened species are often rare and, thus, poorly known. Data are often lacking to identify sites and establish their trigger species as conservation priorities. Nevertheless, it is dangerous to assume that gaps in knowledge are necessarily priorities for conservation action. Given their scarcity, conservation resources need to be invested in the many *known* priorities, instead of in *suspected* ones. Gaps in knowledge should be identified as priorities for research until data confirm whether or not they should be priorities for conservation action. Note that addressing research priorities, as defined in these guidelines, is not the same as, but can be addressed through, monitoring (Section 8.1).

The need for a strategic research agenda as a component of gap analyses

It is important to be selective about where and when to invest resources for such research. Not all gaps in knowledge can be filled at the same time, and some gaps are more detrimental than others to the effectiveness of conservation planning. It is, thus, crucial to develop a strategic research agenda as part of gap analyses, defining clear priorities for which gaps in knowledge to target first. The most urgent priorities for research should be those that are most likely to identify KBAs of high priority for conservation action.

As before, defining priorities for research follows the usual principles: highest urgency corresponds to situations of few spatial and temporal options. An example of a very high priority for research is to establish whether a CR species for which there are no reliable recent records is still extant, and, if so, to identify and safeguard KBAs where it occurs. An example of a lower priority for research is to establish with certainty whether a widespread VU species (i.e., one with many confirmed occurrences) is present at a particular site, where the site is not under great threat.

Relative urgency of research and conservation action

While both research and conservation action are urgent priorities, the latter typically stands out, as the need for so many conservation actions is blatant and the known risks of inaction are larger than the inferred risks of no research. Hence, ensuring the conservation of the single known population of a CR species is generally a more urgent priority than carrying out a field survey in search of a second population. Having said this, however, some research priorities do take precedence over conservation action. For example, it is a more urgent priority to pinpoint an exact location for conserving the remaining population of an elusive CR species than to create a protected area for a VU species that is already well protected, particularly if site-based vulnerability is high in the former case and low in the latter.

A strategic research agenda should thus be implemented and clearly articulated hand-in-hand with the strategic expansion and strengthening of ongoing conservation efforts, rather than something to be considered only when direct conservation action is 'finished'. Research results must feed continuously into the identification of priorities for conservation action, as well as for further research needs.

The main types of knowledge gap are discussed below, together with a discussion of how these can be addressed, their urgency for doing so, and their implications for conservation action. Note that throughout, identified KBAs can simultaneously be priorities for research and for implementation.

- *Species for which only old or unreliable records are available*

  Criteria for KBA designation require a high degree of confidence that at least one of the trigger species be present at each site (Section 5.2.1). In some cases, however, the application of such confidence levels may overlook threatened species for which we have only old or unreliable records, so that only candidate KBAs (or, indeed, none) are identified for these species; consequently, these species may be lost before reliable information is obtained about them. Thus, these species, and the sites where they may (or may not) persist, are the highest priorities for research, even more so if site-vulnerability is high.

  For example, the Alaotra Grebe *Tachybaptus rufolavatus* is a CR species known only from the Lake Alaotra region in Madagascar, with no recent records (BirdLife International 2004a). This lake, which is under growing threat from gill-net use, invasive species, reduced water quality and increased habitat loss, is a top priority for intensive field study, made even more urgent by the great pressure that threatens any possible remaining population.

- *Species for which no specific point localities are known*

  For some threatened species, we have no currently reliable specific locality data, so that it is difficult to pinpoint exact locations where the species is more likely to persist. For example, White-eyed River-martin *Eurochelidon sirintarae* (CR) is known only as a suspected non-breeding visitor to one area in Thailand, though it may still breed within a large area spanning northern Thailand, southern China, Myanmar and Laos (BirdLife *et al.* 2004a). These knowledge gaps are particularly challenging because they require a greater research investment to undertake surveys across the large area where the species may occur (rather than focusing on specific localities). In these situations, the first priority is to search for remaining populations. If and when these are found, they immediately become high priorities for conservation action for highly threatened species.

  As above, the risk of ignoring these knowledge gaps is that species may be lost before reliable information can be obtained about where they can be conserved. However, until enough information is available on how and where to protect the species, any conservation action is likely to be badly focused and ineffective. For example, until 1992, Cebu Flowerpecker *Dicaeum quadricolor* (CR) was considered extinct from its original range in the Philippines (Magsalay *et al.* 1995). The rediscovery of the species has catalysed intensive work to conserve the species by the Cebu Biodiversity Conservation Foundation.

- *Data Deficient species*

  Data Deficient (DD) species are those for which not enough information is available to support a classification in an IUCN Red List Category. Given that threatened species are frequently rare and difficult to find, some of them are initially classified as DD until further information reveals their true status. Frequently, these species are only known from one or a few field records, and no substantial additional field research has been conducted to put those records in context. This was the case with Lamotte's Roundleaf Bat *Hipposideros lamottei* (currently CR), a Mount Nimba endemic which was initially assessed as DD in 1996 (IUCN 2006).

  However, some species initially classified as DD end up being reassessed as non-threatened, particularly those species from remote and poorly studied regions for which additional research reveals relatively secure populations. This was the case with Tibetan Rosefinch *Carpodacus roborowskii* (currently Least Concern), from the Tibetan plateau in China, which had been initially assessed as DD in 1994 (IUCN 2006). Taxonomic uncertainty is also often associated with DD species. Grobben's Gerbil *Gerbillus grobbeni*, for example, is known only from a single specimen from Libya (from which it was described in 1909) but it is unclear whether it is a distinct species or, in fact, a specimen of the widespread Baluchistan Gerbil *G. nanus* (IUCN 2006).

  Given all these uncertainties, DD species (and the regions where they are concentrated) should be considered priorities for research, rather than priorities for conservation. Nevertheless, these species become more urgent research priorities if they are suspected to have quite restricted ranges and the areas where they are known to occur face severe threats. In the latter case, these species would most likely be considered threatened in a reassessment of their IUCN Red List status.

- *Poorly surveyed sites*

  At the global scale, as well as within any given country or region, existing knowledge is invariably biased towards particular areas, typically the most accessible ones (Section 3.5). It is, therefore, essential to ensure that a clear distinction is made between what is known and what is suspected or predicted about species distributions when deciding priorities for conservation investment through site-based protection. Confirmed data should be the basis for establishing priorities for investment in site-based conservation action. Suspected or predicted occurrence can inform priorities for additional research. Models of species distributions, while in no way replacements for fieldwork, can be very useful in helping to identify poorly sampled regions where species have a high probability of occurrence, which are therefore the most promising regions for additional data collection. For example, Raxworthy *et al.* (2003) found seven new species of Malagasy chameleons in a region where modeled species richness was substantially higher than recorded richness.

- *Poorly studied taxa (unknown IUCN Red List status)*

  Most species in any given country or region have not been assessed by IUCN to establish their global threat status. For example, only 4% of all described plant species have been assessed to date (IUCN 2006). Many of these unassessed species are likely to prove to be threatened and so would trigger KBAs, as and when evaluated for the Red List. A major research priority in any given country or region is, thus, to work on

IUCN Red List assessments. Besides assigning each species to an IUCN Red List category, the information collected to support these assessments (distribution, threats, population trends, habitat, conservation measures, etc.) can be a key input to national or regional gap analyses (Rodrigues *et al.* 2006).

- *Obtaining more information on KBAs and species*

  Even when sites are already known to qualify as KBAs, or species are known to trigger KBA status (e.g., globally threatened), there is nearly always a need to obtain more detailed information – the better the underlying data, the better the results of a gap analysis. Important information includes species distributions, threats to sites and species, and the most appropriate conservation measures for addressing particular threats to species or sites. Priority for collecting this additional information should be given to species with higher threat levels, with more restricted ranges and that are less well known.

7.5 Organizing the outputs of a gap analysis

This section provides general guidance on how the results of a national or regional gap analysis can be organized to help meet Goal 1.1 of the CBD Programme of Work on Protected Areas "to establish and strengthen national and regional systems of protected areas integrated into a global network as a contribution to globally agreed goals" (Box 1).

Recommendations for expansion vs. recommendations for strengthening the existing protected area system

The results of a gap analysis should be presented in a way that distinguishes between legally protected areas (i.e., likely recommendations for strengthening existing protected areas) and sites that have no legal protection yet (i.e., likely recommendations for expanding the system). This does not assume that all legally protected areas are effectively managed, or that other sites are necessarily without conservation attention. Rather, it is a way of organizing gap analysis results in a format relevant for decision makers, consistent with the fact that legal designation is a sign of official recognition by national and international authorities that a given site is a conservation priority.

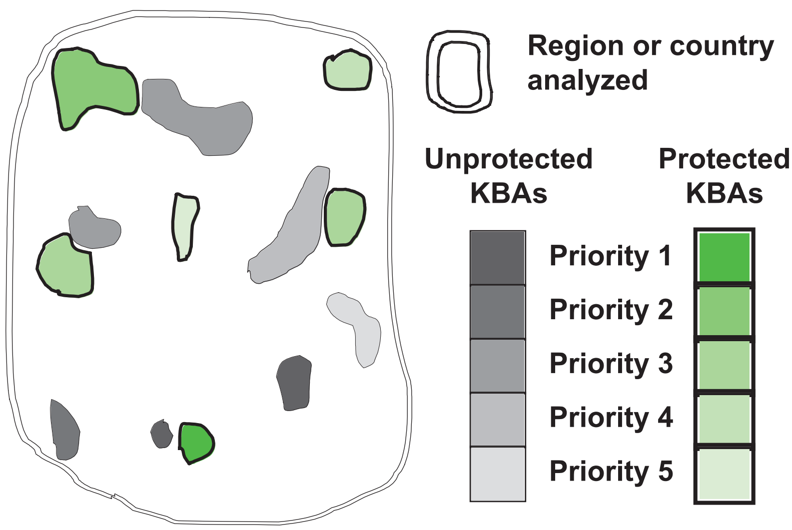
The organization of KBAs into given levels of priority for conservation action (Section 7.2.2) can be represented as a map with both protected and unprotected KBAs, coded with different colors (Figure 22).

Presentation of results: information per KBA, including recommendations for expanding and for strengthening the existing protected area system

The main results of a gap analysis will be first, a review of each KBA in terms of how effectively it conserves the species that triggered KBA designation, and second, recommendations for any actions needed to ensure that such conservation becomes or remains effective. This can be presented in text and/or organized in tables (Appendix 4), and would include information such as:

- Legal status of the KBA;
- IUCN category of the site if protected (related to legal status; IUCN and WCMC 1994);

Figure 22. Schematic representation of the organization of KBAs into five levels of priority for conservation action. Shades of gray represent priorities for expansion, while shades of green represent priorities for strengthening the existing protected areas.



- Level of priority for conservation action (Table 5);
- List of KBA trigger species and the criteria they triggered;
- Threats to trigger species populations at the site and their level of impact; the overall level of conservation at the site (plus, if relevant and known, information on the conservation level for different species);
- Conservation measures that are needed and the urgency with which they are needed;
- Opportunities for conservation action and probabilities for success.

In regions or countries with many KBAs, it may be a daunting task to collect and organize all this information for all sites. If that is the case, it is preferable to invest in developing the best level of detail for higher priority KBAs.

Presentation of results: information per species

In addition to the information per KBA, it would also be useful to present information per species so as to make gap analysis more relevant and user-friendly to individuals or organizations interested in the conservation of particular species. As before, the results can be described as text and/or organized in a table (Appendix 4), indicating information for each species such as:

- IUCN Red List status;
- Degree of endemism;
- Presence in the region (resident or only occurring during a particular life history stage, such as breeding);
- List of KBAs where it is present as a trigger species and the criteria it triggered at each;
- Threats to the species in the region and level of impact;
- Overall level of ongoing conservation action for the species in the region and its effectiveness;
- Conservation measures recommended for the species and their degree of urgency;
- Opportunities for conservation action and probabilities for success.

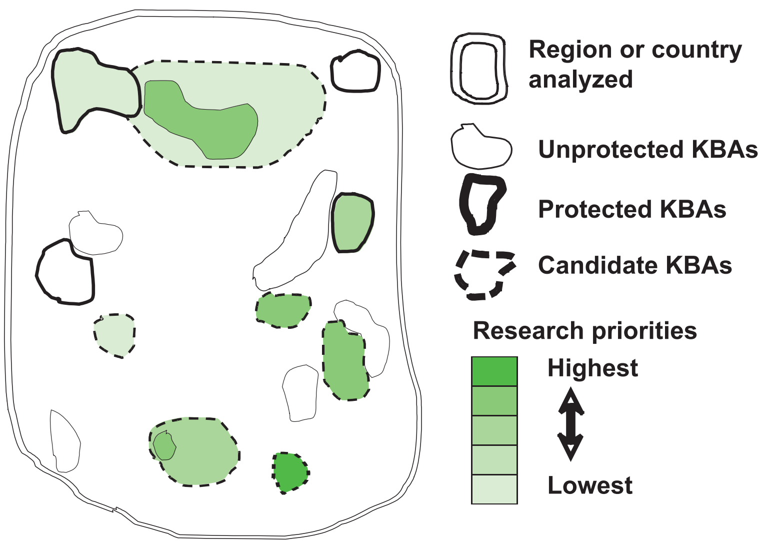
Again, in regions or countries with many KBA trigger species, it may be a daunting task to collect and organize all the above information for all species. In such cases, it is preferable to invest in developing the best level of detail for species with the highest threat level(s) according to the IUCN Red List (i.e., CR or EN).

Presentation of results: research priorities

Spatial representation of research priorities poses some challenges, as not all priorities can be easily represented as a map. It may, nevertheless, be useful to highlight particular sites or broader regions where research is most needed. A map of research priorities (Figure 23) may include: existing KBAs (protected or not) for which more information is needed; candidate KBAs (e.g., areas where only older records of trigger species are available); and broader regions requiring field research (e.g., to pinpoint a site where a CR species can be protected).

More detailed information on research priorities can be presented as text or organized as a table (Appendix 4). Detailed emphasis should only be given to the most urgent research priorities.

Figure 23. Schematic representation of research priorities



7.6 Gap analyses as iterative processes

The purpose of the prioritization strategy formulated through a gap analysis is to enable the most efficient possible allocation of conservation resources, in order to ensure the persistence of the maximum biodiversity over time. While a gap analysis should make the best use of existing information, the results correspond, necessarily, to a snapshot in time, compared to the many years that conservation action generally requires (Meir *et al.* 2004). In most regions, threats to biodiversity are increasing, resulting in reductions in species distributions, and increasing species and site-threat levels (Baillie *et al.* 2004). In many regions, conservation actions are being implemented, with opposite effects. Our understanding of all of these is, furthermore, affected by changes in knowledge as better data are collected.

To maximize its effectiveness as a strategy for conservation planning, KBA prioritization and gap analysis needs, therefore, to be considered an iterative process. Priorities need to be revisited regularly as certain developments occur:

- New KBAs are added (e.g., new taxonomic groups incorporated, new species discovered, species deteriorating in IUCN Red List status, etc.) or existing KBAs cease to qualify as such (e.g., species improving in IUCN Red List status, species extirpated from sites, etc.);
- Species distributions or knowledge of those distributions change, affecting site irreplaceability;
- Species threat levels or knowledge of those levels change, affecting species-based vulnerability;
- Threats to KBAs or knowledge of those threats change, affecting site-based vulnerability; this includes changes in management status (legally protected or not) and in management effectiveness;
- Scientific knowledge advances on the species' ecological requirements, threats, and the most adequate conservation measures.

A gap analysis should be interpreted as an ongoing, continuously adaptive process for guiding the allocation of conservation resources to maximize the long-term persistence of biodiversity in a region (Meir *et al.* 2004). Naturally, it is not feasible to repeat a formal national/regional gap analysis every year, although an ongoing effort should be made to update it as frequently as possible, particularly in regions where knowledge and circumstances are changing most rapidly. If priorities for conservation action are established following a methodology such as the one proposed in Section 7.2.2, then it should be relatively easy to update the broad priority levels for each site (or to add new sites) as new information is made available or as the situation on the conservation status of species or sites changes. However, a systematic review may be needed if significant time elapses or if major new datasets become available.

8. Conclusion

The need for comprehensive protected area networks has never been greater. Biodiversity is facing unparalleled threats from human activities, and many countries will experience dramatic extinction crises without conservation intervention (Brooks *et al.* 2002). Given the CBD Programme of Work on Protected Areas' mandate to establish "comprehensive, effectively managed, and ecologically representative national and regional systems of protected areas" for terrestrial systems by 2010 and marine systems by 2012, the world's protected area network must be expanded in a strategic manner, using limited conservation resources efficiently. In practice, this will require nations to identify globally important sites for biodiversity conservation, using standards that can be applied locally. The KBA concept has been developed to address this need, as these guidelines have outlined.

Because KBAs represent discrete sites that are globally vulnerable and irreplaceable, they can and should form the basis of national-level gap analysis and subsequent conservation planning. Full documentation on species presence per site, an output of KBA identification, enables practitioners to determine which KBAs need most urgent conservation investment (either through the expansion or the consolidation of the existing protected area network). In contrast, other approaches to gap analysis, such as those based on ecosystem data alone, can often result in the oversight of species in most need of protection.

Complementary conservation strategies

How to establish protected area safeguard and monitoring systems that follow from such gap analyses are treated in detail in other volumes of the IUCN Best Practice Protected Area Guidelines Series (Davey 1998, Hockings *et al.* 2000, Thomas and Middleton 2003) and elsewhere (TNC 2000). Similarly, species-specific conservation actions, such as the eradication of invasive species, control of exploitation, and standards and criteria for determining the conservation status of species through the IUCN Red List process are not covered in this volume. As *ex situ* conservation is a special case of such species-specific conservation actions, given that it has an ultimate aim of returning captive populations to the wild, we hope that the KBA approach will provide a template for the botanical garden, zoo, and hobbyist communities to engage with and support conservation *in situ* (Maunder and Byers 2005). Further, we do not discuss conservation approaches at the land and seascape scales, which are essential in conserving the broad-scale ecological processes that allow KBAs and their species to persist but are still an evolving science, in which important progress is being made (Rouget *et al.* 2003). It is clear that KBAs, which represent the last-remaining strongholds for many threatened and geographically concentrated species, should be the nodes for ecological networks and ecosystem approaches.

8.1 Progress and priorities for KBAs

Identification of KBAs to date

The cataloguing of KBAs is progressing rapidly. More than 7,500 Important Bird Areas have now been documented worldwide in 167 countries and territories, including new inventories for Asia (BirdLife International 2004c) and the Tropical Andes (BirdLife International and Conservation International 2005). Having started in Europe, identification of Important Plant Areas has expanded to Africa and is being planned in the Caribbean, Pacific and central and southeast Asia. Alliance for Zero Extinction sites, which hold the last populations of Critically Endangered and Endangered species and form a very important subset of KBAs, have been catalogued globally for terrestrial vertebrates and conifers. Appendix 1 gives initiatives that are currently underway to identify KBAs and to prioritize among these sites.

A global umbrella for KBAs

Beyond identification, documentation and setting priorities among KBAs for urgent conservation action, there is a need to bring the global conservation community together in recognizing the role of KBAs and to increase financial resources for KBA conservation. Clearly, an international initiative is needed to support the Parties to the CBD in identifying priority sites for conservation and meeting the overall goal of the Programme of Work on Protected areas. An important step in this direction would be to develop an overarching body for KBAs. This would help coordinate KBA identification and prioritization at the national level, maintain global standards similar to the IUCN Red List's function for threatened species, and raise awareness of the importance of these globally important sites.

National gap analysis

Conservation practitioners at the international and national levels should make it a priority to help embed the KBA approach in national and regional gap analysis and conservation planning. A number of countries are moving ahead with gap analyses of their national protected areas, and these initiatives are often supported by conservation NGOs. While KBAs are not the only data layer that should be used in gap analysis, the species and sites in greatest need of conservation from a global perspective will be further jeopardized if KBAs are not considered.

Implementation and monitoring

The most urgent priority is to build nationally led processes to recognize, advocate for, safeguard and monitor KBAs, and to build constituency for them. It is not enough merely to identify the sites; concrete actions must be taken on the ground (or in the water). In some cases, formal protected areas at the national level will need to be established or reinforced. In other cases, community-based management with biodiversity conservation as a goal will be more appropriate. Sometimes, zoning will be necessary within KBAs, establishing specific conservation management rules in the most appropriate areas, and communicating to all stakeholders the justifications for the boundaries and different management rules between areas. The international conservation and donor communities must scale-up their efforts to support these nationally led processes and to secure adequate resources for conservation implementation (Box 20).

KBAs as watch lists for development planning

Over and above conservation planning, the KBAs approach and process is important in guiding decision-makers on which sites should be proposed for development purposes. In effect, KBAs can be beneficial as a "watch list" of sites where development sectors (e.g., forestry, mining, transport, and urban planning) should take special precautions. As such, it can provide up-front justification to these sectors about which sites should be avoided or developed particularly carefully. The watch list could also help justify civil society responses (e.g., litigation) if and when development sectors fail to take KBAs into account. Mainstreaming KBAs into development sectors may eventually have an even greater impact than on conservation planning.

Importance of KBAs to human livelihoods

Much has been written on the importance of biodiversity to human welfare (e.g., Millennium Ecosystem Assessment 2005), so we should emphasise the links between KBA identification and conservation, and livelihoods and poverty alleviation. KBAs contribute both to maintaining biodiversity and the services that it provides to humanity. KBAs also provide important livelihood opportunities to local communities and "site-support groups" through employment, recognition, economic investment, societal mobilization, and civic pride. An important agenda for KBAs is to communicate and replicate these benefits, because the long-term future of KBAs rests first and foremost with the communities living around them.

Monitoring KBAs

Equally important are initiatives for monitoring biodiversity at the national and local-scales. Without monitoring, the success (or failure) of conservation interventions cannot be

Box 20. Conservation in IPAs – IPA protection and management

After Important Plant Areas are identified, their conservation must be ensured through appropriate management. Each national IPA team prioritizes their IPA network by analyzing the nature and extent of threats, the levels of effective protection, existing management regimes, etc. IPAs under high threat and situated outside protected areas are frequently those in need of most immediate conservation action.

Conservation strategies are then developed for IPAs with all appropriate stakeholders. These strategies and their action plans should be developed in the context of broader conservation issues, build on existing management approaches that support the conservation of plant diversity, ensure available resources to support local livelihoods (e.g., forestry, pastoralism, wild plant utilization or other resource use), and address site-specific threats. In the long term the IPA concept should be integrated into national institutional frameworks (formal and informal) for nature conservation and resource management.

The management approaches used will be regionally, nationally and site-specific depending on the resources available for conservation and the legal and policy frameworks already in place. Cultural, socio-economic and political factors also have a significant role in the development of effective and sustainable plant conservation measures. In developing countries where the resources available for conservation are very limited, and where many rural people rely on local wild plant resources to survive; ensuring good management of IPAs will require an even stronger role for community involvement in any conservation initiative.

The environment for plant conservation in developed countries is different. In the seven countries in central and eastern Europe where IPA identification has been completed, the IPA teams have outlined eight focal areas for implementing IPA protection and management:

- using IPA data to help important sites gain official status (legal or otherwise);
- developing and implementing site-specific management plans that take account of features important for plant conservation;
- carrying out pilot projects to demonstrate good management and the subsequent promotion of best practice;
- ensuring local community involvement in management, particularly farmers and other resource users;
- increasing awareness of the importance of conserving IPAs;
- developing IPA monitoring systems;
- leveraging funds from specific legal instruments for IPA conservation;
- sharing experiences of IPA identification, protection and management across the region.

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determined and realigned as needed. As KBAs are quantitative targets for conservation at the site scale, they can serve as a baseline for monitoring the state of biodiversity over time. Initiatives are underway in many regions to conduct monitoring activities using remote sensing data, such as satellite imagery and aerial photography. These relatively rapid, cost-effective tools can be used to monitor habitat cover within and around KBAs, as a broad-scale indicator of biodiversity status. Encouragingly, such monitoring is being pioneered by focusing NASA and other satellite data acquisitions onto KBAs. This strategy must be complemented, however, by finer-scale monitoring of KBAs, in order to understand changes in the populations of threatened species, protected area effectiveness, and threats to biodiversity (Box 21).

Box 21. Monitoring IBAs in Africa

One of the major challenges for any monitoring system, especially in countries with scarce resources, is to develop approaches that are sufficiently straightforward and inexpensive, yet produce credible and meaningful data. BirdLife International's framework for monitoring Important Bird Areas (IBAs) is designed to be simple, robust and locally grounded, but to produce scaleable results that can be compiled into national or regional indices as well as informing conservation action at sites (Bennun *et al.* 2005). The framework is designed according to a set of broad principles:

- Embed the process in appropriate national and local institutions – BirdLife Partners cannot possibly monitor every IBA themselves.
- Use straightforward indicators that are easy to assess, and robust yet inexpensive methods.
- Build on and incorporate existing monitoring efforts where possible.
- Make maximum use of volunteers and existing expert networks for collecting useful data.
- Work closely with local communities, to build monitoring from the bottom up and ensure that it is relevant to their needs.
- Target investment towards outreach, capacity development and co-ordination.
- Ensure a constant trickle of resources, avoiding the deluge and drought that characterize many externally-funded projects.
- Link monitoring clearly to conservation action – and ensure a good balance between the two: monitoring is not an end in itself.

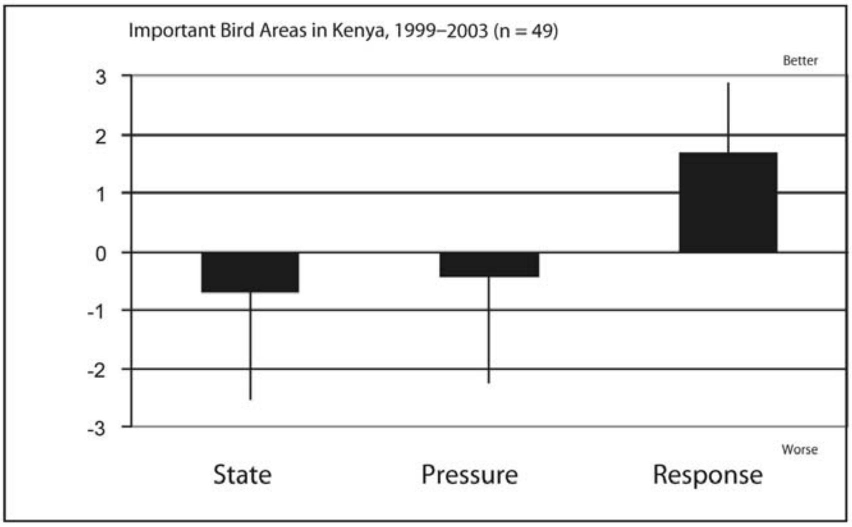
The framework is implemented nationally and institutionalizes monitoring in the appropriate site management authorities and Site Support Groups (community-based organizations of local people working for conservation and sustainable development). Additional data can be incorporated from a wide range of sources, including remote sensing. A small, central monitoring unit, often based in a BirdLife Partner, co-ordinates the program nationally; compiles, analyzes and manages data; and provides feedback.

With 1,230-plus IBAs in Africa, there is an obvious trade-off between the depth and the breadth of monitoring. Producing national and regional indices requires broad coverage, which will necessarily be sketchy at many sites. However, adaptive management may well require more intensive collection of information. The framework balances depth and breadth by differentiating basic and detailed monitoring (see below). 'Basic' monitoring takes place at all sites. Observers compile simple forms asking for primarily non-quantitative information on state, pressure and response indicators. These are collated by the central unit and considered alongside other data to score the condition of the site, the level of threats, the extent of conservation action or safeguard, and the trends in each of these areas. In addition, 'detailed' monitoring takes place at a selected subset of sites, as resources allow, measuring more intensively particular variables closely related to site management targets.

IBA monitoring is now underway in at least 10 African countries, with implementation of the framework most advanced (thanks to a pilot project) in Kenya. The 2004 IBA monitoring report for Kenya (Otieno *et al.* 2004) provides extensive information on individual IBAs, plus indices for national trends in state, pressure and response from 1999–2003, based on data from 49 out of 60 sites (Figure 24). It tells us, for example, that illegal logging, charcoal burning and firewood collection are threats in 19 out of 22 forest IBAs and encroachment for livestock grazing is prevalent at 85% of sites, but that donor-funded, income-generating projects have begun at 18 sites and that research or regular monitoring is underway at 73% of sites. Overall, sites in the network showed a small mean decline in site condition over this period and a small mean increase in threats. More positively, there was a noticeable mean increase in the level of conservation action.

Box 21 cont.

Figure 24. Summary of trends in Kenya's IBAs



Experience in Kenya shows that institutionalization is vital, but takes considerable time and effort; that adequate co-ordination (including timely feedback) is key; and that participatory monitoring has many valuable benefits beyond the data collected. Further work is being undertaken to refine the process, improve its scientific underpinning, strengthen the feedback loop from data and analysis to action on the ground, and investigate how best to incorporate remotely-sensed data.

Leon Bennun, BirdLife International

8.2 Research questions

Research priorities for the KBA agenda

The KBA concept has come a long way in the last few years, owing to the strong foundation from IBA and IPA initiatives. A number of research questions remain to be addressed, however, to ensure that the concept is a robust and practical framework for identifying globally important sites. The following research questions are priorities in particular:

1. *Development of the bioregionally restricted sub-criterion.* Although the restricted-range and congregatory species sub-criteria are well established, the bioregionally restricted sub-criterion, particularly in application to species assemblages rather than individual species, requires additional development to be more widely applicable in defining KBAs.
2. *Testing KBA thresholds.* The numeric thresholds for all KBA criteria require sensitivity analysis.
3. *Taxonomic surrogacy.* The robustness of KBA networks identified using one or a few taxa needs investigation.
4. *Extension of KBA criteria to aquatic systems.* Significant testing of the KBA criteria and thresholds is needed so that they can be applied to freshwater and marine taxa, which present particular complexities for measuring range size.
5. *Incorporation of modeling techniques to identify "candidate" KBAs.* Many sites may meet KBA criteria; however, confirmed species records do not yet exist for these sites. Modeling techniques should be tested to see if they can be applied in identifying candidate KBAs.

Further details of progress to date in all of these research topics are outlined in Chapter 4.

8.3 Synergies with ongoing initiatives

The KBA processes underway in many regions (Appendix 1) provide an excellent basis for gap analyses at the national level. This volume aims to provide guidance for technical staff in governments, NGOs and other organizations charged with implementing the intergovernmental commitments on protected areas at the national level. The chapters give guidance on the key considerations in conservation priority-setting, identifying and delineating KBAs, and in prioritizing among KBAs through gap analysis. The recommendations given in this volume are complementary to other sets of guidelines and tools being developed to support gap analysis (Dudley 2005). By focusing on the identification and prioritization of sites of global conservation importance, we hope these guidelines will help each nation fulfill its commitment to safeguard the biodiversity within its borders.

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Appendix I

KBAs identified to date

Country	IBA publication	IPAs[1]	KBAs
Afghanistan	Evans, M.I. (Ed.) 1994. *Important Bird Areas in the Middle East*. Cambridge, UK: BirdLife International (BirdLife Conservation Series 2).		
Albania	Heath, M.F., Evans, M.I., Hoccom, D.G., Payne, A.J. and Peet, N.B. (Eds) 2000. *Important Bird Areas in Europe: Priority Sites for Conservation, Volume 1 Northern Europe, Volume 2 Southern Europe*. Cambridge, UK: BirdLife International.	Institute of Biological Research, Tirana	
Algeria	Fishpool, L.D.C. and Evans, M.I. 2001. *Important Bird Areas of Africa and Associated Islands: Priority Sites for Conservation*. BirdLife Conservation Series no. 11. Newbury and Cambridge, UK: Pisces Publications and BirdLife International.		
Andorra	Heath, M.F., Evans, M.I., Hoccom, D.G., Payne, A.J. and Peet, N.B. (Eds) 2000. *Important Bird Areas in Europe: Priority Sites for Conservation, Volume 1 Northern Europe, Volume 2 Southern Europe*. Cambridge, UK: BirdLife International.		
Angola	Fishpool, L.D.C. and Evans, M.I. 2001. *Important Bird Areas of Africa and Associated Islands: Priority Sites for Conservation*. BirdLife Conservation Series no. 11. Newbury and Cambridge, UK: Pisces Publications and BirdLife International.		
Argentina	Di Giacomo, A.S. 2005. Areas importantes para la conservación de las aves en Argentina. Sitios prioritarios para la conservación de la biodiversidad. *Temas de Naturaleza y Conservación* 5: 1–514. Buenos Aires, Argentina: Aves Argentinas/Associación Ornitológica del Plata.		
Armenia	Heath, M.F., Evans, M.I., Hoccom, D.G., Payne, A.J. and Peet, N.B. (Eds) 2000. *Important Bird Areas in Europe: Priority Sites for Conservation, Volume 1 Northern Europe, Volume 2 Southern Europe*. Cambridge, UK: BirdLife International.	Institute of Botany of the National Academy of Sciences of RA	Preliminary KBAs identified in 2002 by WWF-Caucasus.[2]
Austria	Dvorak, M. and Karner, E. 1995. *Important Bird Areas in Osterreich*. Wien, Austria: Bundesministerium für Umwelt (Monographien Bund 71). (In German). 454pp. Heath, M.F., Evans, M.I., Hoccom, D.G., Payne, A.J. and Peet, N.B. (Eds) 2000. *Important Bird Areas in Europe: Priority Sites for Conservation, Volume 1 Northern Europe, Volume 2 Southern Europe*. Cambridge, UK: BirdLife International.		
Azerbaijan	Heath, M.F., Evans, M.I., Hoccom, D.G., Payne, A.J. and Peet, N.B. (Eds) 2000. *Important Bird Areas in Europe: Priority Sites for Conservation, Volume 1 Northern Europe, Volume 2 Southern Europe*. Cambridge, UK: BirdLife International.		Preliminary KBAs identified in 2002 by WWF-Caucasus.[2]
Azores	Heath, M.F., Evans, M.I., Hoccom, D.G., Payne, A.J. and Peet, N.B. (Eds) 2000. *Important Bird Areas in Europe: Priority Sites for Conservation, Volume 1 Northern Europe, Volume 2 Southern Europe*. Cambridge, UK: BirdLife International.		

[1] IPA programs are active in the countries listed, some are very advanced while others are just beginning. All programs involve teams of stakeholders from many organizations – the partners listed are the lead institutions in each of the projects.
[2] As part of strategy development for CEPF in this region.

Country	IBA publication	IPAs[1]	KBAs
Bahrain	Evans, M.I. (Ed.) 1994. *Important Bird Areas in the Middle East*. Cambridge, UK: BirdLife International (BirdLife Conservation Series 2).		
Bangladesh	BirdLife International. 2004. *Important Bird Areas in Asia: Key Sites for Conservation*. Cambridge, UK: BirdLife International (BirdLife Conservation series 13). BLI/PB/09j and AS/AA/92.		
Belarus	Heath, M.F., Evans, M.I., Hoccom, D.G., Payne, A.J. and Peet, N.B. (Eds) 2000. *Important Bird Areas in Europe: Priority Sites for Conservation, Volume 1 Northern Europe, Volume 2 Southern Europe*. Cambridge, UK: BirdLife International.	Maslovsky, O. (Ed.) 2005. *Important Plant Areas in Belarus*. Moscow, Russian Federation: IUCN, Institute of Experimental Botany Minsk, Ministry of Environment, Plantlife International, Planta Europa 2005.	
Belgium	Heath, M.F., Evans, M.I., Hoccom, D.G., Payne, A.J. and Peet, N.B. (Eds) 2000. *Important Bird Areas in Europe: Priority Sites for Conservation, Volume 1 Northern Europe, Volume 2 Southern Europe*. Cambridge, UK: BirdLife International.		
Belize			Preliminary KBAs identified in 2003. KBA refinement in progress, led by Belize Tropical Forest Studies.
Benin	Fishpool, L.D.C. and Evans, M.I. 2001. *Important Bird Areas of Africa and Associated Islands: Priority Sites for Conservation.* BirdLife Conservation Series no. 11. Newbury and Cambridge, UK: Pisces Publications and BirdLife International.		
Bhutan	BirdLife International. 2004. *Important Bird Areas in Asia: Key Sites for Conservation*. Cambridge, UK: BirdLife International (BirdLife Conservation series 13). BLI/PB/09j and AS/AA/92.	Royal Government of Bhutan	Preliminary KBAs identified in 2004 by BirdLife Indochina and WWF.[2]
Bolivia	BirdLife International y Conservation International. 2005. *Áreas Importantes para la Conservación de las Aves en los Andes Tropicales: Sitios Prioritarios para la Conservación de la Biodiversidad.* Quito, Ecuador: BirdLife International (Conservation Series No. 14).		KBA identification and delineation in progress.
Bosnia and Herzegovina	Heath, M.F., Evans, M.I., Hoccom, D.G., Payne, A.J. and Peet, N.B. (Eds) 2000. *Important Bird Areas in Europe: Priority Sites for Conservation, Volume 1 Northern Europe, Volume 2 Southern Europe*. Cambridge, UK: BirdLife International.		
Botswana	Fishpool, L.D.C. and Evans, M.I. 2001. *Important Bird Areas of Africa and Associated Islands: Priority Sites for Conservation.* BirdLife Conservation Series no. 11. Newbury and Cambridge, UK: Pisces Publications and BirdLife International.		
Bouvetøya (Bouvet Island)	Fishpool, L.D.C. and Evans, M.I. 2001. *Important Bird Areas of Africa and Associated Islands: Priority Sites for Conservation.* BirdLife Conservation Series no. 11. Newbury and Cambridge, UK: Pisces Publications and BirdLife International.		

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Brazil	Bencke, G.A., Maurício, G.N., Develey, P.F. and Goerck, J.M. 2006. *Áreas Importantes para a Conservação das Aves no Brasil. Parte 1–Estados do Domínio da Mata Atlântica*. São Paulo, Brasil: SAVE Brasil.		KBA identification and delineation in progress for the Atlantic Forest and Cerrado hotspots, as well as the Amazon and Pantanal wilderness areas.
British Indian Ocean Territory	BirdLife International. 2004. *Important Bird Areas in Asia: Key Sites for Conservation*. Cambridge, UK: BirdLife International (BirdLife Conservation series 13). BLI/PB/09j and AS/AA/92.		
Brunei	BirdLife International. 2004. *Important Bird Areas in Asia: Key Sites for Conservation*. Cambridge, UK: BirdLife International (BirdLife Conservation series 13). BLI/PB/09j and AS/AA/92.		
Bulgaria	Kostadinova, I. 1997. [Important Bird Areas in Bulgaria.] Sofia, Bulgaria: Bulgarian Society for the Protection of Birds (BSPB Conservation Series, Book 1). 176pp. (In Bulgarian.) Heath, M.F., Evans, M.I., Hoccom, D.G., Payne, A.J. and Peet, N.B. (Eds) 2000. *Important Bird Areas in Europe: Priority Sites for Conservation, Volume 1 Northern Europe, Volume 2 Southern Europe*. Cambridge, UK: BirdLife International.	Institute of Botany, BAS Sofia and Botanical Garden BAS, Sofia	
Burkina Faso	Fishpool, L.D.C. and Evans, M.I. 2001. *Important Bird Areas of Africa and Associated Islands: Priority Sites for Conservation*. BirdLife Conservation Series no. 11. Newbury and Cambridge, UK: Pisces Publications and BirdLife International.		
Burundi	Fishpool, L.D.C. and Evans, M.I. 2001. *Important Bird Areas of Africa and Associated Islands: Priority Sites for Conservation*. BirdLife Conservation Series no. 11. Newbury and Cambridge, UK: Pisces Publications and BirdLife International.		
Cambodia	Seng Kim Hout, Pech Bunnat, Poole, C.M, Tordoff, A.W., Davidson, P. and Delattre, E. 2003. *Directory of Important Bird Areas in Cambodia: Key Sites for Conservation*. Phnom Penh, Cambodia: Department of Forestry and Wildlife, Department of Nature Conservation and Protection, BirdLife International in Indochina, and the Wildlife Conservation Society Cambodia Program. 116pp. BirdLife International. 2004. *Important Bird Areas in Asia: Key Sites for Conservation*. Cambridge, UK: BirdLife International (BirdLife Conservation series 13). BLI/PB/09j and AS/AA/92.		Preliminary KBAs identified in 2004 by BirdLife Indochina.[2]
Cameroon	Fishpool, L.D.C. and Evans, M.I. 2001. *Important Bird Areas of Africa and Associated Islands: Priority Sites for Conservation*. BirdLife Conservation Series no. 11. Newbury and Cambridge, UK: Pisces Publications and BirdLife International.		
Cape Verde	Fishpool, L.D.C. and Evans, M.I. 2001. *Important Bird Areas of Africa and Associated Islands: Priority Sites for Conservation*. BirdLife Conservation Series no. 11. Newbury and Cambridge, UK: Pisces Publications and BirdLife International.		
Central African Republic	Fishpool, L.D.C. and Evans, M.I. 2001. *Important Bird Areas of Africa and Associated Islands: Priority Sites for Conservation*. BirdLife Conservation Series no. 11. Newbury and Cambridge, UK: Pisces Publications and BirdLife International.		
Chad	Fishpool, L.D.C. and Evans, M.I.(2001. *Important Bird Areas of Africa and Associated Islands: Priority Sites for Conservation*. BirdLife Conservation Series no. 11. Newbury and Cambridge, UK: Pisces Publications and BirdLife International.		

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China (Mainland)	BirdLife International. 2004. *Important Bird Areas in Asia: Key Sites for Conservation*. Cambridge, UK: BirdLife International (BirdLife Conservation series 13). BLI/PB/09j and AS/AA/92.	Kuming Institute for Botany	KBA identification and delineation completed by CI-China in 2006. Preliminary KBAs identified by BirdLife Indochina in the Indo-Burma Hotspot in 2004.[2]
Colombia	BirdLife International y Conservation International. 2005. *Áreas Importantes para la Conservación de las Aves en los Andes Tropicales: Sitios Prioritarios para la Conservación de la Biodiversidad*. Quito, Ecuador: BirdLife International (Conservation Series No. 14).		KBA identification and delineation in progress
The Comoros	Fishpool, L.D.C. and Evans, M.I. 2001. *Important Bird Areas of Africa and Associated Islands: Priority Sites for Conservation*. BirdLife Conservation Series no. 11. Newbury and Cambridge, UK: Pisces Publications and BirdLife International.		
Congo	Fishpool, L.D.C. and Evans, M.I. 2001. *Important Bird Areas of Africa and Associated Islands: Priority Sites for Conservation*. BirdLife Conservation Series no. 11. Newbury and Cambridge, UK: Pisces Publications and BirdLife International.		
Democratic Republic of Congo	Fishpool, L.D.C. and Evans, M.I. 2001. *Important Bird Areas of Africa and Associated Islands: Priority Sites for Conservation*. BirdLife Conservation Series no. 11. Newbury and Cambridge, UK: Pisces Publications and BirdLife International.		
Costa Rica			Preliminary KBAs identified by INBio in 2004. Refinement and delineation is in progress.
Côte D'Ivoire	Fishpool, L.D.C. and Evans, M.I. 2001. *Important Bird Areas of Africa and Associated Islands: Priority Sites for Conservation*. BirdLife Conservation Series no. 11. Newbury and Cambridge, UK: Pisces Publications and BirdLife International.		
Croatia	Heath, M.F., Evans, M.I., Hoccom, D.G., Payne, A.J. and Peet, N.B. (Eds) 2000. *Important Bird Areas in Europe: Priority Sites for Conservation, Volume 1 Northern Europe, Volume 2 Southern Europe*. Cambridge, UK: BirdLife International.	Faculty of Science, University of Zagreb	
Cyprus	Iezekiel, S., Makris, C. and Antoniou, A. 2004. *Important Bird Areas of European Union importance in Cyprus*. Nicosia, Cyprus: BirdLife Cyprus. Heath, M.F., Evans, M.I., Hoccom, D.G., Payne, A.J. and Peet, N.B. (Eds) 2000. *Important Bird Areas in Europe: Priority Sites for Conservation, Volume 1 Northern Europe, Volume 2 Southern Europe*. Cambridge, UK: BirdLife International.		
Czech Republic	Hora, J. and Kanuch, P. 1992. *Vyznamna ptaci uzemi v Evrope* [Important Bird Areas in Europe – Czechoslovakia]. Prague, Czechoslovakia: Czechoslovakia Section of the International Council for Bird Preservation. 124pp. Málková, P. and Lacina, D. (Eds) 2002. *Important Bird Areas in the Czech Republic*. Prague, Czech Republic: Czech Society for Ornithology. Heath, M.F., Evans, M.I., Hoccom, D.G., Payne, A.J. and Peet, N.B. (Eds) 2000. *Important Bird Areas in Europe: Priority Sites for Conservation, Volume 1 Northern Europe, Volume 2 Southern Europe*. Cambridge, UK: BirdLife International.	Agency For Landscape Protection and Nature Conservation	

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Denmark	Heath, M.F., Evans, M.I., Hoccom, D.G., Payne, A.J. and Peet, N.B. (Eds) 2000. *Important Bird Areas in Europe: Priority Sites for Conservation, Volume 1 Northern Europe, Volume 2 Southern Europe*. Cambridge, UK: BirdLife International.		
Djibouti	Fishpool, L.D.C. and Evans, M.I. 2001. *Important Bird Areas of Africa and Associated Islands: Priority Sites for Conservation*. BirdLife Conservation Series no. 11. Newbury and Cambridge, UK: Pisces Publications and BirdLife International.		
Ecuador	BirdLife International y Conservation International. 2005. *Áreas Importantes para la Conservación de las Aves en los Andes Tropicales: Sitios Prioritarios para la Conservación de la Biodiversidad*. Quito, Ecuador: BirdLife International (Conservation Series No. 14).		KBA identification and delineation in progress.
Egypt	Baha El Din, Sherif. 1999. *Directory of Important Bird Areas in Egypt*. Cairo, Egypt: BirdLife International.		
Equatorial Guinea	Fishpool, L.D.C. and Evans, M.I. 2001. *Important Bird Areas of Africa and Associated Islands: Priority Sites for Conservation*. BirdLife Conservation Series no. 11. Newbury and Cambridge, UK: Pisces Publications and BirdLife International.		
Eritrea	Fishpool, L.D.C. and Evans, M.I. 2001. *Important Bird Areas of Africa and Associated Islands: Priority Sites for Conservation*. BirdLife Conservation Series no. 11. Newbury and Cambridge, UK: Pisces Publications and BirdLife International.		
Estonia	Kalamees, A. 2000. *Tähtsad linnualad Eestis* [Important Bird Areas in Estonia]. Tartu, Estonia: Eesti Ornitoloogiaühing. 114pp. Heath, M.F., Evans, M.I., Hoccom, D.G., Payne, A.J. and Peet, N. B. (Eds) 2000. *Important Bird Areas in Europe: Priority Sites for Conservation, Volume 1 Northern Europe, Volume 2 Southern Europe*. Cambridge, UK: BirdLife International.	Environmental Protection Institute	
Ethiopia	Ethiopian Wildlife and Natural History Society. 1996. *Important Bird Areas of Ethiopia*. Addis Ababa, Ethiopia: Ethiopian Wildlife and Natural History Society. 300pp.		
Falkland Islands	Falklands Conservation. 2006. *Important Bird Areas of the Falkland Islands*. London, UK: Falklands Conservation.		
Faroe Islands	Heath, M.F., Evans, M.I., Hoccom, D.G., Payne, A.J. and Peet, N.B. (Eds) 2000. *Important Bird Areas in Europe: Priority Sites for Conservation, Volume 1 Northern Europe, Volume 2 Southern Europe*. Cambridge, UK: BirdLife International.		
Federated States of Micronesia			Preliminary KBAs identified in 2004 by CI-Melanesia/ Pacific and TNC-Micronesia.[2]
Fiji	BirdLife International. 2006. *Important Bird Areas in Fiji: Conserving Fiji's Natural Heritage*. Suva, Fiji: BirdLife International Pacific Partnership Secretariat.		Preliminary KBAs identified in 2004 by CI-Melanesia/ Pacific and WCS-Pacific Islands.[2]
Finland	Leivo, M., Asanti, T., Koskimies, P., Lammi, E., Lampolahti, J., Mikkola-Roos, M., and Virolainen, E. 2002. *Suomen tärkeät lintualueet*. FINIBA. (BirdLife Suomen julkaisuja, 4.) Suomen Graafiset Palvelut, Kuopio. 142pp. EU/FI/12. Heath, M.F., Evans, M.I., Hoccom, D.G., Payne, A.J. and Peet, N.B. (Eds) 2000. *Important Bird Areas in Europe: Priority Sites for Conservation, Volume 1 Northern Europe, Volume 2 Southern Europe*. Cambridge, UK: BirdLife International.	Finnish Protection Unit	

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France	Rocamora, G. 1994. *Les Zones Importantes pour la Conservation des Oiseaux en France*. Angoulême, France: Ligue Pour La Protection des Oiseaux/Ministère de l'Environnement. 339pp. Heath, M.F., Evans, M.I., Hoccom, D.G., Payne, A.J. and Peet, N.B. (Eds) 2000. *Important Bird Areas in Europe: Priority Sites for Conservation, Volume 1 Northern Europe, Volume 2 Southern Europe*. Cambridge, UK: BirdLife International.		
French Polynesia			Preliminary KBAs identified in 2004 by CI-Melanesia/ Pacific and Societé d'Ornithologie de la Polynésie. [2]
French Southern Territories	Fishpool, L.D.C. and Evans, M.I. 2001. *Important Bird Areas of Africa and Associated Islands: Priority Sites for Conservation*. BirdLife Conservation Series no. 11. Newbury and Cambridge, UK: Pisces Publications and BirdLife International.		
Gabon	Fishpool, L.D.C. and Evans, M.I. 2001. *Important Bird Areas of Africa and Associated Islands: Priority Sites for Conservation*. BirdLife Conservation Series no. 11. Newbury and Cambridge, UK: Pisces Publications and BirdLife International.		
The Gambia	Fishpool, L.D.C. and Evans, M.I. 2001. *Important Bird Areas of Africa and Associated Islands: Priority Sites for Conservation*. BirdLife Conservation Series no. 11. Newbury and Cambridge, UK: Pisces Publications and BirdLife International.		
Georgia	Heath, M.F., Evans, M.I., Hoccom, D.G., Payne, A.J. and Peet, N.B. (Eds) 2000. *Important Bird Areas in Europe: Priority Sites for Conservation, Volume 1 Northern Europe, Volume 2 Southern Europe*. Cambridge, UK: BirdLife International.		Preliminary KBAs identified in 2002 by WWF-Caucasus and Georgian Center for the Conservation of Wildlife.[2]
Germany	Winkel, W. and Frantzen, M. 1987. Erfassung von "Important Bird Areas" der Bundesrepublik Deutschland. *Berichte der Deutschen Sektion des Internationalen Rates für Vogelschutz* 27: 13–58. Naturschutzbund Deutschland (NABU). 1991. *Die Europäischen Vogelschutzgebiete (IBA) in den fünf neuen Bundesländern* [IBAs in the five new Bundesländer of the Federal Republic of Germany]. Bonn, Germany: NABU. Sudfeldt, C., Doer, D., Hötker, H., Mayr, C., Unselt, C., Lindeiner, A.V. und Bauer, H.-G. 2002. Important Bird Areas (Bedeutende Vogelschutzgebiete) in Deutschland – überarbeitete und aktualisierte Gesamtliste. *Berichte zum Vogelschutz* 38: 17–110. Heath, M.F., Evans, M.I., Hoccom, D.G., Payne, A.J. and Peet, N.B. (Eds) 2000. *Important Bird Areas in Europe: Priority Sites for Conservation, Volume 1 Northern Europe, Volume 2 Southern Europe*. Cambridge, UK: BirdLife International.		
Ghana	Fishpool, L.D.C. and Evans, M.I. 2001. *Important Bird Areas of Africa and Associated Islands: Priority Sites for Conservation*. BirdLife Conservation Series no. 11. Newbury and Cambridge, UK: Pisces Publications and BirdLife International.		KBA identification and delineation in progress.
Gibraltar	Heath, M.F., Evans, M.I., Hoccom, D.G., Payne, A.J. and Peet, N.B. (Eds) 2000. *Important Bird Areas in Europe: Priority Sites for Conservation, Volume 1 Northern Europe, Volume 2 Southern Europe*. Cambridge, UK: BirdLife International.		

Country	IBA publication	IPAs[1]	KBAs
Greece	Grimmett, R.F.A. and Jones, T.A. 1988. [Important bird areas in Greece]. Cambridge, UK: BirdLife International. (In Greek.) Hellenic Ornithological Society (HOS). 1994. [IBAs for the birds of Greece]. Athens, Greece: HOS. 271pp. (In Greek.) Heath, M.F., Evans, M.I., Hoccom, D.G., Payne, A.J. and Peet, N.B. (Eds) 2000. *Important Bird Areas in Europe: Priority Sites for Conservation, Volume 1 Northern Europe, Volume 2 Southern Europe*. Cambridge, UK: BirdLife International.		
Greenland	Heath, M.F., Evans, M.I., Hoccom, D.G., Payne, A.J. and Peet, N.B. (Eds) 2000. *Important Bird Areas in Europe: Priority Sites for Conservation, Volume 1 Northern Europe, Volume 2 Southern Europe*. Cambridge, UK: BirdLife International.		
Guatemala			Preliminary KBAs identified in 2003. Refinement in progress.
Guinea	Fishpool, L.D.C. and Evans, M.I. 2001. *Important Bird Areas of Africa and Associated Islands: Priority Sites for Conservation*. BirdLife Conservation Series no. 11. Newbury and Cambridge, UK: Pisces Publications and BirdLife International.		KBA identification and delineation in progress by Guineé Ecologie.
Guinea Bissau	Dodman, T., Barlow, C., Sá, J. and Robertson, P. 2004. *Zonas Importantes para as Aves em Guiné-Bissau/Important Bird Areas in Guinea-Bissau*. Wetlands International, Dakar/Gabinete de Planificação Costeira/ODZH, Bissau.		
Guyana			KBA identification and delineation in progress.
Hong Kong	BirdLife International. 2004. *Important Bird Areas in Asia: Key Sites for Conservation*. Cambridge, UK: BirdLife International (BirdLife Conservation series 13). BLI/PB/09j and AS/AA/92.		
Hungary	Heath, M.F., Evans, M.I., Hoccom, D.G., Payne, A.J. and Peet, N.B. (Eds) 2000. *Important Bird Areas in Europe: Priority Sites for Conservation, Volume 1 Northern Europe, Volume 2 Southern Europe*. Cambridge, UK: BirdLife International.		
Iceland	Heath, M.F., Evans, M.I., Hoccom, D.G., Payne, A.J. and Peet, N.B. (Eds) 2000. *Important Bird Areas in Europe: Priority Sites for Conservation, Volume 1 Northern Europe, Volume 2 Southern Europe*. Cambridge, UK: BirdLife International.		
India	Jhunjhunwala, S. 2001. *Important Bird Areas in Maharashtra*. RSPB, Bombay Natural History Society and BirdLife International. 27/AS/IN.mh/IS/IBA.01.J. Zafar-ul Islam, M. 2001, *Important Bird Areas of the Western Ghats, Kerala*. Bombay, India: Bombay Natural History Society. AS/IN/69. Rahmani, A.R. and Zafar-ul Islam, M. (Eds) 2004. *Important Bird Areas in India: Priority Sites for Conservation*. Mumbai, India: Indian Bird Conservation Network. AS/IN/65. BirdLife International. 2004. *Important Bird Areas in Asia: Key Sites for Conservation*. Cambridge, UK: BirdLife International (BirdLife Conservation series 13). BLI/PB/09j and AS/AA/92.	PRAGYA	Preliminary KBAs for the Western Ghats identified in 2004 by ATREE.[2]

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Indonesia	Rudyanto and Rombang, W. 1999. *Important Bird Areas in Java*. Bogor, Indonesia: BirdLife International Indonesia Programme. AS/ID/77. Holmes, D. and Rombang, W.M. 2001. *Daerah Penting bagi Burung: Sumatera*. Bogor, Indonesia: PKA/BirdLife International – Indonesia Programme. AS/ID/95. Holmes, D., Rombang, W.M. and Octavani, D. 2001. *Daerah Penting bagi Burung: di Kalimantan*. Bogor, Indonesia: PKA/ BirdLife International – Indonesia Programme. AS/ID/100. Rombang, W.M., Trainor. C. and Lesmana, D. 2002. *Daerah Penting bagi Burung: Nusa Tenggara*. Bogor, Indonesia: PHKA/ BirdLife International. AS/ID/110. BirdLife International. 2004. *Important Bird Areas in Asia: Key Sites for Conservation*. Cambridge, UK: BirdLife International (BirdLife Conservation series 13). BLI/PB/09j and AS/AA/92.		KBA identification and delineation completed for Sumatra in 2006.
Iran	Evans, M.I.,(Ed.) 1994. *Important Bird Areas in the Middle East*. Cambridge, UK: BirdLife International (BirdLife Conservation Series 2).		Preliminary KBAs identified in 2002 by WWF-Caucasus.[2]
Iraq	Evans, M.I.,(Ed.). 1994. *Important Bird Areas in the Middle East*. Cambridge, UK: BirdLife International (BirdLife Conservation Series 2).		
Ireland	Magee, E. and Coveney, J. 1995. *Important Bird Areas (IBAs): threats and protection status*. Monkstown, Ireland: Irish Wildbird Conservancy. Heath, M.F., Evans, M.I., Hoccom, D.G., Payne, A.J. and Peet, N.B. (Eds) 2000. *Important Bird Areas in Europe: Priority Sites for Conservation, Volume 1 Northern Europe, Volume 2 Southern Europe*. Cambridge, UK: BirdLife International.		
Israel	Gancz, Ady. (Ed.) 1997. *The Torgos No 27, Winter 97–98: Important Bird Areas in Israel*. Society for the Protection of Nature in Israel. 113pp. Evans, M.I. (Ed.) 1994. *Important Bird Areas in the Middle East*. Cambridge, UK: BirdLife International (BirdLife Conservation Series 2).		
Italy	Lambertini, M., Gustin, M., Faralli, U. e Tallone, G. 1991. *IBA – Italia. Aree di Importanza Europea per gli Uccelli Selvatici in Italia*. Parma, Italy: Lega Italiana Protezione Uccelli. 263pp. Gariboldi, A. et al. 2000. *Aree Importanti per L'Avifauna in Italia*. Parma, Italy: LIPU. 528pp. Heath, M.F., Evans, M.I., Hoccom, D.G., Payne, A.J. and Peet, N.B. (Eds) 2000. *Important Bird Areas in Europe: Priority Sites for Conservation, Volume 1 Northern Europe, Volume 2 Southern Europe*. Cambridge, UK: BirdLife International.		
Japan	Wild Bird Society of Japan. 2005. [Important Bird Areas in Japan 2005]. Tokyo, Japan: Wild Bird Society of Japan. (In Japanese). BirdLife International. 2004. *Important Bird Areas in Asia: Key Sites for Conservation*. Cambridge, UK: BirdLife International (BirdLife Conservation series 13). BLI/PB/09j and AS/AA/92.		
Jordan	Evans, M.I. (Ed.) 1994. *Important Bird Areas in the Middle East*. Cambridge, UK: BirdLife International (BirdLife Conservation Series 2).		
Kazakhstan	Skliarenko, S.L. 2005. *Inventory of Important Bird Areas in Kazakhstan: Interim Report*. ASBK.		

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Kenya	Bennun, L. and Njoroge, P. 1999. *Important Bird Areas in Kenya*. Nairobi, Kenya: Nature Kenya. 318pp.		Preliminary KBAs identified by Nature Kenya in 2003 for the Eastern Arc Mountains and Coastal Forests.[2]
Kuwait	Evans, M.I. (Ed.) 1994. *Important Bird Areas in the Middle East*. Cambridge, UK: BirdLife International (BirdLife Conservation Series 2).		
Latvia	Viksne, J. *Putniem Nozimigas Vietas Latvija* [Important Bird Areas in Latvia]. Riga, Latvia: Latvijas Ornitologijas (+ in prep.) Biedriba. 45pp. Rainskis, E. and Stipniece, A. *Putneim starptautiski nozimigas vietas Latvija*. 184pp. Racinskis, E. 2004. *Important Bird Areas of European Union importance in Latvia*. Riga, Latvia: Latvian Ornithological Society. Heath, M.F., Evans, M.I., Hoccom, D.G., Payne, A.J. and Peet, N.B. (Eds) 2000. *Important Bird Areas in Europe: Priority Sites for Conservation, Volume 1 Northern Europe, Volume 2 Southern Europe*. Cambridge, UK: BirdLife International.		
Laos	BirdLife International. 2004. *Important Bird Areas in Asia: Key Sites for Conservation*. Cambridge, UK: BirdLife International (BirdLife Conservation series 13). BLI/PB/09j and AS/AA/92.		Preliminary KBAs identified in 2004 by BirdLife Indochina.[2]
Lebanon	Evans, M.I. (Ed.) 1994. *Important Bird Areas in the Middle East*. Cambridge, UK: BirdLife International (BirdLife Conservation Series 2).		
Lesotho	Fishpool, L.D.C. and Evans, M.I. 2001. *Important Bird Areas of Africa and Associated Islands: Priority Sites for Conservation*. BirdLife Conservation Series no. 11. Newbury and Cambridge, UK: Pisces Publications and BirdLife International.		
Liberia	Fishpool, L.D. C. and Evans, M. I. 2001. *Important Bird Areas of Africa and Associated Islands: Priority Sites for Conservation*. BirdLife Conservation Series no. 11. Newbury and Cambridge, UK: Pisces Publications and BirdLife International.		KBA identification and delineation in progress by Fauna & Flora International, Society for the Conservation of Nature in Liberia.
Socialist People's Libyan Arab Jamahiriya	Fishpool, L.D.C. and Evans, M.I. 2001. *Important Bird Areas of Africa and Associated Islands: Priority Sites for Conservation*. BirdLife Conservation Series no. 11. Newbury and Cambridge, UK: Pisces Publications and BirdLife International.		
Liechtenstein	Heath, M.F., Evans, M.I., Hoccom, D.G., Payne, A.J. and Peet, N.B. (Eds) 2000. *Important Bird Areas in Europe: Priority Sites for Conservation, Volume 1 Northern Europe, Volume 2 Southern Europe*. Cambridge, UK: BirdLife International.		
Lithuania	Raudonikis. L. and Kurlavicius, P. *Important Bird Areas in Lithuania*. Lutute, Vilnius: Lithuanian Ornithological Society and Institute of Ecology. Raudonikis. L. *Important Bird Areas of the European Union Importance in Lithuania*. Lutute, Kaunas: Lithuanian Ornithological Society and Institute of Ecology. Heath, M.F., Evans, M.I., Hoccom, D.G., Payne, A.J. and Peet, N.B. (Eds) 2000. *Important Bird Areas in Europe: Priority Sites for Conservation, Volume 1 Northern Europe, Volume 2 Southern Europe*. Cambridge, UK: BirdLife International.		

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Luxembourg	Heath, M.F., Evans, M.I., Hoccom, D.G., Payne, A.J. and Peet, N.B. (Eds) 2000. *Important Bird Areas in Europe: Priority Sites for Conservation, Volume 1 Northern Europe, Volume 2 Southern Europe*. Cambridge, UK: BirdLife International.		
Macao	BirdLife International. 2004. *Important Bird Areas in Asia: Key Sites for Conservation*. Cambridge, UK: BirdLife International (BirdLife Conservation series 13). BLI/PB/09j and AS/AA/92.		
Macedonia FYR	Heath, M.F., Evans, M.I., Hoccom, D.G., Payne, A.J. and Peet, N.B. (Eds) 2000. *Important Bird Areas in Europe: Priority Sites for Conservation, Volume 1 Northern Europe, Volume 2 Southern Europe*. Cambridge, UK: BirdLife International.	Faculty of Biology, University of Sv. Kiril and Metoji	
Madagascar	Project ZICOMA. *Les Zones d'Importance pour la Conservation des Oiseaux à Madagascar*. Antananarivo, Madagascar. 266pp.		KBA identification completed in 2006 by CI-Madagascar.
Madeira	Heath, M.F., Evans, M.I., Hoccom, D.G., Payne, A.J. and Peet, N.B. (Eds) 2000. *Important Bird Areas in Europe: Priority Sites for Conservation, Volume 1 Northern Europe, Volume 2 Southern Europe*. Cambridge, UK: BirdLife International.		
Malawi	Fishpool, L.D.C. and Evans, M.I. 2001. *Important Bird Areas of Africa and Associated Islands: Priority Sites for Conservation*. BirdLife Conservation Series no. 11. Newbury and Cambridge, UK: Pisces Publications and BirdLife International.		
Malaysia	BirdLife International. 2004. *Important Bird Areas in Asia: Key Sites for Conservation*. Cambridge, UK: BirdLife International (BirdLife Conservation series 13). BLI/PB/09j and AS/AA/92.		
Maldives	BirdLife International. 2004. *Important Bird Areas in Asia: Key Sites for Conservation*. Cambridge, UK: BirdLife International (BirdLife Conservation series 13). BLI/PB/09j and AS/AA/92.		
Mali	Fishpool, L.D.C. and Evans, M.I. 2001. *Important Bird Areas of Africa and Associated Islands: Priority Sites for Conservation*. BirdLife Conservation Series no. 11. Newbury and Cambridge, UK: Pisces Publications and BirdLife International.		
Malta	Borg, J.J. and Sultana, J. 2004. *Important Bird Areas of EU importance in Malta*. Ta' Xbiex, Malta: BirdLife Malta. Heath, M.F., Evans, M.I., Hoccom, D.G., Payne, A.J. and Peet, N.B. (Eds) 2000. *Important Bird Areas in Europe: Priority Sites for Conservation, Volume 1 Northern Europe, Volume 2 Southern Europe*. Cambridge, UK: BirdLife International.		
Mauritania	Fishpool, L.D.C. and Evans, M.I. 2001. *Important Bird Areas of Africa and Associated Islands: Priority Sites for Conservation*. BirdLife Conservation Series no. 11. Newbury and Cambridge, UK: Pisces Publications and BirdLife International.		
Mauritius	Fishpool, L.D.C. and Evans, M.I. 2001. *Important Bird Areas of Africa and Associated Islands: Priority Sites for Conservation*. BirdLife Conservation Series no. 11. Newbury and Cambridge, UK: Pisces Publications and BirdLife International.		
Mayotte	Fishpool, L.D.C. and Evans, M.I. 2001. *Important Bird Areas of Africa and Associated Islands: Priority Sites for Conservation*. BirdLife Conservation Series no. 11. Newbury and Cambridge, UK: Pisces Publications and BirdLife International.		

Country	IBA publication	IPAs[1]	KBAs
Mexico	Del Coro Arizmendi, Ma. y Marquez Vadelamar, Laura. (Eds) *Áreas de Importancia para la Conservación de las Aves en México*. 440pp.		Preliminary KBAs identified for the region east of the Isthmus of Tehuantepec in 2003. Refinement in progress.
Moldova	Heath, M.F., Evans, M.I., Hoccom, D.G., Payne, A.J. and Peet, N.B. (Eds) 2000. *Important Bird Areas in Europe: Priority Sites for Conservation, Volume 1 Northern Europe, Volume 2 Southern Europe*. Cambridge, UK: BirdLife International.		
Mongolia	BirdLife International. 2004. *Important Bird Areas in Asia: Key Sites for Conservation*. Cambridge, UK: BirdLife International (BirdLife Conservation series 13). BLI/PB/09j and AS/AA/92.		
Montenegro		University of Podgorica	
Morocco	Fishpool, L.D.C. and Evans, M.I. 2001. *Important Bird Areas of Africa and Associated Islands: Priority Sites for Conservation*. BirdLife Conservation Series no. 11. Newbury and Cambridge, UK: Pisces Publications and BirdLife International.	Scientific Institute, Rabat	
Mozambique	Fishpool, L.D.C. and Evans, M.I. 2001. *Important Bird Areas of Africa and Associated Islands: Priority Sites for Conservation*. BirdLife Conservation Series no. 11. Newbury and Cambridge, UK: Pisces Publications and BirdLife International.	National Institute of Agronomical Research (INIA)	
Myanmar	BirdLife International. 2004. *Important Bird Areas in Asia: Key Sites for Conservation*. Cambridge, UK: BirdLife International (BirdLife Conservation series 13). BLI/PB/09j and AS/AA/92.		Preliminary KBAs identified in 2004 by BirdLife Indochina. [2]
Namibia	Fishpool, L.D.C. and Evans, M.I. 2001. *Important Bird Areas of Africa and Associated Islands: Priority Sites for Conservation*. BirdLife Conservation Series no. 11. Newbury and Cambridge, UK: Pisces Publications and BirdLife International.	National Botanical Research Institute	
Nepal	Baral, H.S. and Inskipp, C. 2005. *Important bird areas in Nepal: key sites for conservation*. Kathmandu, Nepal and Cambridge, UK: Bird Conservation Nepal and BirdLife International. 242pp. BirdLife International. 2004. *Important Bird Areas in Asia: Key Sites for Conservation*. Cambridge, UK: BirdLife International (BirdLife Conservation series 13). BLI/PB/09j and AS/AA/92.	Ethnobotanical Society of Nepal	Preliminary KBAs identified in 2004 by BirdLife Indochina and WWF. [2]
Netherlands	van den Tempel, R. and Osieck, E.R. [Areas important for birds in the Netherlands: wetlands and other areas of international or European importance for birds.] Zeist, Netherlands: Vogelbescherming Nederland (Techn. Rep. 13E). (In Dutch.) 126pp Eggenhuizen, T. and van den Tempel, R. *Belangrijke Vogelgebieden*. Zeist, Netherlands: Vogelbescherming Nederland. 160pp. Heath, M.F., Evans, M.I., Hoccom, D.G., Payne, A.J. and Peet, N.B. (Eds) 2000. *Important Bird Areas in Europe: Priority Sites for Conservation, Volume 1 Northern Europe, Volume 2 Southern Europe*. Cambridge, UK: BirdLife International.		
Nicaragua			KBA identification and delineation in progress by Fundacion Cocibolca.

Country	IBA publication	IPAs[1]	KBAs
Niger	Fishpool, L.D.C. and Evans, M.I. 2001. *Important Bird Areas of Africa and Associated Islands: Priority Sites for Conservation*. BirdLife Conservation Series no. 11. Newbury and Cambridge, UK: Pisces Publications and BirdLife International.		
Nigeria	Fishpool, L.D.C. and Evans, M.I. 2001. *Important Bird Areas of Africa and Associated Islands: Priority Sites for Conservation*. BirdLife Conservation Series no. 11. Newbury and Cambridge, UK: Pisces Publications and BirdLife International.		
North Korea	BirdLife International. 2004. *Important Bird Areas in Asia: Key Sites for Conservation*. Cambridge, UK: BirdLife International (BirdLife Conservation series 13). BLI/PB/09j and AS/AA/92.		
Norway	Heath, M.F., Evans, M.I., Hoccom, D.G., Payne, A.J. and Peet, N.B. (Eds) 2000. *Important Bird Areas in Europe: Priority Sites for Conservation, Volume 1 Northern Europe, Volume 2 Southern Europe*. Cambridge, UK: BirdLife International.		
Oman	Evans, M.I. (Ed.) 1994. *Important Bird Areas in the Middle East*. Cambridge, UK: BirdLife International (BirdLife Conservation Series 2).		
Pakistan	BirdLife International. 2004. *Important Bird Areas in Asia: Key Sites for Conservation*. Cambridge, UK: BirdLife International (BirdLife Conservation series 13). BLI/PB/09j and AS/AA/92.	WWF Pakistan	
Palestine	Atrash, I. 1999. *Important Bird Areas in Palestine*.		
Panama	Angehr, G.R. Directorio de áreas importantes para aves en Panamá – Directory of Important Bird Areas in Panama. Panamá: Panama Audubon Society/BirdLife International/Vogelbescherming Nederland. 342pp.		Preliminary KBAs identified in 2004. Refinement and delineation is in progress by ANCON.
Peru	BirdLife International y Conservation International. 2005. Áreas Importantes para la Conservación de las Aves en los Andes Tropicales: Sitios Prioritarios para la Conservación de la Biodiversidad. Quito, Ecuador: BirdLife International (Conservation Series No. 14).		KBA identification and delineation in progress
Philippines	Mallari, N.A., Tabaranza, B.R. and Crosby, M. 2001. *Key Conservation Sites in the Philippines*. Manila, Philippines: Bookmark. BirdLife International. 2004. *Important Bird Areas in Asia: Key Sites for Conservation*. Cambridge, UK: BirdLife International (BirdLife Conservation series 13).		Terrestrial KBA identification and delineation completed in 2006 by CI-Philippines, The Haribon Foundation and DENR-PAWB.
Poland	Gromadzki, M., Dyrcz, A., Glowacinski, Z. and Wieloch, M. *Ostoje Ptaków w Polsce*. Gdansk, Poland: Ogólnopolskie Towarzystwo Ochrony Ptaków. 403pp. Gromadzki, M. and Sidlo, P.O. 2000. *Ostoje ptaków na polskim wybrzezu Baltyku* [Important Bird Areas on the Polish Baltic coast]. Gdansk, Poland: Ogólnopolskie Towarzystwo Ochrony Ptaków. Heath, M.F., Evans, M.I., Hoccom, D.G., Payne, A.J. and Peet, N.B. (Eds) 2000. *Important Bird Areas in Europe: Priority Sites for Conservation, Volume 1 Northern Europe, Volume 2 Southern Europe*. Cambridge, UK: BirdLife International.	Mirek Z., Paul W. and Wilk L. 2005. Ostoje Ros' linne w Polsce. Instytut Botaniki im. W. Szafera Polska Academia Nauk, Kraków 2005.	

Country	IBA publication	IPAs[1]	KBAs
Portugal	Costa, L.T., Nunes, M., Geraldes, P. and Costa, H. *Zonas Importantas para as Aves em Portugal*. Lisboa, Portugal: Sociedade Portuguesa para o Estdo das Aves. 160pp. Heath, M.F., Evans, M.I., Hoccom, D.G., Payne, A.J. and Peet, N.B. (Eds) 2000. *Important Bird Areas in Europe: Priority Sites for Conservation, Volume 1 Northern Europe, Volume 2 Southern Europe*. Cambridge, UK: BirdLife International.		
Qatar	Evans, M.I. (Ed.) 1994. *Important Bird Areas in the Middle East*. Cambridge, UK: BirdLife International (BirdLife Conservation Series 2).		
La Réunion	Fishpool, L.D.C. and Evans, M.I. 2001. *Important Bird Areas of Africa and Associated Islands: Priority Sites for Conservation*. BirdLife Conservation Series no. 11. Newbury and Cambridge, UK: Pisces Publications and BirdLife International.		
Romania	Heath, M.F., Evans, M.I., Hoccom, D.G., Payne, A.J. and Peet, N.B. (Eds) 2000. *Important Bird Areas in Europe: Priority Sites for Conservation, Volume 1 Northern Europe, Volume 2 Southern Europe*. Cambridge, UK: BirdLife International.	Association of Botanical Gardens	
Russian Federation	Sviridova, T.V. and Zubakin, V.A. (Eds) 2000. [Important Bird Areas of Russia. Volume 1. Important Bird Areas of European Russia]. Moscow, Russian Federation: Bird Conservation Union. 702pp. (In Russian). Kondratyev, A. *Important Bird Areas of the Baltic region of Russia (Kaliningrad and Leningrad regions)*. RBCU. Heath, M.F., Evans, M.I., Hoccom, D.G., Payne, A.J. and Peet, N.B. (Eds) 2000. *Important Bird Areas in Europe: Priority Sites for Conservation, Volume 1 Northern Europe, Volume 2 Southern Europe*. Cambridge, UK: BirdLife International.		Preliminary KBAs identified for part of Caucasus portion of the country in 2002 by WWF-Caucasus.[2]
Russian Federation (Eastern)	BirdLife International. 2004. *Important Bird Areas in Asia: Key Sites for Conservation*. Cambridge, UK: BirdLife International (BirdLife Conservation series 13). BLI/PB/09j and AS/AA/92.		
Rwanda	Fishpool, L.D.C. and Evans, M.I. 2001. *Important Bird Areas of Africa and Associated Islands: Priority Sites for Conservation*. BirdLife Conservation Series no. 11. Newbury and Cambridge, UK: Pisces Publications and BirdLife International.		
Samoa			Preliminary KBAs identified in 2004 by CI-Melanesia/ Pacific. [2]
São Tomé and Príncipe	Fishpool, L.D.C. and Evans, M.I. 2001. *Important Bird Areas of Africa and Associated Islands: Priority Sites for Conservation*. BirdLife Conservation Series no. 11. Newbury and Cambridge, UK: Pisces Publications and BirdLife International.		
Saudi Arabia	Evans, M.I. (Ed.) 1994. *Important Bird Areas in the Middle East*. Cambridge, UK: BirdLife International (BirdLife Conservation Series 2).		
Senegal	Fishpool, L.D.C. and Evans, M.I. 2001. *Important Bird Areas of Africa and Associated Islands: Priority Sites for Conservation*. BirdLife Conservation Series no. 11. Newbury and Cambridge, UK: Pisces Publications and BirdLife International.		
Serbia		University of Belgrade SAS	
Seychelles	Fishpool, L.D.C. and Evans, M.I. 2001. *Important Bird Areas of Africa and Associated Islands: Priority Sites for Conservation*. BirdLife Conservation Series no. 11. Newbury and Cambridge, UK: Pisces Publications and BirdLife International.		

Country	IBA publication	IPAs[1]	KBAs
Sierra Leone	Okoni-Williams, A., Thompson, H.S., Koroma, A.P. and Wood, P. 2005. *Important Bird Areas in Sierra Leone: priorities for biodiversity conservation*. Conservation Society of Sierra Leone and Forestry Division, GOSL. Fishpool, L.D.C. and Evans, M.I. 2001. *Important Bird Areas of Africa and Associated Islands: Priority Sites for Conservation*. BirdLife Conservation Series no. 11. Newbury and Cambridge, UK: Pisces Publications and BirdLife International.		
Singapore	BirdLife International. 2004. *Important Bird Areas in Asia: Key Sites for Conservation*. Cambridge, UK: BirdLife International (BirdLife Conservation series 13). BLI/PB/09j and AS/AA/92.		
Slovakia	Hora, J. and Kanuch, P. [Important Bird Areas in Europe—Czechoslovakia.] Prague, Czechoslovakia: Czechoslovakia Section of the International Council for Bird Preservation. 124pp. Rybanic, R., Sutiakova, T. and Benko, S. (Eds) 2004. [Important bird areas of European Union importance in Slovakia]. Bratislava, Slovakia: Society for the Protection of Birds in Slovakia. (In Slovakian with English summaries.) EU/SK/03. Heath, M.F., Evans, M.I., Hoccom, D.G., Payne, A.J. and Peet, N.B. (Eds) 2000. *Important Bird Areas in Europe: Priority Sites for Conservation, Volume 1 Northern Europe, Volume 2 Southern Europe*. Cambridge, UK: BirdLife International.	DAPHNE Institute of Applied Ecology	
Slovenia	Polak, S. *Mednarodno Pomembna Obmocja za Ptice v Sloveniji* [Important Bird Areas (IBAs) in Slovenia]. Ljubljana, Slovenia: DOPPS. EU/SI/03. Bozic, L. 2003. *Important Bird Areas (IBA) in Slovenia 2: proposed special protected areas (SPA) in Slovenia*. Slovenia: DOPPS-BirdLife Slovenia. Heath, M.F., Evans, M.I., Hoccom, D.G., Payne, A.J. and Peet, N.B. (Eds) 2000. *Important Bird Areas in Europe: Priority Sites for Conservation, Volume 1 Northern Europe, Volume 2 Southern Europe*. Cambridge, UK: BirdLife International.	University of Ljubljana	
Somalia	Fishpool, L.D.C. and Evans, M.I. 2001. *Important Bird Areas of Africa and Associated Islands: Priority Sites for Conservation*. BirdLife Conservation Series no. 11. Newbury and Cambridge, UK: Pisces Publications and BirdLife International.		
South Africa	Barnes, K.N. (Ed.) *The Important Bird Areas of southern Africa*. Johannesburg, South Africa: BirdLife South Africa. 394pp. Fishpool, L.D.C. and Evans, M.I. 2001. *Important Bird Areas of Africa and Associated Islands: Priority Sites for Conservation*. BirdLife Conservation Series no. 11. Newbury and Cambridge, UK: Pisces Publications and BirdLife International.	South African National Biodiversity Institute	
South Korea	BirdLife International. 2004. *Important Bird Areas in Asia: Key Sites for Conservation*. Cambridge, UK: BirdLife International (BirdLife Conservation series 13). BLI/PB/09j and AS/AA/92.		
Spain (regional pilots)	de Juana, E. (Ed.) 1992. *Áreas Importantes para las Aves en España*. Madrid, Spain: Sociedad Española de Ornitología (Monografía 3). 183pp. Viada, C. 1998. *Áreas Importantes para las Aves en España*. Madrid, Spain: Sociedad Española de Ornitología/BirdLife (Monografía 5). 398pp. Heath, M.F., Evans, M.I., Hoccom, D.G., Payne, A.J. and Peet, N.B. (Eds) 2000. *Important Bird Areas in Europe: Priority Sites for Conservation, Volume 1 Northern Europe, Volume 2 Southern Europe*. Cambridge, UK: BirdLife International.		

Country	IBA publication	IPAs[1]	KBAs
Sri Lanka	*Preliminary IBA Site directory*. Columbo, Sri Lanka: Field Ornithology Group of Sri Lanka. 130pp. BirdLife International. 2004. *Important Bird Areas in Asia: Key Sites for Conservation*. Cambridge, UK: BirdLife International (BirdLife Conservation series 13). BLI/PB/09j and AS/AA/92.		Preliminary KBAs were identified and delineated by the Wildlife Heritage Trust, in 2004. [2]
St. Helena	Fishpool, L.D.C. and Evans, M.I. 2001. *Important Bird Areas of Africa and Associated Islands: Priority Sites for Conservation*. BirdLife Conservation Series no. 11. Newbury and Cambridge, UK: Pisces Publications and BirdLife International.		
Sudan	Fishpool, L.D.C. and Evans, M.I. 2001. *Important Bird Areas of Africa and Associated Islands: Priority Sites for Conservation*. BirdLife Conservation Series no. 11. Newbury and Cambridge, UK: Pisces Publications and BirdLife International.		
Suriname			KBA identification and delineation in progress.
Svalbard and Jan Mayen	Heath, M.F., Evans, M.I., Hoccom, D.G., Payne, A.J. and Peet, N.B. (Eds) 2000. *Important Bird Areas in Europe: Priority Sites for Conservation, Volume 1 Northern Europe, Volume 2 Southern Europe*. Cambridge, UK: BirdLife International.		
Swaziland	Fishpool, L.D.C. and Evans, M.I. 2001. *Important Bird Areas of Africa and Associated Islands: Priority Sites for Conservation*. BirdLife Conservation Series no. 11. Newbury and Cambridge, UK: Pisces Publications and BirdLife International.		
Sweden	Heath, M.F., Evans, M.I., Hoccom, D.G., Payne, A.J. and Peet, N.B. (Eds) 2000. *Important Bird Areas in Europe: Priority Sites for Conservation, Volume 1 Northern Europe, Volume 2 Southern Europe*. Cambridge, UK: BirdLife International.		
Switzerland	Heath, M.F., Evans, M.I., Hoccom, D.G., Payne, A.J. and Peet, N.B. (Eds) 2000. *Important Bird Areas in Europe: Priority Sites for Conservation, Volume 1 Northern Europe, Volume 2 Southern Europe*. Cambridge, UK: BirdLife International.		
Syria	Evans, M.I. (Ed.) 1994. *Important Bird Areas in the Middle East*. Cambridge, UK: BirdLife International (BirdLife Conservation Series 2).		
Taiwan	Huang, M., Hsieh, J. and Lai, P.H. 2001. *Important Bird Areas in Taiwan*. Taipei, Taiwan: Wild Bird Federation Taiwan. 187pp. BirdLife International. 2004. *Important Bird Areas in Asia: Key Sites for Conservation*. Cambridge, UK: BirdLife International (BirdLife Conservation series 13). BLI/PB/09j and AS/AA/92.		
Tanzania	Baker, E. and Baker, N. 2002. *Important Bird Areas in Tanzania*. RSBP. 302pp.		Preliminary KBAs identified in 2003 for the Eastern Arc Mountains and Coastal Forests by Wildlife Conservation Society of Tanzania.[2]

Country	IBA publication	IPAs[1]	KBAs
Thailand	Pimathi, R., Jukmongkol, R., Round, P.D. and Tordoff, A.W. (Eds) 2004. *Directory of Important Bird Areas in the Kingdom of Thailand: Key Sites for Conservation*. Bangkok, Thailand: Bird Conservation Society of Thailand and BirdLife International. AS/TH/07a, AS/TH/07b (CD ROM). BirdLife International. 2004. *Important Bird Areas in Asia: Key Sites for Conservation*. Cambridge, UK: BirdLife International (BirdLife Conservation series 13). BLI/PB/09j and AS/AA/92.		Preliminary KBAs identified in 2004 by BirdLife Indochina.[2]
Timor-Leste	BirdLife International. 2004. *Important Bird Areas in Asia: Key Sites for Conservation*. Cambridge, UK: BirdLife International (BirdLife Conservation series 13). BLI/PB/09j and AS/AA/92.		
Togo	Fishpool, L.D.C. and Evans, M.I. 2001. *Important Bird Areas of Africa and Associated Islands: Priority Sites for Conservation*. BirdLife Conservation Series no. 11. Newbury and Cambridge, UK: Pisces Publications and BirdLife International.		
Tonga			Preliminary KBAs identified in 2004 by CI-Melanesia/ Pacific. [2]
Tunisia	Fishpool, L.D.C. and Evans, M.I. 2001. *Important Bird Areas of Africa and Associated Islands: Priority Sites for Conservation*. BirdLife Conservation Series no. 11. Newbury and Cambridge, UK: Pisces Publications and BirdLife International.		
Turkey	Ertan, A., Kılıç, A. and Kasparek, M. 1989. *Türkiye'nin Önemli Kus Alanlari*. Istanbul, Turkey: Doğal Hayatý Koruma Derneği. 155pp. Magnin, G. and Yarar, M. 1997. [Important Bird Areas in Turkey.] Istanbul, Turkey: Doğal Hayatý Koruma Derneği. 313pp. Heath, M.F., Evans, M.I., Hoccom, D.G., Payne, A.J. and Peet, N.B. (Eds) 2000. *Important Bird Areas in Europe: Priority Sites for Conservation, Volume 1 Northern Europe, Volume 2 Southern Europe*. Cambridge, UK: BirdLife International.	Özhataty, N., Byfield, A. and Atay, S. 2003. Türkiye'n Önemli Bitki Alanlan WWF Türkiye (Doğal Hayati Koruma Vakfi) Istanbul, Türkiye.	Eken, G., Bozdoğan, M., İsfendiyaroğlu, S., Kılıç, D.T., Lise, Y. (Editörler) 2006. Türkiye'nin Önemli Doğa Alanlar. Doğa Derneği, Ankara.
United Arab Emirates	Evans, M.I. (Ed.) 1994. *Important Bird Areas in the Middle East*. Cambridge, UK: BirdLife International (BirdLife Conservation Series 2).		
Uganda	Byaruhanga, A., Kasoma, P. and Pomeroy, D. 2001. *Important Bird Areas in Uganda*. Kampala, Uganda: Nature Uganda – The East African Natural History Society. AF/UG/49.		
Ukraine	Ikityuk, A. 1999. [Important Bird Areas of the Ukraine]. Kiev, Ukraine: Ukrainian Union for Bird Conservation. (In Russian). Heath, M.F., Evans, M.I., Hoccom, D.G., Payne, A.J. and Peet, N.B. (Eds) 2000. *Important Bird Areas in Europe: Priority Sites for Conservation, Volume 1 Northern Europe, Volume 2 Southern Europe*. Cambridge, UK: BirdLife International.	Institute of Botany, UAS, Kyiv	
United Kingdom	Pritchard, D.E., Housden, S.D., Mudge, G.P., Galbraith, C.A. and Pienkowski, M.W. (Eds) *Important Bird Areas in the UK including the Channel Islands and the Isle of Man*. Sandy, UK: Royal Society for the Protection of Birds. 540pp. Heath, M.F., Evans, M.I., Hoccom, D.G., Payne, A.J. and Peet, N.B. (Eds) 2000. *Important Bird Areas in Europe: Priority Sites for Conservation, Volume 1 Northern Europe, Volume 2 Southern Europe*. Cambridge, UK: BirdLife International.	Plantlife International, Salisbury	

Country	IBA publication	IPAs[1]	KBAs
USA	Wells, J.V. 1998. *Important Bird Areas in New York State*. New York, USA: National Audubon Society. Crossley, G.J. 1999. *Important Bird Areas in Pennsylvania: a guide to identifying and conserving critical bird habitat*. Camp Hill, USA: Pennsylvania Audubon Society. Cullinan, T. 2001. *Important Bird Areas of Washington*. Olympia WA, USA: Audubon Washington. 170pp Lyon, A. 2002. *Important Bird Areas of Wyoming*. Casper WY, USA: Audubon Wyoming. 86pp. Cooper, D.S. 2004. *Important Bird Areas of California*. Pasadena CA, USA: Audubon California. 286pp. Burger, M.F. and Liner, J.M. 2005. *Important Bird Areas of New York. Second edition. Habitats Worth Protecting.* New York, USA: Audubon New York. 352pp. McIvor, D.E. 2005. *Important Bird Areas of Nevada*. Reno, USA: Lahontan Audubon Society. 150pp.		
Venezuela	BirdLife International y Conservation International. 2005. *Áreas Importantes para la Conservación de las Aves en los Andes Tropicales: Sitios Prioritarios para la Conservación de la Biodiversidad*. Quito, Ecuador: BirdLife International (Conservation Series No. 14).		KBA identification and delineation in progress.
Vietnam	Tordoff, A.W. (Ed.) 2002. *Directory of Important Bird Areas in Vietnam: Key Sites for Conservation*. Hanoi, Vietnam: BirdLife International in Indochina and the Institute of Ecology and Biological Resources. 233pp. BirdLife International. 2004. *Important Bird Areas in Asia: Key Sites for Conservation*. Cambridge, UK: BirdLife International (BirdLife Conservation series 13). BLI/PB/09j and AS/AA/92.		Preliminary KBAs identified in 2004 by BirdLife Indochina.[2]
Yemen	Evans, M.I. (Ed.) 1994. *Important Bird Areas in the Middle East*. Cambridge, UK: BirdLife International (BirdLife Conservation Series 2).		
Former Republic of Yugoslavia	Heath, M.F., Evans, M.I., Hoccom, D.G., Payne, A.J. and Peet, N.B. (Eds) 2000.*Important Bird Areas in Europe: Priority Sites for Conservation, Volume 1 Northern Europe, Volume 2 Southern Europe*. Cambridge, UK: BirdLife International.		
Zambia	Leonard, P. 2005. *Important Bird Areas in Zambia*. Lusaka, Zambia: Zambian Ornithological Society. 218pp. Fishpool, L.D.C. and Evans, M.I. 2001. *Important Bird Areas of Africa and Associated Islands: Priority Sites for Conservation.* BirdLife Conservation Series no. 11. Newbury and Cambridge, UK: Pisces Publications and BirdLife International.		
Zimbabwe	Fishpool, L.D.C. and Evans, M.I. 2001. *Important Bird Areas of Africa and Associated Islands: Priority Sites for Conservation.* BirdLife Conservation Series no. 11. Newbury and Cambridge, UK: Pisces Publications and BirdLife International.		

Appendix II

Online data sources for identifying and delineating KBAs

The online databases listed below provide data that are useful for identifying and delineating KBAs. These include existing site-scale priorities, species distributional data, and contextual datasets.

A. Existing site-scale priorities

- Alliance for Zero Extinction (AZE) sites www.zeroextinction.org/
- Important Bird Areas www.birdlife.net/datazone/sites/index.html
- Important Plant Areas www.plantlife.org.uk/html/important_plant_areas/important_plant_areas_index.htm

B. Species distributional data

The species distributional data made available in the following online databases range from broad-scale distributions to point localities. The list is not geographically or taxonomically comprehensive.

Multiple Taxonomic Groups

- IUCN Red List of Threatened Species www.iucnredlist.org/
- Global Biodiversity Information Facility (GBIF) www.gbif.org/ – provides access to over 60 million specimen locality records from more than 120 museums and herbaria worldwide
- Species Analyst http://speciesanalyst.net/ – provides access to more than 60 institutional collections and is associated with taxon-specific databases for mammals (the Mammal Networked Information System), reptiles and amphibians (HerpNet), and fishes (FishNet)
- Biodiversity Hotspots Vertebrate Species Database www.biodiversityhotspots.org/xp/Hotspots/search/
- WildFinder www.worldwildlife.org/wildfinder/index.cfm
- Rapid Assessment Program Database http://farm.conservation.org/rap
- Information Center for the Environment's Biological Inventories of the World's Protected Areas www.ice.ucdavis.edu/bioinventory bioinventory.html
- Species 2000 www.sp2000.org/
- World Biodiversity Database www.eti.uva.nl/Database/WBD.html
- IUCN-SSC Species Action Plans www.iucn.org/themes/ssc/actionplans/actionplanindex.htm

Plants

- SALVIAS database http://eeb37.biosci.arizona.edu/pages/database_info.php
- TROPICOS database http://mobot.mobot.org/W3T/Search/vast.html – database initiative of the Missouri Botanical Garden that has made two million plant specimen records available

Birds

- Threatened Birds of the World www.birdlife.net/datazone/species/index.html
- Threatened Birds of Asia www.rdb.or.id/

Mammals

- Mammal Species of the World www.nmnh.si.edu/msw/
- Mammal Networked Information System http://elib.cs.berkeley.edu/manis/

Reptiles

- The EMBL Reptile Database www.embl-heidelberg.de/~uetz/Reptiles.html
- World Turtle Database http://emys.geo.orst.edu/main_pages/database.html
- HerpNet www.herpnet.org/

Amphibians

- Global Amphibian Assessment www.globalamphibians.org/
- Amphibian Species of the World http://research.amnh.org/herpetology/amphibia/index.php

- HerpNet www.herpnet.org/
- AmphibiaWeb http://elib.cs.berkeley.edu/aw/

Fishes

- A Catalog of the Species of Fishes www.calacademy.org/research/ichthyology/species/
- Fishbase www.fishbase.org/home.htm
- Inter-Institutional Database of Fish Biodiversity in the Neotropics (NEODAT) www.neodat.org/
- FishNet http://habanero.nhm.ku.edu/fishnet/

Orthoptera (Grasshoppers, Katydids, and Crickets)

- Orthoptera Species File http://osf2x.orthoptera.org/osf2.2/OSF2X2Frameset.htm

Spiders

- The World Spider Catalog http://research.amnh.org/entomology/spiders/catalog/index.html

Marine

- ReefBase www.reefbase.org/
- Ocean Biogeographic Information System (OBIS) www.iobis.org/Welcome.htm

C. Contextual data

The following datasets can be very useful for delineation of KBAs. In addition to the global datasets listed below, there are often higher resolution, better quality datasets available at the regional or national level from government agencies or NGOs.

Protected Areas

- World Database of Protected Areas http://sea.unep-wcmc.org/wdbpa/

Land cover

- Global Land Cover 2000 (1km resolution) www-gvm.jrc.it/glc2000/defaultGLC2000.htm
- Land Cover Type (1km resolution) http://duckwater.bu.edu/lc/mod12q1.html
- Vegetative Continuous Field / Percent Tree Cover (0.5km resolution) http://glcf.umiacs.umd.edu/data/modis/vcf/
- MODIS Visible Reflectance (1km resolution) http://earthobservatory.nasa.gov/Newsroom/BlueMarble/
- Landsat Mosaics (30m resolution) https://zulu.ssc.nasa.gov/mrsid/

Topography

- Shuttle Radar Topography Mission (90m resolution) http://srtm.usgs.gov/index.html
- The Global Land One-km Base Elevation (GLOBE) Project (1km resolution) www.ngdc.noaa.gov/mgg/topo/globe.html

Base map layers

- The Vector Map Level 0 (Formerly Digital Chart of the World – DCW) datasets of rivers, roads, cities, country and administrative borders http://geoengine.nga.mil/geospatial/SW_TOOLS/NIMAMUSE/webinter/rast_roam.html

Gazetteers

- BioGeomancer www.biogeomancer.org/
- Alexandria Digital Library Gazetteer http://testbed.alexandria.ucsb.edu/gazclient/index.jsp

Global scale priorities

- Biodiversity Hotspots www.biodiversityhotspots.org
- Endemic Bird Areas www.birdlife.net/action/science/endemic_bird_areas/
- Global 200 Ecoregions www.worldwildlife.org/science/ecoregions/g200.cfm
- High Biodiversity Wilderness Areas www.conservation.org/xp/news/press_releases/2002/120402.xml
- Last of the Wild and the Human Footprint www.ciesin.org/wild_areas/
- Frontier Forests http://forests.wri.org/pubs_description.cfm?PubID=2619
- Centres of Plant Diversity, the Americas www.nmnh.si.edu/botany/projects/cpd/namap.htm

Appendix III

Organizing data for a KBA-based gap analysis

Table 6 below gives an example of how to organize the data for a KBA-based gap analysis (Section 7.1). A matrix of *n* species versus *m* sites (in green) indicates the occurrence of each species across KBAs. The relative importance of each KBA for the conservation of each species is indicated using different codes (see legend below the table), depending on the available information. The following additional information is also provided for each species: the type of data used to code the species-site combination; the segment(s) of their life history when present in the country/region; the number of KBAs where they occur; their global threat status (following the IUCN Red List); and their degree of endemism. The following additional information is provided for each site: legal protection status; degree of site-based vulnerability (ideally, this would be given by species); and conservation cost (ideally, this would be given by species). Analyzing data for species with distinct distribution patterns throughout different segments of their life history is easier if each segment is presented separately (e.g., Species 4 in Table 6).

Table 6. Illustration of how to organize basic KBA data for a gap analysis

	KBA1	KBA2	KBA3	KBA4	KBA5	…	KBA*m*	Data type	Life history	No. of KBAs	IUCN	Endem.
Species 1	0	0	1	0	0	…	0	P/A	R	1	CR	100
Species 2	50	0	2	0	12	…	0	POP	J	3	NT	75
Species 3	0	< 10	0	10–25	0	…	25–50	HAB	R	8	VU	~20
Species 4 breeding	0	1	1	0	0	…	0	P/A	B	2	EN	100
Species 4 non-breeding	0	0	1	0	0	…	1	P/A	NB	4	EN	~10
Species 5	95	0	1	0	0	…	1	POP	R	3	CR	97
…	…	…	…	…	…	…	…	…	…	…	…	…
Species *n*	0	> 95	0	0	0	…	0	HAB	R	1	VU	100
# species	12	5	16	2	10	…	8					
Legal prot.	None	NP	NR	None	NP	…	None					
Vulnerability	H	L	H	M	?	…	M					
Cons. cost	H	L	M	M	?	…	H					

Data type: type of data used to assess relative importance of the site for each species:
P/A – if no information is available, then the data type is coded as presence (1) or absence (0);
HAB – estimate of the percentage of global population occurring at the site, based on data on extent and condition of suitable habitat;
POP – percentage of global population occurring at the site, based on population data.
Life history: life history segment(s) in which the species is present in the country/region of analysis:
R – year-round resident; **B** – breeding; **NB** – non-breeding; **M** – migratory; **J** – juvenile; **A** – adult.
No. of KBAs: number of KBAs where the species occurs in the country/region of analysis.
IUCN: species threat status according to the IUCN Red List:
CR – Critically Endangered; **EN** – Endangered; **VU** – Vulnerable; **NT** - Near Threatened;
LC – Least Concern; **DD** – Data Deficient.
Endem. – degree of endemism, assessed as the percentage of the species' global population estimated within the country/region of analysis.
 # species: number of trigger species known to occur at the site.
Legal prot. – legal protection status of the site:
None – no legal protection; NP – National Park; NR – Nature Reserve.
Vulnerability: site-based vulnerability:
H – high; **M** – medium; **L** – low; **?** – unknown.
Cons. Cost: cost of conservation action at the site:
H – high; **M** – medium; **L** – low; **?** – unknown.

In Table 6, it is assumed that site-based vulnerability varies across sites but is the same for all trigger species at the site. For example, a 'high' site-based vulnerability indicates that all species have a high risk of local extinction, perhaps because all species depend on forest that is being intensively logged. However, if information is available, it is more appropriate to code the site-based vulnerability of each individual species in each site separately: the threats may be different for different species (e.g., some species are hunted, others are not), species may be affected differently by ongoing change (e.g., some species cope well with conversion from forest to shaded coffee, others do not), and species may benefit from different levels of protection (e.g., some species receive supplemental feeding, others do not). Again, a matrix of *n* species × *m* sites is the best way of representing this information (Table 7). One methodology for assigning a site-based vulnerability score to each trigger species at each site is given in Box 18.

Table 7. Illustration of how to organize information on levels of site-based vulnerability for each trigger species at each site

	KBA 1	KBA 2	KBA 3	KBA 4	KBA 5	…	KBA *m*
Species 1	0	0	H	0	0	…	0
Species 2	L	0	H	0	?	…	0
Species 3	0	?	0	M	0	…	H
Species 4 breeding	0	L	L	0	0	…	0
Species 4 non-breeding	0	0	L	0	0	…	M
Species 5	H	0	H	0	0	…	M
…	…	…	…	…	…	…	…
Species *n*	0	L	0	0	0	…	0

Site-based vulnerability:
H – high; **M** – medium; **L** – low; **?** – unknown.

In Table 6, it is also assumed that conservation cost varies across sites but is the same for all species that occur at the site. For example, a 'low' conservation cost typically indicates a high opportunity (low financial cost, strong political will, available funding source, etc.) to do conservation action at the site. As above, conservation cost may also vary across the trigger species at any given site. For example, there may be political will/community support for implementing a ban on hunting of some species but not for others. If this information is available, a third table (similar to Table 7) could be created, to show the conservation cost for each individual trigger species at each site. If so, Table 6 would not have a row on conservation cost.

Assuming that data are organized in a similar way to that suggested here, the identification of sites that fall into a given priority level can be done through simple queries and/or filters. For example, in identifying sites that fall into Priority Level 1, sites with ≥95% of the global population of a CR species could be found by first filtering the species-site matrix to show only those species such that **IUCN** = "CR" and **Data type** = "POP" or "HAB"; any cell in the resulting sub-matrix with a value ≥95 falls into Priority Level 1 (in Table 6, this would be the case with KBA1, triggered by Species 5). Identifying sites holding an endemic, single-site, CR species could be done by filtering species such that **IUCN** = "CR" and **No. of KBAs** = 1 and Endem. ≥95%; any site where such species occur also meets Priority Level 1 (in Table 6, this would be the case with KBA3, triggered by Species 1).

Appendix IV

Presenting the results from a gap analysis

The following tables provide guidance on organizing information per KBA on the results of a gap analysis in tabular form.

Table 8. Suggestion for organizing information per KBA on the results of a gap analysis – priorities for expansion of the system of protected areas

KBA	Overview	Trigger species (criteria)	Threats	Overall level of conservation action at the site	Conservation measures needed	Opportunity
KBA1	**Legal status**: None **Priority level**: 1	**#Species**: 12 Species 2 (CR), Species 5 (EN); …; Species *n* (restricted-range)	**Very high impact**: Forest logging **Moderate impact**: Reduction in water quality as a result of increasing erosion.	**Very insufficient**: Not legally recognized. Privately owned. Owners actively engaged in the conservation of Species 2 by preventing over-fishing and committing not to build dams. However, ongoing logging is seriously threatening Species 5 at a global scale (95% of global population in this site), as well as affecting the regional populations of Species XX and YY.	*Extremely high urgency*: Stop all logging within the area where Species 5 is known or suspected to occur, and ideally in the entire KBA. *Medium urgency*: Monitor populations of Species 2 …	**Medium**: Land owners interested in conserving and providing adequate management for Species 2. By emphasizing the links with water quality, may be possible to reduce logging.

Table 9. Suggestion for organizing information per KBA on the results of a gap analysis – priorities for the consolidation of the system of protected areas

KBA	Overview	Trigger species (criteria)	Threats	Overall level of conservation action at the site	Conservation measures needed	Opportunity
KBA2	**Legal status**: National Park **IUCN PA category**: II **Priority level**: 2	**#Species**: 5 Species 3 (VU); Species 4(b) (EN); …; Species *n* (restricted-range)	**Low impact**: Agricultural encroachment; illegal hunting.	**Sufficient**: Legally protected as a National Park, which is well staffed and has a good management plan that is being reinforced. Some agricultural encroachment and illegal hunting remain at a low level.	**Lower urgency**: Reduction of illegal hunting of Species *n*. **Lower urgency**: Prevention of agriculture encroachment.	**High**: All conditions are in place to ensure long-term conservation of this KBA.
…	…	…	…	…	…	…

Table 10. Suggestion for organizing information per species on the results of a gap analysis

Species	Overview	KBAs where present (KBA criteria triggered)	Threats	Overall level of ongoing conservation action for the species in the region	Conservation measures needed for the species	Opportunity for conserving the species
Species 1	**IUCN**: CR **Endemism**: 100% **Presence**: Resident	**#KBAs**: 1 KBA3 (vuln.)	**High impact**: Habitat loss	**Very insufficient**: The species and its habitat are legally protected under the national Species Conservation Decree, in the management plan of KBA3 Nature Reserve. However, KBA3 is suffering from intensive logging, resulting in a very high risk of global extinction in the near future.	**Extremely high urgency:** Immediate reinforcement of logging ban at KBA3. **High urgency**: Habitat restoration to increase available habitat and reduce fragmentation (explore plantations of native species for sustainable use).	**Low**: Effective enforcement of protected area management regulations at KBA3 is difficult, given how logging is embedded into the local furniture business. **Medium**: Plantations can provide alternative sources of wood for the furniture industry within the context of a habitat restoration plan.
Species 2	**IUCN**: NT **Endemism**: 75% **Presence**: Juvenile stage only	**#KBAs**: 3 KBA1 (irrepl: 50%) KBA3 (irrepl: 1.6%) KBA5 (irrepl: 12%)	**Medium impact**: dam construction; over-exploitation. **Low impact**: water quality.	**Moderate**: Most of the regional population congregates at KBA1, where it is currently relatively safe on private lands. However, forest loss at KBA1 has implications for water quality, so the species will suffer in the long term. High local threat at KBA3 (despite legal protection) but affects a relatively minor population. Well protected by a nature reserve at KBA5.	**High urgency**: Work with landowners at KBA1 to reduce logging at least in a buffer area around the river. **Medium urgency**: Monitoring of the population at KBA1 key to ensure the maintenance of the overall non-threatened status of this species. **Medium urgency**: Reinforcement of protection at KBA3.	**High**: Land owners at KBA1 interested in conserving and providing adequate management for this particular species. **Medium**: Work on reinforcement of nature reserve status at KBA3.
…	…	…	…	…	…	…

Table 11. Suggestion for organizing information on research priorities

Priority level	Description	Justification
Very high	Field survey for species Y in region W.	Species Y (endemic) is classified as CR, even though no precise locality is known. It is only known from five specimens collected in village markets in region W. Stomach contents reveal that the species is frugivorous and thus forest dependent. It is obviously exploited for consumption, and the general region around the villages where it is collected is being intensively logged, so it requires urgent protection where it occurs.
Very high	Field survey for species X at sites V and Z.	Species X (endemic) is classified as CR but may be extinct. The most recent confirmed record is from 1965 (specimen collected at site V). However, there are two independent records from site Z of unidentified species whose description matches species X. If still extant, the population(s) of this species must be very small and require urgent protection.
…	…	…
High	Field survey for species S at sites Q and R.	Species S (CR, endemic) occurs at site H, where it is reasonably protected. However, there are old records from sites Q and R where it may still persist in small numbers but would probably be highly vulnerable to extirpation due to ongoing logging. The protection of a second population of this species would provide additional insurance against its extinction.
…	…	…
Moderate	Biodiversity assessment of region K	Region K is very poorly known, as no systematic scientific study has ever been undertaken there. It is probably quite intact given its remoteness and very low human use. However, human use is increasing and a settlement now exists in the north of the region, so threat is probably increasing.
…	…	…
Lower	Understanding levels of sustainable exploitation for species G at site J	Levels of overexploitation of species G (VU, non-endemic) at site J are increasing and may lead to its local extirpation in the near future. About 30% of the species' range occurs in the country. It occurs at 12 other KBAs in the country, with stable and well-protected populations at five of them.
…	…	…

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