Key Biodiversity Areas as Site Conservation Targets

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Site conservation is among the most effective means to reduce global biodiversity loss. Therefore, it is critical to identify those sites where unique biodiversity must be conserved immediately. To this end, the concept of key biodiversity areas (KBAs) has been developed, seeking to identify and, ultimately, ensure that networks of globally important sites are safeguarded. This methodology builds up from the identification of species conservation targets (through the IUCN Red List) and nests within larger-scale conservation approaches. Sites are selected using standardized, globally applicable, threshold-based criteria, driven by the distribution and population of species that require site-level conservation. The criteria address the two key issues for setting site conservation priorities: vulnerability and irreplaceability. We also propose quantitative thresholds for the identification of KBAs meeting each criterion, based on a review of existing approaches and ecological theory to date. However, these thresholds require extensive testing, especially in aquatic systems.

Keywords: biodiversity conservation, gap analysis, protected areas, threatened species, irreplaceability

The current rate of global extinction for plants and animals, which is due to human activities, is more than a thousand times higher than the typical rates throughout life's history on Earth (Pimm et al. 1995). However, conservationists do not have the time or resources to conserve species one by one (Ehrlich 1992); they need to maximize the return from conservation investments. Large-scale conservation planning initiatives, such as ecoregions (Olson et al. 2001), biodiversity hotspots (Myers et al. 2000), and endemic bird areas (Stattersfield et al. 1998), have been among the effective responses to this need in guiding global conservation investment, but they do not identify targets for fine-scale conservation action. Strategically targeted site conservation programs can tackle the main cause of extinctions by reducing the loss of natural habitats and of the species that they shelter (Bruner et al. 2001). It is therefore critical to identify those sites where globally important biodiversity must be conserved in the short term.

Existing systems of protected areas are rarely designed to conserve biodiversity systematically, and they often fail to include all species for which site conservation is needed (Pressey 1994). Eleven years ago, IUCN (The World Conservation Union; IUCN 1993) advocated that at least 10% of the land area of each major terrestrial biome should be set aside for site conservation. However, although the current network covers 11.5% of the terrestrial land surface, global assessments reveal large gaps in the existing network of protected areas in almost all regions, particularly in the tropics (Brooks et al. 2004, Ferrier et al. 2004). Filling these gaps requires the establishment of explicit, measurable, and repeatable targets for biodiversity conservation (Rodrigues et al. 2004a).

Much effort in conservation assessment has been concentrated at the species level, leading to the emergence of quantitative and threshold-based criteria for the assessment of extinction risk as a basis for the IUCN Red List (IUCN 2001). If biodiversity is to be protected, there is an urgent need to establish a similar methodology for the identification of site-based targets using quantitative criteria that, drawing on available information, can be applied consistently. Perhaps the longest-standing quantitative, criteria-driven approach to the identification of site-scale conservation targets is the concept of important bird areas (IBAs), used by BirdLife International since the early 1980s (Osieck and Mörzer Bruyns 1981). National IBA directories have been published for 48

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countries, with regional inventories produced for Europe (Heath and Evans 2000), the Middle East (Evans 1994), and Africa (Fishpool and Evans 2001) and currently under way for other regions. Several projects have recently been developed to extend the IBA approach to other taxa. These include important plant areas (Anderson 2002), prime butterfly areas (van Swaay and Warren 2003), important mammal areas in the United States (Linzey 2002), and important sites for freshwater biodiversity, with prototype criteria developed for freshwater mollusks (Darwall and Vié forthcoming). Initial studies suggest that the congruence between IBAs and important sites for other taxa is high (Brooks et al. 2001).

In this article, we build on these developments and propose a general framework and associated criteria for identifying key biodiversity areas (KBAs). The overall goal of the KBA methodology is to suggest universal standards for selecting sites of global significance for conservation through the application of quantitative criteria. Such criteria should be easily and consistently applied across all biogeographic regions and taxonomic groups. They should also be applicable through a national- or regional-level, bottom-up, iterative process, involving local stakeholders, to maximize the usefulness of the resulting site priorities (Younge and Fowkes 2003).

Site-scale conservation, although essential, will not alone ensure the long-term persistence of biodiversity (Soulé and Terborgh 1999). Therefore, KBAs should form the anchors of the broader ecosystem approach to conservation (Eken et al. 2004), including landscape- and seascape-scale frameworks such as ecoregional planning (Loucks et al. 2004), conservation of landscape species (Sanderson et al. 2002), biodiversity conservation corridors (Sanderson et al. 2003), and habitat planning (Tucker and Evans 1997). Relative to these approaches, KBAs have a finer grain, and they should be seen as complementary to and nested within larger-scale conservation initiatives that aim to conserve other elements of biodiversity for the long term (Redford et al. 2003). Priority setting for site conservation within these broad units has often progressed through consensus-based expert workshops (Hannah et al. 1998), which can usefully form the starting point for identification of KBAs.

Here we provide a baseline concept for the definition of KBA criteria, demonstrating the necessity and appropriateness of using thresholds for site selection, and outlining a process for setting thresholds for each KBA criterion. On the basis of a review of the widely applied IBA concept and a number of regional KBA applications to date, we suggest provisional site-selection thresholds for refinement through a process of iterative testing on sufficiently large data sets.

Rationale for key biodiversity area criteria

Key biodiversity areas are globally important sites that are large enough or sufficiently interconnected to support viable populations of the species for which they are important (Bibby 1998). We use the terms *area* and *site* interchangeably to imply homogeneous units that can be delimited and, potentially, managed for conservation. The KBA selection process uses four criteria, based on the presence of species for which site-scale conservation is appropriate: (1) globally threatened species, (2) restricted-range species, (3) congregations of species that concentrate at particular sites during some stage in their life cycle, and (4) biome-restricted species assemblages.

The first of these four criteria (the presence of globally threatened species) addresses vulnerability, while the latter three cover different components of irreplaceability, following the two main considerations used in planning networks of sites for biodiversity conservation (Margules and Pressey 2000). Globally threatened species face a high risk of extinction in the short or medium term, and all areas where these species occur in significant numbers must be considered global priorities for site-scale conservation. Restricted-range, congregatory, and biome-restricted species are, by definition, geographically concentrated, and consequently they depend on a network of irreplaceable sites within at least part of their ranges or life cycles. A KBA network defined according to the presence of these species would therefore be expected to embrace all sites that play a critical role in maintaining the global population of all species for which site conservation is essential.

All four criteria have been applied to identify KBAs for one taxonomic group (birds) for over 20 years, and the effectiveness of this approach in identifying site conservation priorities has been validated by extensive research. For example, the population sizes of several bird species in Europe triggering the KBA criteria are reported to have substantially increased since the early 1990s as a result of IBA conservation (BirdLife International 2004).

Species richness per se is not a criterion for identifying KBAs. Species-poor sites that nevertheless play a critical role for one or more criteria-triggering species are also explicitly included in the network of KBAs. Using species richness by itself may be misleading in identifying conservation targets, and it may tend to overemphasize areas that include ecotones and widely dispersed and/or wide-ranging species (Williams et al. 1996).

Although some authors have proposed the incorporation of evolutionary distinctiveness into conservation site selection (Vane-Wright et al. 1991), we do not include this measure in the KBA criteria. Species that are common and widespread, regardless of their evolutionary distinctiveness, are clearly not priorities for site-scale conservation. Furthermore, recent research suggests that the incorporation of evolutionary distinctiveness into site selection techniques only makes a difference in exceptional cases (Rodrigues et al. 2004b).

The KBA approach, unlike the many reserve selection algorithms, does not aim to minimize the size of the site network. Rather, it provides the universe of sites significant for conservation, to which complementarity-based methods for reserve selection (Margules and Pressey 2000) can then be applied. By applying explicit criteria for initial site selection, KBAs provide a much more effective starting point for complementarity-based procedures than applications such as

Box 1. The Alliance for Zero Extinction.

Within the broader set of key biodiversity areas, or KBAs, there exists a particularly sensitive subset of sites: those known to hold the last remaining populations of critically endangered or endangered species. These sites, where policymakers 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; *www.zeroextinction.org*), a partnership of international, regional, national, and local nongovernmental conservation organizations. Vulnerability, irreplaceability, and the discreteness of site boundaries have to be strictly incorporated to pinpoint these sites of imminent species extinction.

To date, AZE has identified more than 600 sites globally for birds, amphibians, mammals, and conifers. 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.

Information on AZE was provided by Michael Parr, vice president for program development, American Bird Conservancy, Washington, DC 20036; e-mail: mparr@abcbirds.org.

grid-based distribution maps, which typically do not correspond with relevant management units on the ground. The Alliance for Zero Extinction, for example, prioritizes highly threatened and wholly irreplaceable KBAs as requiring the most urgent conservation action (box 1).

This article outlines criteria for KBAs of global importance for biodiversity conservation; however, lower thresholds may be set to identify sites of subglobal (regional or subregional) significance to complement globally important sites (Heath and Evans 2000).

Rationale for key biodiversity area thresholds

Thresholds have a single purpose: to ensure repeatability in the application of criteria around the world, over time, and among different practitioners. With KBAs, we aim to apply the criteria on a global scale and to repeat the analysis iteratively to account for temporal changes in the status of species and sites. Consequently, we propose a standard set of thresholds to avoid subjectivity in the selection of globally important sites and to ensure repeatability in the application of KBA criteria. Such an approach is currently used to great effect for applying the IUCN Red List criteria to identify and rank globally threatened species (IUCN 2001).

The overall process of setting thresholds for each criterion should ensure that a population of a species triggering a KBA is (a) of global conservation significance and (b) viable. On the one hand, we consider that a species population at a site is of global conservation significance if its conservation is likely to prevent a major deterioration in that species' global status. On the other, the viability of a species population in a given site is often expressed in terms of its risk of extinction or decline, its expected time to extinction, or its chance of recovery (Akçakaya and Sjögren-Gulve 2000). Following these two principles, a threshold for selecting KBAs should minimize both commission errors (i.e., the inclusion of sites that do not support viable populations of global conservation significance) and omission errors (i.e., the exclusion of sites that support populations for which site-based conservation would make a significant contribution to the species' global status). The emphasis on which of these types of error should be minimized will vary among criteria.

Threatened species, by definition, have a high probability of extinction, and so all of their populations make a significant contribution to their survival. Even very small populations of such species may be viable, provided that the right conservation strategies are implemented (Turner and Corlett 1996). Thus, we can be confident that omission errors are much more serious than commission errors in the identification of KBAs for threatened species, because they would result in the exclusion of KBAs for populations of global conservation significance. Therefore, we propose the use of absolute thresholds—regardless of the global population size—for the criterion of globally threatened species, with these absolute thresholds low enough to minimize omission errors.

The degree of concentration of a species' global population at a given site, through range restriction, congregatory behavior, or biome endemism, is effectively a measure of irreplaceability (Eken et al. 2004). We therefore propose using percentage thresholds for the three irreplaceability criteria (in contrast to absolute thresholds for the threatened species criterion), so that thresholds vary according to the global population size of the trigger species. These percentage thresholds should be high enough to capture globally significant populations, thus reducing commission errors. Nevertheless, we recommend considerable testing of sites identified using the proposed irreplaceability thresholds, perhaps using population viability analysis (Brook et al. 2000), to ensure that these do indeed embrace viable populations.

Criteria and provisional thresholds for selecting key biodiversity areas

Following the rationale described above, we now review the major considerations when setting thresholds for each criterion and summarize those thresholds that have been applied by KBA and other related programs to date. Since 2002, building on two decades of IBA identification, preliminary

Box 2. Key biodiversity areas in Madagascar.

The process of identifying key biodiversity areas (KBAs), following the draft criteria outlined in this article, is currently being tested in a number of countries worldwide, including Madagascar. Over the last decade, there have been a number of exercises in Madagascar aimed at identifying priority areas for conservation (Hannah et al. 1998). More recently, the project of identifying important bird areas (Project ZICOMA 1999) initiated the KBA process by identifying site-scale conservation targets for avian biodiversity in Madagascar. Building from this work, researchers have now identified 141 KBAs in Madagascar (figure 1), incorporating the distribution of 754 globally threatened species covering eight taxa: mammals, birds, amphibians, freshwater fish, reptiles, arthropods, gastropods, and plants. They have yet to identify KBAs on the basis of restricted-range, congregatory, or biome-restricted species criteria for taxa other than birds. Testing these criteria and delineating site boundaries will be the next steps in the identification of Madagascar's KBAs.

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Box 3. Overview of key biodiversity area criteria.

Each of the four criteria for key biodiversity areas is based on one of the two main considerations in planning networks of sites: vulnerability or irreplaceability (Margules and Pressey 2000).

Criterion based on vulnerability
Criterion 1: Globally threatened species. Sites in which a globally threatened species regularly occurs in significant numbers.

Criteria based on irreplaceability
Criterion 2: Restricted-range species. Sites that hold a significant proportion of the global population of one or more restricted-range species on a regular basis.

Criterion 3: Congregatory species. Sites that hold a significant proportion of the global population of a congregatory species on a regular basis.

Criterion 4: Biome-restricted assemblages. Sites that hold a significant proportion of the group of species whose distributions are restricted to a biome or a subdivision of it.

KBA identification has begun in a number of countries and regions, including the tropical Andes, Turkey, Indochina, East Africa, and Madagascar (box 2). The four criteria and provisional thresholds for KBA identification outlined here are informed by these works, but we emphasize that establishing their suitability and generality requires further testing. We foresee an evolving process for establishing definite thresholds for KBA criteria, similar to that employed in the development of the IUCN Red List criteria (Fitter and Fitter 1987). In particular, application of the proposed KBA criteria to marine and freshwater environments, and to taxa other than vertebrates and plants, requires much further development.

The four criteria (box 3) and associated draft thresholds are presented in more detail below.

Criterion 1: Globally threatened species. If KBAs are to prevent biodiversity loss, their criteria must incorporate an element of global vulnerability. This is most effectively addressed through assessment of the regular occurrence of globally threatened species in a given site (Collar 1993–1994), for which the IUCN Red List provides a quantitative standard (IUCN 2003). Sites that meet this criterion are defined as those in which a globally threatened species regularly occurs in significant numbers. The phrase "regularly occurs" is used to

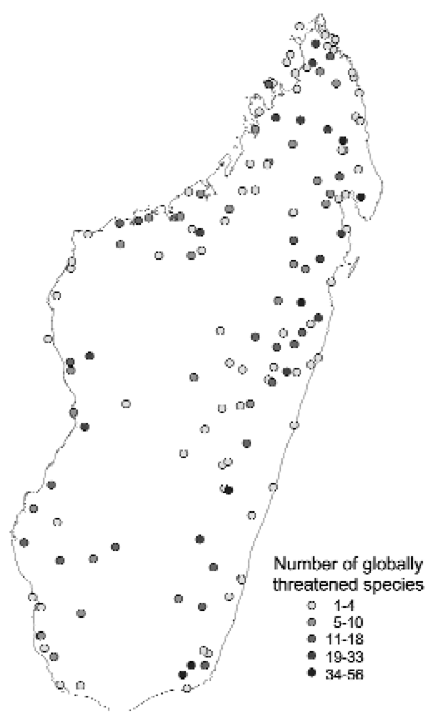

Figure 1. Key biodiversity areas (KBAs) in Madagascar (shown as circles), with the number of globally threatened species in each KBA. To date, 141 key biodiversity areas have been identified in Madagascar, incorporating the distributions of 754 globally threatened species covering eight different taxa.

ensure that instances of vagrancy, marginal occurrence, and historical records are excluded. Sites may be included, however, where the species' occurrence is seasonal (e.g., for breeding) or episodic (e.g., in temporary wetlands) (Fishpool and Evans 2001).

We confine this category to those species quantitatively assessed as threatened on the IUCN Red List, and therefore omit species listed as "near threatened," "least concern," "data deficient," "extinct in the wild," or "conservation dependent," the last of which is in any case no longer an active Red List category (IUCN 2001). The "extinct in the wild" category could potentially be covered by this criterion to highlight site targets for reintroduction. Strictly speaking, however, such species by definition require species-specific conservation efforts until a population has been reestablished at a given site. The species would then be reevaluated as globally threatened rather than extinct in the wild, and thus the site would qualify as a KBA.

Subglobal Red Lists have considerable importance for national and regional policy, and these lists sometimes incorporate data of higher quality than those used at the global level (Rodríguez et al. 2000). Further, IUCN has produced extensive guidelines for applying the criteria at the regional level to ensure greater consistency among these listings (Gardenförs et al. 2001). Direct inclusion of subglobally threatened species would, however, dilute the global significance of KBAs and prevent comparability between selected sites. Thus, we suggest including subglobally threatened species in KBA identification only (a) where these assessments follow IUCN guidelines for regional application of the Red List, (b) where the species are endemic to the region of assessment, and (c) where the species has not been assessed globally. We see such applications as forming hypotheses regarding the global status of these national or regional endemics, which should be tested by their evaluation for inclusion on the global Red List.

As discussed above, it is desirable to establish low absolute thresholds for the occurrence of a threatened species in defining a KBA. For conservation of threatened species, omission errors are more serious than commission errors. We therefore propose a simple threshold where for highly threatened (critically endangered or endangered) species, the presence of just one individual is sufficient to designate the site. For species classified as vulnerable, we suggest a threshold of 10 pairs or 30 individuals, following the guidelines for selecting IBAs for African bird species (Fishpool and Evans 2001), to reduce commission errors as well as omission errors. These thresholds are arbitrary but provide a sensible starting point for subsequent testing.

Criterion 2: Restricted-range species. To highlight all sites of global significance for biodiversity conservation, KBAs must identify highly irreplaceable sites—those for which there are few spatial options for the conservation of their biodiversity. As discussed above, we propose three criteria for the identification of irreplaceable KBAs, of which the first is the presence of species with restricted global ranges. To meet this criterion, sites must hold a significant proportion of the global population of one or more restricted-range species on a regular basis. (Many such species are also globally threatened and so will have also been captured by the first criterion for KBA identification.) This first requires defining what it means for a species to have a restricted global range. Fortunately, this definition has been pioneered for birds (Stattersfield et al. 1998), and data are now available to test it for other taxa (box 4).

Box 4 shows clear global congruence between centers of endemism of birds, mammals, and amphibians. This suggests that 50,000 square kilometers (km^2) is a robust cutoff for defining restricted-range species, with geographic implications that are broadly stable across taxa. This said, cutoffs for range restriction for plants and invertebrates require further testing, because of their fine-grained distributions. Further, this global congruence does not imply that all species with ranges of less than 50,000 km^2 require site-scale conservation, while those with larger ranges do not—although experience suggests that this is a good first approximation (Stattersfield et al. 1998).

Previous applications of the range-restriction criterion for IBA identification (e.g., Fishpool and Evans 2001) have used qualitative rather than quantitative thresholds. Because this criterion is a measure of irreplaceability, a percentage threshold is likely to be appropriate for selecting sites for restricted-range species, as discussed above. We provisionally propose that sites embracing 5% or more of the global population of a restricted-range species qualify as KBAs. Although such a high threshold would almost certainly ensure that the trigger population is viable, and also reduce commission errors (identification of numerous sites for abundant and widespread restricted-range species), we emphasize the need for further testing to consider possible omission errors.

Criterion 3: Congregatory species. Those sites that hold large proportions of the global population of an individual species at a given time are often considered as irreplaceable (BirdLife International 2002). These may comprise breeding colonies or other sites used during the nonbreeding season (e.g., for foraging and roosting) as well as bottleneck sites (where significant numbers of a species pass through over a concentrated period of time). To meet the criterion for congregatory species, a site must hold a significant proportion of the global population of a congregatory species on a regular basis. The congregation criterion is not relevant to sessile organisms such as plants; hence, Anderson (2002) did not use this criterion in defining important plant areas. We provisionally set the threshold for this criterion at 1% of the global population of a species, based on the 1% thresholds in wide use under the Ramsar Convention (BirdLife International 2002).

Although it has been used for IBAs (e.g., Heath and Evans 2000), a criterion for absolute numbers of congregating individuals is not included for selecting KBAs. Using absolute numbers would introduce larger commission errors and

Box 4. Congruence between restricted-range birds, mammals, and amphibians.

Stattersfield and colleagues (1998) defined restricted-range terrestrial bird species as those with a historical breeding extent of occurrence of 50,000 square kilometers (km^2) or less, based on the work of Terborgh and Winter (1983). This definition incorporates approximately 25% of all birds, highly concentrated in endemic bird areas holding two or more restricted-range species (figure 2a; Stattersfield et al. 1998). For other taxonomic groups, a number of potential techniques exist for the assessment of a species as having a restricted range. Range restriction could be measured relative to the overall distribution of range sizes within a given taxon. For example, the lowest quartile of species' range sizes could be considered to comprise restricted-range species. However, this approach faces both a theoretical and a practical problem. The theoretical problem is that it is silent as to the taxonomic level at which the lowest percentile of range sizes should be assessed. This is problematic because 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 mammals in general. The practical problem is that the percentile approach relies on assessment of all species within a given group before a species can be defined as having a restricted range, potentially hindering the identification of key biodiversity areas.

A possible solution to these problems is provided by examining the data on extent of occurrence compiled by the IUCN/SSC (Species Survival Commission)–CI/CABS (Conservation International/Center for Applied Biodiversity Science) Global Mammal Assessment and Global Amphibian Assessment (Brooks et al. 2004). For mammals, the application of Stattersfield and colleagues' (1998) threshold of 50,000 km^2 classifies approximately 25% of species as having restricted ranges, a similar percentage as for birds, with the global distribution of areas holding two or more restricted-range mammals being very similar to that for birds (figure 2b). In contrast, for amphibians, the application of Stattersfield and colleagues' (1998) threshold yields approximately 60% 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 2c). Thus, restricted-range amphibians occur in many of the same places as birds and mammals, but are much more concentrated within these regions.

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would change the criterion to reflect total biomass rather than irreplaceable biodiversity. We also avoid using multispecies congregations for the identification of KBAs, because it would raise the problematic question of which would be the appropriate taxonomic level at which to conduct a given assessment.

Criterion 4: Biome-restricted assemblages. The surface of the planet is heterogeneous in terms of environmental characteristics such as rainfall, temperature, and elevation; this heterogeneity defines many patterns in species distributions (Holdridge 1978). Therefore, the assemblages of species that are endemic to individual environmental domains represent an additional component of irreplaceable biodiversity. Numerous methods have been proposed to classify the world's environmental domains. The biome classification used by the World Wildlife Fund (Olson et al. 2001), while not without its limitations, is probably the most widely used of such classifications. Therefore, we propose the criterion of biome-restricted assemblages based on this standard classification. To meet this criterion, sites must hold a significant proportion of the group of species whose distributions are restricted to a biome or to a subdivision of it.

This criterion may be thought of as seeking to protect contextual species richness, that is, species richness within a species assemblage that is restricted to a given biome. The analysis of contextual species richness must be undertaken separately for each targeted taxonomic group (notwithstanding the problems resulting from this approach; see below). In Turkey, for example, any site with more than 25% of its bird species globally confined to a given terrestrial biome, following Olson and colleagues (2001), was considered a KBA and added to the network (Kılıç and Eken 2004). Such a threshold can be used to weight the contextual species richness at a given site as a quantitative proxy of the irreplaceability of the entire assemblage. However, this assemblage-based threshold does not tackle the viability of populations of each biome-restricted species at a site.

Endemism varies with the areal extent of environmental domains (Peterson and Watson 1998); hence, it is necessary to scale the application of this criterion according to the characteristic extent of occurrence of different taxa. Thus, for tetrapod vertebrates and other species with coarse-grained distribution, species assemblages should be assessed at the level of the entire biome. Conversely, for those species with fine-grained distributions, such as plants, it becomes necessary to

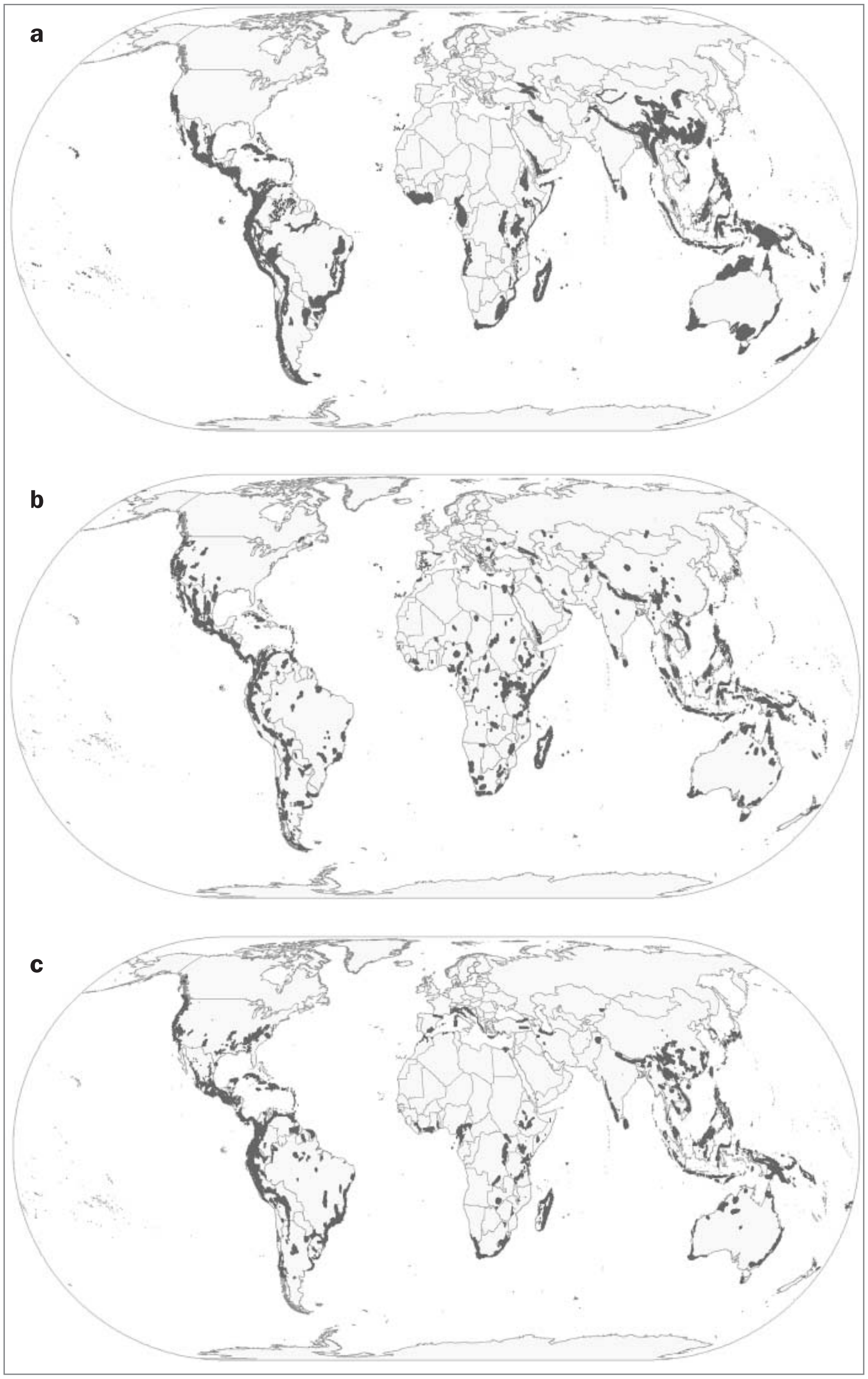

Figure 2. Global maps of areas that hold two or more (a) bird, (b) mammal, or (c) amphibian species with a global range less than 50,000 km^2, showing the congruence of these areas.

scale assessment down to subdivisions of ecoregions, such as individual habitats (Anderson 2002).

However, the application of this criterion presents a number of problems. Some of these are conceptual, including the fact that most bioregional classifications are derived from specialist opinion rather than from objective data sets, and that even for those that are based on continuous environmental data, the resolution of classification is largely arbitrary (Wright et al. 1998). Further, scaling the resolution of bioregional classification (biomes, ecoregions, habitats) according to the distribution patterns (coarse-grained or fine-grained) of different species groups brings logical problems regarding the lack of equivalence within and across different taxonomic levels. In addition, using an assemblage-based threshold does not address the viability of populations of each biome-restricted species at a given site.

The practical issue facing researchers and managers who use the biome-restricted species criterion is how to identify contextually species-rich sites. It is not a sensible investment of resources to derive species lists for each biome, ecoregion, or habitat, given that these numbers would need to be recalculated from scratch each time the boundary of the biogeographic unit changed (and such boundaries are generally arbitrary). Rather, we urge users to derive data on extent of occurrence in their own right, and then overlay whichever biogeographic polygons are required. More generally, we stress that this criterion is the most preliminary of the four, and it requires considerable further development and testing to determine its practical value.

Conclusions

The quantitative criteria underlying the identification of KBAs provide an objective framework for establishing site-scale conservation targets. The repeatability of this approach, however, depends critically on how KBAs are delineated in practice. Boundaries have to be delineated in such a way that the resulting KBAs are homogeneous units that are potentially manageable for conservation. Clearly, the boundaries of a KBA should be determined by the requirements of the species for which it is defined. In global biodiversity hotspots (Myers et al. 2000) where much natural habitat has already been lost, KBA delineation will generally follow the boundaries of the remaining habitat. While restoration must be an important conservation activity in such regions, KBAs should not be identified for potentially important sites requiring restoration until such sites firmly meet the criteria. In contrast, KBA delineation in wilderness areas (Mittermeier et al. 2003) will be more difficult, and will generally necessarily align with natural features such as mountains and rivers. In many such situations, it may be desirable to identify KBAs initially as points or circles, only adding delineation as the appropriate data become available. Although the boundaries of KBAs are underpinned by biological considerations, the use of socioeconomic data (e.g., data on threats and opportunities) is a crucial next step for determining the most effective tactics for safeguarding the biodiversity within these areas.

Because of uneven sampling, well-known sites such as existing protected areas will often form the first focus when selecting KBAs. However, the identification process brings additional sites onto the conservation agenda for the first time, and thus KBAs provide an excellent basis for national- or regional-scale gap analysis. The European IBA inventory, for example, is recognized by the European Court of Justice and the European Commission as a "shadow list" of sites for designation as special protection areas under European Union law (Heath and Evans 2000). Nevertheless, not all KBAs necessarily require protection according to traditional definitions; they might, for example, be sustainably used and managed by local or indigenous communities or by private individuals or corporations. While KBA conservation should aim for all sites to be managed to safeguard the important biodiversity that they shelter, the types of conservation tactics that are appropriate may vary with socioeconomic context.

Key biodiversity areas are one of the main pillars of biodiversity conservation, yet they are not the whole or the only answer. Protected areas, although necessary, are insufficient to conserve biodiversity in the long term (Soulé and Terborgh 1999). Some species, such as those dispersed at low densities across wide areas, are not well protected by the site conservation approach. For others—for example, colonially nesting species that disperse extensively during the nonbreeding season—site conservation may only be appropriate across some of their range or for parts of their life cycle (Fishpool and Evans 2001). Human-induced threats such as climate change, introduced species (including pathogens), and pollution, which must be incorporated into conservation plans, cannot necessarily be dealt with by establishing site conservation. For long-term success, conservation strategies must also include ways to maintain large-scale environmental, ecological, and evolutionary processes. Hence, KBAs should form part of a wider, integrated approach that embraces conservation not only of sites but also of species and landscapes (Redford et al. 2003).

The application of some of the criteria to freshwater and marine systems is problematic. In aquatic systems, the measurement of extent of occurrence may require alternative metrics, such as length, discharge, or volume (for riverine systems). The identification of KBAs for restricted-range aquatic species therefore remains a major challenge. Similarly, the selection of sites for aquatic biome-restricted assemblages requires considerable further research.

In spite of these limitations, numerous benefits accrue through the identification of KBAs. They can be defined using objective, quantitative criteria, which provides repeatability and credibility, and means that KBAs can form a global conservation currency. The KBA criteria are simple and robust enough that they can be applied uniformly and cost-effectively. Their application does not require complete data sets, since the method is based on individual biological values and not on relative significance. Such information has to be generated by national and local organizations, working on the ground. Therefore, the implementation process can be, and has already been, a powerful tool for building institutional capacity and setting an effective conservation agenda (Bennun and Fishpool 2000).

Clearly, the identification of KBAs is just the first step in a continuing conservation process. Following identification, considerable investment must be devoted to gap analysis, scheduling, and planning, to ensure that the right conservation tactics can be brought to bear in each site. After this, conservation implementation must put these plans into effect to safeguard a given KBA, followed by the development of monitoring systems to measure the effectiveness of these actions over time, and by further refinement of planning and interventions. This is a process that can and should begin right away. There is no reason to delay taking action to conserve the thousands of IBAs, important plant areas, and other KBAs identified to date. Additional sites will certainly be added by incorporating a fuller spectrum of biodiversity, but those that are already known form an excellent starting point for immediate conservation efforts.

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