KBA monitoring strategy

Compiled by the KBA Technical Working Group

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Summary

More than 16,000 KBAs have been identified worldwide, but we lack comprehensive information on the condition of these sites, the threats to them, the conservation measures in place, and changes in these aspects over time. Such information is essential to set priorities, hold governments and other actors to account, inform policies, influence donors and decision-makers.

The KBA Technical Working Group (TWG) developed KBA monitoring strategy that sets out a protocol for in situ monitoring, and identifies a range of other datasets and tools that may support the process. A State, Pressure and Response approach forms the basis of KBA monitoring, defined as follows:

- State: The current condition of biodiversity trigger elements within the site
- Pressure: The threats, including assessments of timing, scope and severity
- Response: The adequacy of actions being taken at the site to avoid and mitigate threats and benefit biodiversity elements triggering criteria at the site.

Monitoring submissions come from a range of possible participants (site managers, KBA Partners, National Coordination Groups, etc.)

These evaluations will be supported by KBA-relevant metrics from high-resolution remote sensing datasets are available online that can inform monitoring evaluations by allowing determination of landcover (and other environmental) change. Some of these datasets are hosted on dedicated platforms, which reduces/removes the need for downloads of very large datasets and also often enables analysis within the platforms using these datasets. Other available global datasets that will be of value to KBA monitoring include the World Database of Protected Areas and datasets from WWF Sight, among others. Furthermore, a range of citizen science datasets, databases, data platforms and reports are available that could provide details useful for monitoring evaluations are freely available, either upon request, or through a dedicated API.

In-situ assessments are ideally supported by robust, site-level datasets on biodiversity trigger element abundance, extent and/ or distribution, condition. It is beyond the capacity of the KBA Committee to get involved in developing detailed methods for censusing species and/ or evaluating ecosystem condition for example. Some of the information gathered as part of KBA monitoring evaluations will support KBA assessments and reassessments, and measures of State.

Monitoring evaluations are also supported by a broad range of potential data sources, where available and appropriate, i.e. data from other sources can be used to partially inform State-Pressure-Response assessments. Recognising that the structured monitoring evaluations generated through direct inputs from stakeholders will not be possible for many KBAs (due to limited resources, knowledge etc.), the applicability of other datasets in informing state, pressure and response is crucial.

The outputs from monitoring evaluations will be publicised through the KBA website (KBA factsheets and KBA Dashboard), through IBAT, and will be made available for analyses upon request. These site-level assessments may be aggregated to inform the status of KBAs at broader scales (spatial, taxonomic group).

Contents

1. Background

KBAs are sites of significance for biodiversity, so it is important that we are able to understand what is happening within these sites and potentially affecting the trigger species and ecosystems. At the site level, a KBA monitoring protocol is needed to provide an early warning of any problems at the site, and to enable assessment of the effectiveness of any conservation measures in place. These site-level outputs, if sufficiently robust, can potentially provide metrics that inform the state of KBAs more broadly, such as across a country or regions, or across those sites that support a particular taxonomic group for example.

More than 16,000 KBAs have been identified worldwide, but comprehensive information on the condition of these sites, the threats to them, the conservation measures in place, and changes in these aspects over time is limited. Such information is essential to set priorities, hold governments and other actors to account, inform policies, influence donors and decision-makers, and achieve the KBA Strategic Plan (the development of a KBA monitoring system is explicitly mentioned in Result 6 of the Plan).

KBA Partner networks work in thousands of KBAs around the world, implementing conservation projects and collecting valuable information on species, threats and conservation actions, through both systematic approaches and less structured efforts. Many KBAs are monitored by KBA Partners and others using systematic approaches (e.g. BirdLife's IBA monitoring protocol, Management Effectiveness Tracking Tool (METT) used to monitor Protected Areas). These in situ monitoring evaluations are supported by outputs from increasing numbers of free, high resolution, regularly updated datasets from a range of sources (e.g. remote sensing, citizen science among others).The data generated by these and other efforts are fed into a simple, streamlined system located in the World Database of KBAs (WDKBA).

This review sets out a KBA monitoring strategy developed by the KBA Technical Working Group (TWG), informed by and building off other approaches, and structured to capitalise on existing efforts.

2. KBA monitoring strategy

A State-Pressure-Response framework (Fig. 1) commonly used causal classification across many ecological monitoring schemes (BirdLife International 2006, Levrel *et al.* 2009, Das *et al.* 2020) underpins KBA monitoring, where the pressures cause the changes to the system, the state changes are the unwanted changes that result from the pressures, and the responses are what society does to remove, reduce, or mitigate the pressures.

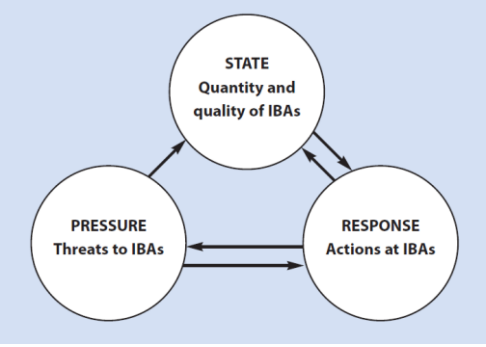

Figure 1. Relationship between the indicators of pressure, state and response.

The *state* evaluation reflects changes to the condition of the KBA and is measured by either the population sizes of the trigger species or the extent and condition of the ecosystems. The p*ressure* (or threat) evaluation reflects the pressures or threats facing a site and their likely impact on the trigger species or ecosystems. The *response* evaluation reflects the extent of protected area designation, management planning and conservation actions being implemented at a site.

KBA monitoring evaluations are generated at the individual site level, by Partners, Proposers, NCGs or indeed any others who are associated with, or at least those who are familiar with, specific KBAs, to track how each is faring over time.

These evaluations are supported by KBA-relevant metrics extracted from increasing numbers of free, high resolution, regularly updated datasets from a range of sources (remote sensing, citizen science among others).

The proposed KBA monitoring strategy comprises the following components:

1. Supporting datasets from remote sensing, citizen science and other sources
2. Strategy to identify supports needed for monitoring biodiversity triggers
3. Development of a framework for monitoring state, pressure and response
4. Proposed outputs

3. In situ KBA monitoring protocol

3.1 Overview

In situ KBA monitoring evaluations are required every four years, to track changes over time and to enable identification and implementation of timely actions where needed. Each evaluation provides an overall snapshot of state, pressure and response in a given year, or recent years, taking into consideration any known evidence, such as from species and ecosystem surveys and/ or relevant research. Monitoring evaluations relate to what is happening 'now' – in terms of pressure and response. The most recent data available for measuring state may be from a time point in the past, and may not be current, and some may be much older; so it may not be possible to measure change directly, and there may be a need to use these older data, together with other information or data sources where available, to infer change based.

Assessors are encouraged (and supported by NCGs where they exist) to collaborate among Partners, Proposers, NCGs, Local Conservation Groups or any others who are familiar with the specific KBA to participate and coordinate evaluations for as many of the trigger elements possible (to minimise partial evaluations). The monitoring process should pull together information held by others, in consultation, where available, e.g. through consultation with a team of park wardens for identifying what threats are taking place, and perhaps with the help of research to generate information about the potential impacts on the triggers. The evaluations should be based on a combination of their knowledge of the site, and on the metrics from other datasets that may be useful (3.1 above), and any other relevant datasets that are available for the site.

Site-level knowledge about state, pressure and response will vary substantially between KBAs, and sufficient flexibility is given within the protocol to support and encourage input, including those sites with very little information available, e.g. sites that are remote and very inaccessible, to those sites where comprehensive information exists, e.g. sites that are actively managed and monitored. Coherent guidelines, with illustrated examples, on how undertake these state, pressure and response evaluations are provided to maximise consistency across the submissions.

The protocol is based on a series of questions, most with up to four categorical options. A four-point scale, consistent with many other monitoring frameworks (e.g. most PAME tools), seems to be a suitable balance (Mwangi *et al.* 2010) between being simple enough to facilitate participation and being sophisticated enough to provide sensitivity. More complex protocols with more categories would require more data, expertise and knowledge, and could risk impacting on participation.

Monitoring evaluations will be captured in the World Database of KBAs (WDKBA), a data management system dedicated to compiling and managing all KBA-related data. Assessors will be able to log in at any stage and complete their evaluations. The WDKBA will take the assessor through the monitoring evaluation process stage by stage, while automating summaries of the evaluation and completing any calculations needed (refer to guidelines available here).

Monitoring evaluations will be encouraged as part of biodiversity assessments and reassessments (KBA updates), where the Proposer is invited in an appealing and streamlined way to provide specific details relating to monitoring, and/ or as an output from any site-level projects taking place.

Participation in monitoring will be encouraged through a variety of means, including

- Feedback through summaries made available through the WDKBA and on the KBA website.
- Support through webinars and direct support if and where needed.
- Provision of metrics from other datasets made available through the KBA monitoring dashboard.
- Mechanisms that facilitate data flow, e.g. imports functionality in the WDKBA

3.2 State

Assessing state

State evaluations aim to measure the health of the KBA by assessing how the KBA triggers are faring by comparing their current status against a reference point, or benchmark. The benchmark will be the estimate of the trigger when the site was first identified as a KBA for that trigger (the baseline year), i.e. the value provided during the first assessment.

Setting a benchmark when first identified as a trigger means that there may be some KBAs with trigger element baseline years vary considerably (e.g. a KBA identified first for amphibians in 2015, and an ecosystem added in 2025). It is also acknowledged that for some triggers, this benchmark value may be considerably older than the assessment year, and for some we could be setting a baseline year some 50 years before the site was confirmed as a KBA. But in such cases, it will be assumed that the estimate provided is representative of the assessment year.

Some of the limitations associated with using the condition for a species or ecosystem at the time of identification as a KBA trigger as a benchmark, are that its condition at the time of identification is unknown, so state evaluations may not detect where there has been a recent decline in a trigger (e.g. a trigger may show increase at a site when it has lost half of its population, such as where the condition at the time of identification was very poor). Over time, it will be important to compare state not only with the benchmark, but also with the last monitoring evaluation to indicate shorter-term changes, which may be of value in alerting any significant negative changes between evaluations so that actions may be identified and implemented. This will be facilitated through the WDKBA.

State evaluations for each trigger will be categorised using the first two columns below (second is for ecosystems only).

% change[1] relative to the benchmark (or last evaluation)	Ecosystem condition
Very substantial improvement (>160%)	Very substantial improvement
Substantial improvement (>130-160%)	Substantial improvement
Moderate improvement (>110-130%)	Moderate improvement
Unchanged (>90-110%)	Unchanged
Moderate deterioration (>70-90%)	Moderate deterioration
Substantial deterioration (>40-70%)	Substantial deterioration
Very substantial deterioration (≤40%)	Very substantial deterioration

[1] % change in site population for a species trigger (which can be inferred from relative abundance, AOO, ESH, range etc), % change in ecosystem extent and condition, and % change in ecological integrity indicators.

Data requirements and considerations

Which trigger elements should be monitored?

Ideally, all suitable triggers will be assessed. For KBAs with many triggers, the assessor may select a representative sample of trigger elements, including samples that cover 1) the taxonomic groups represented, 2) guilds, and/ or 3) habitats. Importantly, the triggers that are included in a monitoring evaluation should continue to be monitored in subsequent monitoring evaluations to ensure continuity and consistency when comparing evaluations. New triggers may also be added to the evaluation over time. Some triggers, such as those prone to substantial temporal fluctuations in abundance, and whose evaluation when compared to the benchmark may therefore not accurately their condition, may be excluded.

What data are required?

For each trigger element, assessors provide a current estimate that can be compared against the benchmark, or they can indicate the category that best describes the change inferred based on other sources of information. State evaluations cannot be estimated for the triggers at a new site (because the current equals the benchmark) or for a newly added trigger at a site.

Where a value is provided, it can be based on the same parameter used when the trigger was first identified at the site. Evaluations of state should be based on the number of mature individuals of each trigger species at the site, the extent and condition of each ecosystem trigger at the site. However, species assessments based on area-based parameters are less likely to change in the short term, and alternative parameters may be used.

When updated estimates of the KBA assessment parameters are unavailable, proxies can be used (e.g. number of active burrows). In each case, a benchmark will be needed to compare this against. These measures could be:

- the extent and condition of a habitat (where there is known linkage with the trigger)
- an estimate based on a representative sample from within the KBA

What happens if state cannot be measured directly?

There will be cases where the assessor does not have updated estimates of abundance at the site to be able to measure change relative to the benchmark. Furthermore, there is a link between ecosystem condition and cumulative pressures in some settings, so it is fairly common to infer condition from

other data, especially pressure data which is often more easily available. The assessor may therefore allocate a state category inferred from other indirect observations relating to the trigger, e.g.

- Comprehensive national monitoring scheme of a trigger, providing a country-level or local-level population trend, but at a scale larger than the particular KBA. Assessors need to carefully consider if and how the trend within the KBA is likely to differ, for example, owing to more effective conservation and lower rates of habitat loss/degradation within the KBA than outside.
- Known information about key threats to a trigger at a KBA (e.g. hunting, pollution, or water abstraction) that directly influence their distribution and/ abundance.
- Extent and condition of habitat, but this should only be used where the trigger, but assessors should also take into consideration the influence of other factors, e.g. hunting/harvest, predation/competition, disease, invasive species). Database development should support selection of multiple species against the habitat.
- Other, e.g. expert opinion from Local Communities or Indigenous Peoples (additional details are needed in a free-text field to explain the basis of this judgement).

3.3 Pressure

Measuring pressure

There may be many pressures identified at a site, but not all of these will necessarily impact on the KBA trigger elements. The objective of Pressure monitoring is to understand the effects of those pressures that are affecting trigger elements (i.e. their threat impact), and how these are changing over time. Accordingly, data should be documented on all major threats facing all trigger biodiversity elements at a site.

Threats are documented based on the IUCN threat classification scheme, along with a category that describes its timing:

- Only in the past and unlikely to return
- In the past but now suspended and likely to return
- Ongoing
- Only in the future
- Unknown

Assessors are asked to indicate for each threat the trigger elements that are affected, and an evaluation of impact for each pressure-trigger combination based on an evaluation of *scope* and *severity* for each, defined as follows and using the categories set out below:

- *Scope*, which reflects the proportion of the trigger element at the site affected, and
- *Severity*, which is an indication of the effect that pressure poses on the trigger element within the scope. Specifically, this is the rate of population decline over 10 years or 3 generations, (whichever is longer) for species triggers within the scope of the threat at the site, and the rate of loss over 50 years for ecosystem triggers within the scope of the threat at the site.

Scope	**Severity (rate of decline)**
Whole (>90%)	Very rapid (>30%)
Majority (>50-90%)	Rapid (>20-30%)
Minority (>10-50%)	Slow but significant (>1-20%)
Limited (≤10%)	Negligible (≤1%)

Scope and severity will be integrated within the WDKBA to generate an impact category as very high, high, medium or low):

		Severity (rate of decline)			
		Very Rapid	Rapid	Slow, Significant	Negligible
Scope	Whole	Very High	High	Medium	Low
	Majority	Very High	High	Medium	Low
	Minority	High	Medium	Medium	Low
	Limited	Low	Low	Low	Low

In subsequent evaluations, the former pressure evaluation is provided as a basis to work from, so that each pressure and pressure-trigger combination is considered.

Data requirements and considerations
Challenges facing the assessor

There are some anticipated challenges expected in gathering this level of information:

1. It is expected that in many cases, scope and severity will be based on informed estimates, rather than accurate measurements, and will require common sense, drawing upon perhaps the experience of the effects of similar threats previously or elsewhere.
2. In some cases, assessors may struggle to list *all* of the triggers affected by each, but where possible they should be encouraged to list as many of the triggers possible that they consider are affected by each pressure identified affects, and to provide a scope and severity score for each pressure-trigger combination.

It will be important to measure the quality of the scope and severity evaluation, and a quality value should be assigned to each pressure-trigger combination, that defaults to a category that reflects 'Qualitative estimate' (to minimise additional burdens on those undertaking evaluations), but that asks assessors to indicate which if any of their evaluations are based on higher quality information ('Quantitative measure').

Streamlining the process, especially for KBAs with a large number of trigger-pressure combinations

Guidance will be needed on how to assess pressure at sites with large numbers of triggers, and functionality in the database will be needed to streamline the process for assessors.

For the user journey, the evaluations should be grouped into stages, acknowledging that for some, the details will be limited. Could be set out in a hierarchal frame, allowing assessors to identify what they have completed or not:

1. Identify pressures and timing
2. For each pressure, select the triggers likely to be affected (with an option for all, and all within a taxonomic group).
3. for each pressure-trigger combination, add scope and severity categories

Information on a site should be encouraged from all three levels (above), so we capture 1) the pressures, 2) what triggers they are affecting, and 3) the extent of the impacts. However, we should enable flexibility stage 3 could be optional (this is where people will struggle most).

3.3 Response

Measures of response

The objective of *Response* monitoring is to summarise the level and type of conservation efforts ongoing at a site. Response is measured by:

- Conservation designation: refers to the formal designation (whether or not legally binding) that should safeguard the site's biodiversity. Coverage by Protected Areas and Other Effective area-based Conservation Measures (OECMs) should be reported separately (by definition, these are mutually exclusive categories).
- Management planning: reflects the availability and comprehensiveness of Management Plans for the site, and with respect to the trigger elements.
- Conservation action: reflects the extent and appropriateness of conservation actions being implemented.

Coverage by Protected Areas and OECMs is calculated annually for all KBAs and these values are pre-populated for all monitoring evaluations, other than where the evaluation is being undertaken at the same time as the first assessment at the site.

There may be cases where management planning and/ or conservation actions are not needed, e.g. some Criterion C KBAs which are not meant be dependent on in situ anthropogenic management (except perhaps management to keep external threats such as disease, invasives at bay, plus monitoring/enforcement). This may apply to other KBAs, especially those that are remote and distant from human habitation, whose triggers are faring well. Assessors should first indicate whether or not management planning and/ or conservation actions are needed or appropriate, and if so they should provide an evaluation.

The three factors are each categorised as follows:

Coverage by protected areas or OECMs	**Management planning***	**Conservation action ***
Whole area (>90%)	**Comprehensive plan** to maintain or improve status of the biodiversity trigger elements	**Comprehensive and effective conservation measures** are currently being implemented
Most (>50-90%)*	**Plan exists but not comprehensive** or is out-of-date	**Conservation measures are currently being implemented** but these are either not comprehensive or not very effective
Some (>10-49%)	**No plan but some management planning** process started	**Some limited conservation initiatives** are currently in place but these are not effective
Little/ none (≤10%)	**No management planning** at the site	**Very little/ no current conservation action**
	Not needed	**No actions needed**

Additionally, conservation actions underway and needed are captured using the IUCN Conservation Actions and Research Needed classification schemes. Together, these classification schemes set out a standardized approach to gathering details on conservation actions, even though the main aim of these schemes is focused on the conservation and research needs, as opposed to actions underway.

3.4. Quality evaluation

The information available and/ or the expertise of those undertaking monitoring evaluations will vary considerably between sites. Assessors are asked to inform the quality of evaluations of each of state, pressure and response by identifying the statement that best represents the quality of the data that contribute to each (state, pressure and response):

- Regular monitoring provides reliable data
- Some monitoring data are collected but they are either sparse or irregular
- Some monitoring data are collected but they are both sparse and irregular
- Very little/ no monitoring.

4. Resources available to support KBA monitoring

4.1 Other available datasets

Remote sensing

There is a range of high-resolution remote sensing datasets available online that can inform monitoring evaluations by allowing determination of landcover (and other environmental) change, such as the Global Forest Change dataset (Hansen *et al.* 2013). Some of these datasets are hosted on dedicated platforms, which not only reduces/removes the need for downloads of very large datasets (e.g. forest loss dataset is more than one terabyte) but also often enable analysis within the platforms using these datasets. Some go one step further to make the tools very user-friendly and maximise use of the tools (e.g. Global Forest Watch dashboard). Many of these datasets are updated on a regular basis, varying from daily and monthly measures to seasonal and annual averages.

Many of these remote-sensing datasets are available through Google Earth Engine (GEE). Google Earth Engine is a cloud computing platform that enables users to run large scale, complex geospatial analysis on Google's servers (therefore not restricted to one's computer processing ability) and grants access to a large range of geospatial datasets. This system is available for non-commercial use by scientists, researchers, and developers to detect changes, map trends, and quantify differences globally. A selection of relevant layers identified that are available through GEE are presented in Appendix 7.1.

There are other datasets and platforms available online that would support KBA monitoring evaluations of state, pressure and response, and following some manipulation of the datasets (spatial overlays), relevant statistics may be extracted.

Protected Area Monitoring Effectiveness (PAME)

The global database of Protected Areas (GD-PAME) hosts a considerable volume of information that could fill some gaps and/ or support monitoring evaluations for KBAs. Other monitoring datasets include METT, RAPPAM (Rapid Assessment and Prioritisation of Protected Area Management Tool), World Heritage Outlook among others. There are many parallels, for example, they compile information on threats using the same threat classification scheme.

Future improvements to METT assessments (through METT4), will undoubtedly improve the utility of these data into the future. It is probably of most value if relevant fields from METT data (assuming availability and agreement) and any other monitoring datasets that may be available, are extracted with some interpretation on usage, and made available to those undertaking evaluations through the KBA monitoring platform. The relevant fields will mostly relate to pressures, but others have been identified that would be useful in informing Response.

Datasets from citizen science projects

There are many citizen science platforms generating huge volumes of data annually, particularly in the form of georeferenced species records. There is a proliferation of such schemes that are covering an increasing range of animal and plant taxa (typically with the usual geographic biases). Stephenson & Stengel (2020) undertook an inventory of existing global datasets, databases, data platforms and reports identifying 145 global data sources, which are described and listed, with links, in an open access website. This list includes some citizen science data platforms, such as

- eBird (Cornell Lab of Ornithology), http://ebird.org/, citizen science bird observations.
- iNaturalist (California Academy of Sciences and National Geographic Society), https://www.inaturalist.org/, citizen science nature observations.
- BirdLasser (BirdLife South Africa), https://www.birdlasser.com/, citizen science bird observations.
- Global Biodiversity Information Facility, (GBIF), http://www.gbif.org/, while not specifically a citizen science platform, it does hold records from many of these schemes, including over 1.6 billion species occurrence records from over 54,600 data sets (as of October 2020).

Datasets such as these could support KBA reassessments (e.g. confirming Reproductive Units and delineation of boundaries). Depending on the extent of the datasets, some may help inform state, although the data in the platforms listed above are generally not systematically collated (limiting interpretation on change in populations for example).

KBA monitoring App development

While KBA monitoring evaluations should be based on a variety of inputs and sources and the results captured 'at the desk'. There is scope for future app development that may support evaluations, e.g. opportunities for gathering data from the wider public that would inform monitoring. Information about threats, in particular their location, extent and any narratives about perceived impacts, would be of use to those undertaking evaluations of pressure.

4.2 Utility of other datasets in KBA monitoring

The availability of global and other datasets provides many new opportunities in supporting KBA monitoring, especially in providing assessors with additional information about their KBAs that they may not be familiar with, potentially helping to fill some gaps at large sites with limited or no access.

Automated integration of metrics from external datasets into the KBA monitoring protocol at this point is limited because

1. The quality of some of the datasets (e.g. from remote sensing), especially at a finer resolution (small KBAs) is variable, is poor, and in some cases the availability of data in some parts of the world is very limited and therefore requires interpretation. The quality of the data collated through citizen science platforms is also variable, so these data also require interpretation to inform monitoring evaluations, and some caution may be needed due to potential for misinterpretation.

2. There is no automated way to inform the effects of the pressure being inferred on the trigger elements. Specifically, interpretation is needed on a) whether the pressure that the dataset is inferring (for example) is affecting the trigger elements, and b) giving context relative to other pressures that cannot be measured in an automated way (e.g. invasive alien species, hunting etc) that are perhaps more significant in their effects on the trigger elements.

For now, the availability of KBA-specific metrics from external datasets are used mainly to support those who are familiar with their sites and who are undertaking monitoring evaluations. However, presentation of these metrics at larger scales (e.g. aggregated across KBAs in a country and/ or region) could be potentially powerful, especially in informing change more generically at broader scales. It may be possible to use some of these datasets/ for some KBAs to deliver the Convention on Biological Diversity (CBD) complementary indicator 'Status of KBAs' (or 'Proportion of KBAs in favourable condition') that Governments may supply.

4.3 Presentation of metrics from other datasets

The metrics from other datasets extracted from other global datasets are available in a dedicated KBA monitoring dashboard. Over time, as this resource continues to develop, there may need to be an improved structure to ensure the information is available in a clear and coherent format, and to make further refinements such as (for example) curtailing the outputs to those KBAs where relevant (e.g. forest-related metrics available for forest KBAs etc.). The user may wish to access further information relating to the datasets, so relevant links will be made available where additional information exists. It will also be important that these datasets are routinely updated. Currently these metrics are manually extracted, and over time it may be possible to streamline updates through APIs – feeding directly into the relevant dashboards (e.g. eBird) and/ or through other dashboards (e.g. Google Earth Engine (GEE).

4.4 Biodiversity monitoring in KBAs

Robust datasets on species abundance and distribution, and on their long-term trends, are important for targeting conservation resources to priority species and sites but are often limited. Biodiversity monitoring in general is poorly coordinated and often haphazard in its occurrence (Pereira & Cooper 2006) and suffers from many taxonomic, regional and methodological biases (Chandler *et al.* 2017, Wetzel et al. 2018, Moussy *et al.* 2022).

It is beyond the capacity of the KBA Committee to get involved in developing species monitoring protocols, or in setting priorities for monitoring within sites. However, there may be a role in gathering and sharing lessons learned from assessments and reassessments underway, perhaps through the development of case studies, illustrating the kinds of information that will be useful. And ongoing consultation with the IUCN SSC Species monitoring specialist group will be crucial.

A dedicated KBA monitoring platform will be needed to store and manage all of supporting external information (identified in 3.1 above). It will require:

- Storage and management of KBA-level statistics extracted from the online and remote sensing datasets identified above, with some fed in through discrete GEE platform.
- Functionality to enable those undertaking assessments, reassessments of triggers, and of state, pressure and response, to access these supporting datasets.

5. Dissemination of monitoring results

Outcomes from monitoring evaluations should include clear results that inform the conservation status of the site. This should be amalgamable across multiple sites to inform the results at various scales, e.g. across a region or globally (assuming the sample of sites is sufficient and representative).

At the time of writing these outputs had not yet been designed. It is anticipated that site-level outputs from the monitoring evaluations will be presented in a specific monitoring tab in the **KBA factsheets**. These factsheets will present overarching metrics summarising state, pressure and response evaluations, specific metrics relating to each KBA.

Summary infographics that present the status of KBAs scales broader than site-level (national, regional, global, selected sites, taxonomic) could be generated by aggregating site-level metrics across various selections and presenting them on a new tab on the **KBA dashboard**. These infographics presenting KBA-relevant aggregated across multiple sites informed by the selections filtered on the dashboard. The availability of these data enhances their utility in the context of both national planning for the implementation of the various agreements, conventions etc., and in the context of producing the international reviews concerning the network of sites.

These metrics available at country level will deliver the Protected Area and OECMs coverage indicator (made available for terrestrial, freshwater, marine and mountains, required by Governments for delivering Targets 14 and 15. And perhaps alongside others extracted from global datasets may usefully inform the CBD ‘Status of KBAs’ complementary indicator referred to above.

A selection of anticipated outputs that will be made available are presented in Appendix 7.2.

6. Useful reading

BirdLife International. 2006. *Monitoring Important Bird Areas: a global framework*. Cambridge, UK. BirdLife International. Version 1.2.

Chandler, M., See, L., Copas, K., Bonde, A.M.Z., López, B.C., Danielsen, F., Legind, J.K., Masinde, S., Miller-Rushing, A.J., Newman, G., Rosemartin, A. & Turak, E. 2017. Contribution of citizen science towards international biodiversity monitoring. *Biological Conservation* 213: 280–294.

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Levrel, H., Kerbiriou, C., Couvet, D. & Weber, J. 2009. OECD pressure–state–response indicators for managing biodiversity: a realistic perspective for a French biosphere reserve. *Biodivers Conserv* 18: 1719–1732.

Moussy, C., Burfield, I.J., Stephenson, P.J., Newton, A.F.E., Butchart, S.H.M., Sutherland, W.J., Gregory, R.D., McRae, L., Bubb, P., Roesler, I., Ursino, C., Wu, Y., Retief, E.F., Udin, J.S., Urazaliyev, R., Sánchez-Clavijo, L.M., Lartey, E. & Donald, P.F. 2022. A quantitative global review of species population monitoring. *Conservation Biology* 36.

Stephenson, P.J. & Stengel, C. 2020. An inventory of biodiversity data sources for conservation monitoring. *PLoS ONE* 15: e0242923.

Wetzel F.T., et al. 2018. Unlocking biodiversity data: prioritization and filling the gaps in biodiversity observation data in Europe. *Biol. Conserv*. 221: 78-85.

7. Appendices

Appendix 7.1 A selection of remote sensing and other datasets of value to KBA monitoring

Indicator and dataset (remote sensing)	Monitoring (and relevance to State, Pressure, and/ or Response)	Annual?
Tidal flats: Murray Global Intertidal Change Classification	SP	n
Forest loss: Hansen Global Forest Change v1.6 (2000-2018) - average annual tree-cover loss since 2001 and forest cover in the year 2000	SP	y
Burned area: MCD64A1.006 MODIS Burned Area Monthly Global 500m	P	y
Precipitation: Climate Hazards Group InfraRed Precipitation with Station Data (version 2.0 final)	P	y
Drought: Monthly Climate and Climatic Water Balance for Global Terrestrial Surfaces, University of Idaho	P	y
Night lights: VIIRS Stray Light Corrected Nighttime Day/Night Band Composites Version 1	P	y
Soil moisture: Famine Early Warning Systems Network (FEWS NET) Land Data Assimilation System		y
Surface water: JRC Monthly Water History, v1.1	SP	y
Sea surface temperature: Standard Mapped Image MODIS Terra Data	P	y
Vessel hours: GFW (Global Fishing Watch) Daily Vessel Hours	P	n
Fishing hours: GFW (Global Fishing Watch) Daily Fishing Hours	P	n
Ozone	P	y
Nitrogen dioxide	P	y
Sulphur dioxide	P	y
Land surface temperature: MYD11A2.006 Aqua Land Surface Temperature and Emissivity 8-Day Global 1km		y
Snow cover: MOD10A1.006 Terra Snow Cover Daily Global 500m	SP	y

Indicator and dataset (other datasets)	Monitoring	Annual?	KBA type
Population: Estimated Residential Population per 100x100m Grid Square (available through GEE)	P	n	B, C
GHS settlement grid: Global Human Settlement Layers, Settlement Grid 1975-1990-2000-2014 (P2016) (GEE)	P	n	A - E
GHS built-up grid: Global Human Settlement Layers, Built-Up Grid 1975-1990-2000-2015 (P2016) (GEE)	P	n	A - E
World Database of Protected Areas (WDPA) to inform PA coverage of KBAs: Spatial datasets on Protected Areas globally. Overlap assessments are undertaken each year to generate an assessment of protected area coverage of KBAs, as an indicator for the Sustainable Development Goals.	R	y	A - E
World Database of Other Effective-area Conservation Measures (WD-OECMs) to inform OECM coverage of KBAs: OECMs are now available as a discrete spatial layer and like PAs, the overlap of OECMs is included as part of the indicator for the Sustainable Development Goals.	R	y	A - E
Forest Landscape Integrity Index to inform proportions of high, medium and low-integrity forests in KBAs: integrates data on	S	n	A - E

observed and inferred forest Ps and lost forest connectivity to generate a globally consistent, continuous index of forest integrity.			
Ramsar Sites Information Service to inform presence and abundance of triggers, and Ps taking place in KBAs: online database on wetlands that have been designated as internationally important under the Ramsar convention.	R	y	A - E
WWF Sight to inform a range of infrastructure datasets	P	n	A - E
eDNA may be useful in informing the species diversity at a site (and therefore species diversity loss over time) which could be used in measuring S: eDNA is likely to be more valuable for detecting presence/absence of species than monitoring changes in abundance.	S		A - E
SMART to inform Ps at sites: The SMART (Spatial Monitoring And Reporting Tool), which includes 'CyberTracker' for use on a smartphone or PDA, was originally developed to help protected area and wildlife managers better monitor, evaluate and adaptively manage patrolling activities.	PR	y	A - E
Marine Data Science: A list of databases and repositories that provide different type of marine data for specific regions.			A - E
Management Effectiveness (PAME): Hosted on the Protected Planet website, this global database is the most comprehensive global database of management effectiveness assessments for protected areas.	R	y	A - E
Human footprint	P	y	B, C
Mangrovewatch	SP	n	A-E
Ocean nitrate level	P	y	A - E
Cropland change	P	n	A - E
forest height change	P	n	A - E
forest biomass / flux	SP	n	A - E
red list of ecosystems	SPR	y	A - E
citizen science monitoring through picture pile (IIASA)	P		A-E

Appendix 7.2 A selection of metrics that will be available on the KBA website

Site-level results

Site-level results for each of state will include (with comparison from last evaluation where available):

- % triggers assessed for state
- Poorest condition
- Median condition
- % triggers (of those assessed) in each category:
  - Very substantial improvement
  - Substantial improvement
  - Moderate improvement
  - Unchanged
  - Substantial decline
  - Severe decline
  - Very severe decline
- % triggers showing improvement, no change or showing deterioration since baseline
- % triggers showing improvement, no change or showing deterioration since last evaluation

The summary statistics shown for Pressure will include (with comparison from last evaluation where available):

- Number of impacting pressures identified
- Highest impact category identified
- % pressures in each impact category
- % pressures happening now/ near future
- % of pressures that are (at worst) High or Very High-impacting
- Trend, possibly
  - % change in number of impacting pressures
  - % change in number of impacting pressures that are High or Very High impacting
  - Change in highest impact category triggers showing improvement

The summary statistics shown for Response will include (with comparison from last evaluation where available):

- % PA and OECM cover
- Management planning category
- Conservation action category
- Number of conservation actions
  - Needed
  - % underway
- Number of conservation actions needed in each main category: Land/water protection, Species management, Education & awareness, Law & policy, Livelihood/ economic, Research, External capacity building
- Trend possibly:
  - % change PA/ OECM cover
  - Change in management planning and conservation action categories (improvement/ stable/ decline)

- Change in % actions underway (that are needed)Number of conservation actions underway, and % that are appropriate to the trigger elements

Results available at broader scales determined by the KBA dashboard filter

Summary infographics that could be generated from the monitoring evaluations include:

- Proportion of KBAs in favourable condition
- Proportion of KBAs in unfavourable/very unfavourable condition
- Proportion of KBAs with high-impact threats happening now and in the short-term future, across multiple sites (e.g. by country, region, globally or for particular groups of species)
- Most important threats (i.e. most frequently recorded threats with high or medium impact) across multiple sites.
- Mean % coverage by PA/OECM
- % sites full, partial no PA/OECM coverage.