Development of the standard for identification of sites contributing significantly to the global persistence of biodiversity (Key Biodiversity Areas): Recommendations from the Thresholds Workshop

Sapienza Universitá di Roma and Fondazione Bioparco di Roma, Italy, 1-5 Dec 2013

1. Introduction and workshop overview

The IUCN WCPA/SSC Joint Taskforce on Biodiversity and Protected Areas has convened a global consultation process to consolidate the criteria and methodology for identification of sites contributing significantly to the global persistence of biodiversity, or Key Biodiversity Areas (KBAs). A Framing workshop held in June 2012 in Cambridge recommended several technical workshops to address various aspects of the KBA standard. This summary outlines the recommendations of the Thresholds technical workshop held 1-5 Dec 2013 in Rome, Italy. The workshop was generously hosted by Sapienza University and Fondazione BioParco of Rome.

The objective of this workshop was to develop quantitative thresholds for the four criteria recommended at the Criteria and Delineation workshop in March 2013 and to consider development of a fifth criterion suggested at the Framing workshop. These criteria aim to identify sites contributing significantly to the global persistence of (A) threatened biodiversity, (B) geographically restricted biodiversity, (C) biodiversity through outstanding ecological integrity, (D) outstanding biological processes, and (E) biodiversity as identified through a quantitative irreplaceability analysis. Such sites vary in size, but are typically between 100 and 1,000 km^2. Thirty participants with expertise spanning ecosystems and biomes, taxonomic groups, and genetic contributed to this workshop.

Following a welcome by workshop chair Bob Smith and host Carlo Rondinini, Jane Smart gave an overview of the IUCN consultation process for KBAs, Bob Smith summarized the similarities and differences between KBAs and systematic conservation planning, and Penny Langhammer presented the results of the Criteria and Delineation workshop and general considerations for developing thresholds. Specific considerations for each criterion were presented by Tiziana Ulian (criterion A), John Lamoreux (criterion B), Justina Ray (criterion C), and Jaime Garcia Moreno (criterion D). Dan Faith presented genetic considerations for the criteria and thresholds.

Working groups first tackled operational definitions ("thresholds of applicability") for criteria A, C and D; for example, what should be considered a globally threatened species or outstanding ecological integrity. On the following day Moreno Di Marco presented an analysis of the conditions under which sites identified through threshold approaches (specifically, Important Bird Areas) align to grid cells identified through comprehensively quantitative calculation of irreplaceability, designed to inform operational definitions and thresholds of significance. Graham Edgar followed with a short presentation on likely implications of different thresholds in the marine realm, and Lincoln Fishpool gave an overview of the number, and percent land/ocean area covered, of KBAs identified for birds and other taxa to date. The remainder of the workshop was spent in working groups dedicated to developing thresholds of significance for each of the five criteria and reports back to plenary with subsequent discussion.

The thresholds recommended by the workshop are summarized in the table below. Extended notes on each of threshold are in the Annex and should be read in conjunction with the table for a full understanding. In general, they are higher than the thresholds that have been used to date, to reflect the aim of KBAs to be of high global biodiversity significance and to avoid the problem of having too many KBAs as additional taxonomic groups and ecosystems are considered, which would dilute their impact in informing land-use planning and protected area extension. These require short-term examination of their impact on both a) existing KBAs; and b) potential identification of KBAs for other biodiversity features. It is understood that if the impact is too severe, for example, if many sites that previously triggered global thresholds no longer qualify, a subsequent process will be required to consider these differences and reach a compromise accordingly.

2. Recommended Thresholds

CRITERIA	PROPOSED THRESHOLDS OF SIGNIFICANCE	OPERATIONAL DEFINITIONS
A. Sites contributing significantly to the global persistence of threatened biodiversity		
A1. Taxa that are formally assessed as globally threatened or expected to be classified as globally threatened once their risk of extinction is formally assessed; or nationally/regionally endemic taxa that have not been formally globally assessed but have been nationally/regionally assessed as threatened	(a) A site holds at least: 0.5% of the global population of a CR or EN taxon, OR at least 1% of a VU taxon AND 5 functional reproductive units of a CR or EN species, OR 10 functional reproductive units of a VU taxon are observed, estimated, or inferred to occur regularly at the site, as measured by any of: Population, Genetic diversity, Number of sites, Area of Occupancy, Extent of suitable habitat, OR Extent of Occurrence OR, (b) A site effectively holds the entire global population of a CR or EN taxon OR, (c) For taxa assessed as threatened only under Criterion A of the IUCN Red List Categories and Criteria (i.e., rapidly declining, widely distributed threatened species), the site holds at least: 0.1% of the global population of a CR or EN species, OR at least 0.5% of VU species; AND 5 functional reproductive units of a CR or EN species, OR 10 functional reproductive units of a VU taxon are observed, estimated, or inferred to occur regularly at the site, as measured by any of: Population, Genetic diversity, Number of sites, Area of Occupancy, Extent of suitable habitat, OR Extent of Occurrence	*Threatened* includes taxa assessed as CR, EN, VU under the IUCN Red List Categories and Criteria and taxa assessed (including peer review and consistency check) as Threatened but not yet published. Taxa assessed as threatened under outdated versions of the IUCN Red List Categories and Criteria or under other documented global assessments of extinction risk (e.g., Heritage Methodology G-ranking) may trigger the identification of Candidate KBAs. Similarly, nationally/regionally endemic taxa that have not been globally assessed as threatened can be considered for triggering Candidate KBA identification. Sites from which a threatened taxon has been extirpated but is extant elsewhere (including for taxa assessed as Extinct in the Wild) and into which reintroduction is planned could trigger the identification of Candidate KBAs. These Candidate KBAs would become eligible for identification as KBAs when the taxon in question recolonizes or is reintroduced into the site. A *functional reproductive unit* is defined as the minimum number and/or combination of individuals necessary to trigger a successful reproductive event at the site or elsewhere (e.g., for sites identified in non-breeding areas or for juveniles). Examples of five functional reproducing units would be: 5 pairs; 5 reproducing females in 1 harem; 1 spawning aggregation (usually); 5 clones; 1 group of dolphins with 5 reproducing females, or 2 or more groups, if fewer reproducing females; 1 lek site, if 5 females and enough males to attract females.

A2: Ecosystems that are formally assessed as globally threatened or expected to be classified as globally threatened once their risk of collapse is formally assessed	A site holds at least 0.5% of the global extent of a CR or EN ecosystem, OR at least 1% of a VU ecosystem.	*To Be Defined (TBD)*

B. Sites contributing significantly to the global persistence of geographically restricted biodiversity

B1. Species that are geographically restricted by having highly clumped populations or by occurring at few sites[1]	(a) A site holds at least 20% of the global population, observed or inferred, of a species; OR, (b) A site holds a species known or strongly assumed to occur in 3 or fewer sites globally.	The three or fewer sites should be essential to the species persistence to avoid selecting KBAs where species is only known from type locality.
B2. Assemblages of species with geographically restricted ranges in centers of endemism or genetic distinctness	A site is located within a center of endemism or genetic distinctness AND contains at least 10% of the global population, observed, estimated or inferred, of a number of restricted range species, as determined by the following function: 	Total # species in class/order	# of restricted range species at site	 |---|---
up to 10,000	2-5
10,000-100,000	5-10
More than 100,000	10+
All orders/classes mixed	*20-50*		*Restricted range* refers to species with a global extent of occurrence less than 10,000 km^2 (200 km for linearly distributed species), OR, With a range less than or equal to the 25th percentile of the range-size distribution in a globally analyzed class/order, whichever range is larger. *Center of endemism* refers to an area less than 50,000 km^2 that has a disproportionately high number of endemic species, OR is defined according to a published global or continental analysis covering a taxon rank of at least an order. *Disproportionately high TBD* *Center of genetic distinctness TBD*
B3: Ecosystems with geographically restricted distributions or which occur at few sites	*TBD*	*TBD*

---

[1] Criterion wording changed from "Species with ranges that are permanently or periodically geographically restricted, or highly clumped populations, or which occur at few sites" (Criteria & Delineation workshop).

C. Sites contributing significantly to the global persistence of biodiversity because they are exceptional examples of ecological integrity and naturalness.		
C1. Intact species assemblages, comprising the composition and abundance of native species and their interactions, within the bounds of natural ranges of variation	One or more sites representing the most outstanding portions of an area identified as an Area of Outstanding Ecological Integrity (AOEI), which covers contiguous native habitat of at least 50,000 km^2. The aggregate KBA area must cover at least 10% of the AOEI, and each KBA should be at least 10,000 km^2 in size, within the confines of manageability.	*Areas of outstanding ecological integrity (AOEI)* contain intact species assemblages similar to a historical benchmark (95% similarity to 1500 AD but within the bounds of natural variation) averaged across the area in question, considering both terrestrial and aquatic components) within contiguous native habitat of at least 50,000 km^2 in size. Species composition and abundance/ biomass/ functionality is observed, estimated or inferred from: (a) direct measures of species composition and abundance/biomass, contextualized by historical information; OR, (b) absence (or very low levels) of direct human impact, as quantified by appropriate indices at the scale of interest and verified on the ground.
C2. The most outstanding places, within biogeographic regions, of relatively intact regionally distinct, contiguous areas of ecosystem and habitat diversity that contain regionally distinct species assemblages with high contextual species richness[2]	One site per country per ecoregion that represents an outstanding example of a regionally distinct species assemblage or contiguous area of ecosystem and habitat diversity.	The intactness of a site is assessed relative to the combination of ecoregion and country in which that site occurs. For consideration, the country should hold >5% of the total extent of the ecoregion. Intactness is defined by size (area of natural habitat), its composition of ecoregion-restricted species and its integrity (where integrity is measured, when possible, using the same approach as C1 but assessing % similarity to 1500 AD relative to other parts of the ecoregion/country rather than against a fixed threshold).

---

[2] Criterion wording changed from "The most outstanding places, within biogeographic regions, of relatively intact: a) regionally distinct species assemblages with high contextual species richness; OR, b) regionally distinct, contiguous areas of ecosystem and habitat diversity" (Criteria and Delineation workshop)

D. Sites contributing significantly to the global persistence of outstanding biological processes		
D1. Sites that, because of the evolutionary processes of exceptional importance that occur within them, contribute significantly to the persistence or rapid diversification of biodiversity.[3]	*TBD*	*TBD*
D2. Sites that support species at key stages in their life-cycles, in which they occur in geographic and/or demographic aggregations[4]	a) A site holds a population aggregation at a particular stage of the species' life-cycle AND at least 1% of the species' global population present at any given time; OR b) A site is one of up to 3 sites globally where that phase of the life-cycle occurs.	*Aggregation* is defined as the spatial clustering of individuals engaged in the relevant stage of the life-cycle, such that they occur at a density known or inferred to be at least two orders of magnitude larger than the species' average density during the non-aggregation stages
D3. Sites that, because of the ecological processes of exceptional importance that occur within them, contribute significantly to the long-term persistence biodiversity.[5]	TBD	This includes for example source populations (e.g. spiny lobster in the Caribbean) that produce most or all of the propagules of a species, and ecological refugia (e.g. areas in Australia that persist during periods of severe drought). *Ecosystem definitions TBD*
E. Sites contributing significantly to the global persistence of biodiversity as identified through a comprehensive quantitative analysis of irreplaceability		
Sites of exceptional irreplaceability, as identified through complementarity-based approaches.	*TBD*	*TBD*

---

[3] Sub-criterion wording changed from "Evolutionary processes of exceptional importance in maintaining biodiversity or driving rapid diversification" (Criteria & Delineation workshop).
[4] Sub-criterion wording changed from "Species at key stages in their life-cycles, such as those which are migratory or congregatory, as indicated by high relative abundance" (Criteria & Delineation workshop).
[5] Sub-criterion wording changed from "Ecological processes of exceptional importance in maintaining biodiversity" (Criteria & Delineation workshop).

ANNEX -- NOTES PERTAINING TO EACH CRITERION

Notes on Criterion A

- "Taxa that are formally assessed as globally threatened or expected to be classified as globally threatened once their risk of extinction is formally assessed". This relates to taxa for which extinction risk has been assessed and published as Threatened under the IUCN Red List Categories and Criteria, and to taxa assessed (including peer review and consistency check) as Threatened but not yet published. Taxa assessed as Threatened under the IUCN Red List Categories and Criteria but with these assessments not yet peer reviewed and consistency checked may trigger the identification of Candidate KBAs, for consideration as KBAs subsequent to endorsement through peer review and consistency check. Taxa assessed as threatened under outdated versions of the IUCN Red List Categories and Criteria (i.e., before Version 3.1) or under other documented global assessments of extinction risk (e.g., Heritage Methodology G-ranking) may trigger the identification of Candidate KBAs.

- With respect to "nationally/regionally endemic taxa that have not been formally globally assessed but have been nationally/regionally assessed as threatened", such taxa may trigger the identification of Candidate KBAs. It should also be noted that where such national/regional assessments include documentation of small range size, such taxa or ecosystems may also be considered for triggering the identification of KBAs under the KBA Criterion B1 or B3 respectively. Nationally/regionally endemic taxa that have been globally assessed as threatened should be considered for triggering KBA identification as above.

- Taxa that have been assessed as threatened using evidence based process other than the IUCN Red List of Threatened Species Categories and Criteria may trigger the identification of Candidate KBAs.

- In the case of taxa with taxonomic discrepancies, it was agreed to prioritize the IUCN global assessments vs the national assessments, because this process is to identify KBAs at the global level. However, such taxa could be considered either for candidate KBAs or for national KBAs.
- Example of Melocactus pedernalensis, vs Melocactus intortus:
  M. pedernalensis is considered endemic in Dominica Republic and it is listed as endangered in the national red list, while it is considered a synonym of *M. Intortus* in the Global Red List, where it is described as widely distributed in the Caribbean Region and it is listed as Least Concern.

- Taxa assessed as Near Threatened (including – because KBAs do not prescribe any particular kind of management actions – those taxa assessed as Near Threatened and conservation dependent based on the maintenance of actions necessary to prevent the taxon becoming Threatened), Least Concern, or Data Deficient would not be considered for triggering the identification of KBAs under the A criterion.

- Taxa assessed as Critically Endangered and flagged as Possibly Extinct should be treated in the same way as Critically Endangered taxa in general in all cases.

- In situations where the biodiversity feature for which the site is important has been extirpated from the site but is extant elsewhere (including for taxa assessed as Extinct in the Wild), the site will not be identified as a KBA for that feature. However, such situations could trigger the identification of Candidate KBAs. Such Candidate sites would then become eligible for identification as a KBAs, when the taxon in question recolonizes or is reintroduced into the site, or the ecosystem in question is restored in the site.

- How reasonable are the proposed % thresholds?
    - Likely reasonable for: invertebrates, Hippopotamus, Blue Whale, small mammals, birds, narrow-ranged plants
    - May be too severe: most cetaceans, marine turtle nesting beaches, Humphead Wrasse aggregatioaqns, narrow endemic plant species, some large terrestrial mammals (e.g. Lion), [needs more consideration], using body size scaling would result in differences in thresholds within taxonomic groups that would not make sense and is therefore probably not workable.
    - May be too generous: widely-distributed plants

- Start with proposed thresholds; if, after testing, these are problematic, consider multiple (or scaled) thresholds; consult SSC Specialist Groups, Sub-Committees, RL partners on specific examples

- Thresholds for A3 await the outcome of a Jan 2014 Red List of Ecosystems meeting as to the definition of the unit for ecosystem assessment; a similar approach to A1 is recommended.

- The thresholds of significance under A1 "(b) A site effectively holds the entire global population of a CR or EN taxon" has been modified after the workshop to include EN species. Although it is very unlikely that a single site EN species could have <5 functional reproductive units, it has been added taking a precautionary approach.

Notes on Criterion B

- B1 and B2 require testing to determine impact of these higher thresholds on existing KBAs. Testing IBAs may be a challenge because assessing whether a site has 10% of the population (or range) of a bird species requires a level of mapping precision not currently used. A 10% threshold will exclude existing sites identified for restricted-range bird species occurring at more than 10 sites.

- Should the impact of the proposed thresholds prove too severe to existing sites (i.e., IBAs), a suggestion was made after the workshop (John Lamoreux) to then allow sites identified under IBA criterion A2 (restricted-range) to be recognized as KBAs and use these proposed thresholds for other taxonomic groups. This requires further discussion.

- KBAs should not be identified under B1 for species only known from the type locality, as once more data is available, the species might prove to be widely distributed.

- There was significant debate as to how to define the number of restricted range species that must be in a site within a center of endemism to trigger a KBA under B2. There was general

agreement that the thresholds in current use for birds (minimum of one species, in exceptional cases, per site in a center of bird endemism) would not be workable for other taxonomic groups, because of the huge number of places on the planet where at least two restricted-range species might overlap (think insects). The group proposed to determine the number of restricted-range species per site as a function of known species richness in a vertebrate class or non-vertebrate order as follows (approximate log function), subsequent to testing:

Total # species in class/order	X (range for testing)
up to 10,000	2-5
10,000-100,000	5-10
More than 100,000	10+
All orders/classes mixed	*20-50*

- Thresholds for B3 await outcome of Jan 2014 Red List of Ecosystems meeting as to the definition of an ecosystem. If ecosystems are defined at a scale greater than a site but smaller than a biome, an approach to thresholds similar to that used for B1 could be considered, but higher thresholds may be needed to avoid the problem of too many sites.

Notes on Criterion C

Sub-criterion C1

- C1 is about absolute intactness and C2 is about relative intactness (to the ecoregion).

- C1 is not meant to capture small intact ecosystems, like a perfect cave system or a mountaintop, which could, if important, be addressed by another criterion (e.g., B3). This is about ecosystem types that require large, intact areas to maintain integrity. We imagine that KBAs identified under C1 will be much fewer in number and larger in size (on average) than those identified by other criteria. The thresholds under C1 need to be set very high in order to find truly outstanding examples of the global scale of still-natural and intact places that are storehouses for biodiversity.

- KBAs under this subcriterion are selected in a step-wise process:
    - STEP 1: Areas of outstanding ecological integrity (AOEI) are identified
    - STEP 2: One or more KBAs are identified within AOEI, selecting the best portions relative to baseline conditions and where possible, overlapping with other KBAs.

Re Step 1 (identification of AOEI):
- Ecological studies directly measuring species composition and abundance, biomass, and/or productivity should be contextualized by historical information that allows inference on the "natural bounds of variation" for diversity/abundance in this particular ecosystem, particularly for species indicative of long-term structural stability (e.g., corals or tree species) and functionality (predators, keystone species), or those known to be highly sensitive to human impact (e.g., large predators, migratory fish, or economically valuable species).

- Indices of human activities implying impacts on biodiversity can be obtained from information such as deforestation from satellite imagery, maps of shipping lanes or roads, human density data, field-based measures of habitat condition/impact. They are not enough on their own and should be verified on the ground, particularly for impacts that cannot be detected remotely, such as overexploitation or invasive species. Scale of interest dependent on realm or system of interest (e.g., terrestrial/freshwater system within the catchment(s), marine?). Ground-truthing needs to focus on those aspects that cannot be inferred from remotely-sensed data. For example, an area that appears 100% intact on a satellite image may actually have much lower intactness in terms of species composition (e.g., due to overharvesting, selective logging, invasive species, etc.). This does not include pervasive global threats that would affect every candidate site.

    -).
    - Because of the 95% similarity requirement, the impacts outside the area should be detectable. With respect to inferring intactness through impact, documentation will need to explain rationale.
    - Wherever possible, these intact areas should be evaluated on the basis of entire catchments, in recognition of the interaction between freshwater and terrestrial components. But terrestrial and freshwater may also be considered separately.
    - This concept does have applicability to marine systems (e.g., Graham and McClanahan 2013), but needs further consultation with marine experts, particularly with respect to historical benchmark.
    - The 50,000 km^2 threshold is somewhat arbitrary (as are all metrics used to define "intact"), but is meant to be a high bar. It also needs to be meaningful from a freshwater perspective (e.g., the boundaries of the intact piece where extent of intactness is evaluated would conform with water catchment area).
    - Pervasive, global-scale ongoing threats that affect all marine and/or terrestrial areas (e.g., climate change, overharvest of large marine predators and cetacean, ocean acidification) are not included in impact metrics that define ecological integrity.

KBAs under C1 need to be identified separately in Terrestrial, Freshwater, and Marine ecoregions. Whenever sites overlap (freshwater/terrestrial) or are adjacent (e.g. marine + terrestrial/freshwater), the delineation phase should attempt to combine them.
Re Step 2 (selecting the KBAs within the AOEI)
    - KBA (s) selected within an AOEI should be at least 10,000 km^2, in keeping with "wilderness definition" (Mittermeier 2003; Watson et al. 2009; Graham & McClanahan 2013).
    - Recognition that KBAs selected through C1 may (and likely will) have KBAs within them that are selected along other criteria. These should be complemented wherever possible (e.g., draw KBA boundaries within AOEI that overlap most with the other KBAs), but not defaulted to the other KBA boundaries as need to be at least 10,000 km2. Likewise, other KBAs defined through other criteria shouldn't necessarily be swallowed up (i.e., losing site for the reasons for identification) in a C1-criterion KBA.

Sub-criterion C2

- The most important aspect of C2 is identifying intact areas that are important for species and ecosystems not covered by other criteria

- Proposed thresholds under C2 are subject to testing:
    - Potential transboundary (e.g. Lakes)
    - Number of country/ecoregion combinations
    - Research to identify KBA size thresholds in each ecoregion type
    - Approaches for measuring the intactness of potential KBAs and deciding when it meets a minimum threshold
    - Implications for existing IBAs and IPAs identified to conserve biome-restricted species and habitat types

- KBA identification under C2 needs to be informed by existing KBA coverage for C1 and B.

- There is scope to consider a similar approach for C2 and B2, because the scale of C2 applicability is the ecoregion as defined by WWF, which is the same scale as Endemic Bird Areas. If the current approach and thresholds proposed under B2 are unworkable for existing KBAs (i.e. too many would cease to meet global thresholds), we could consider combining C2 and B2 for taxa whose centers of endemism approximate the scale of ecoregions.

- We may want to set a threshold for the proportion of an ecoregion to be in a country (e.g. >5%) for a KBA to be identified within it.

- Intactness = size + species composition (ecoregion-restricted species) + integrity (where data available)

- Each KBA should be greater than the minimum size relative to size of ecoregion (different rules for terrestrial, freshwater rivers, freshwater lakes, marine)

Notes on Criterion D

Sub-criterion D1

- The working group on D1 considered a number of processes and concepts like rapid evolution, speciation through hybridization, "engine rooms of diversification", and connectivity of populations, but could not restrict them to sites or identify examples.

- Two possibilities were put forth for further consideration:
    - Places that contain a *disproportionate amount* of the genetic diversity for *two or more* species[6].

---

[6] Vandergast *et al.* 2008. Are hotspots of evolutionary potential adequately protected in southern California?' Thomassen *et al.* 2011. Mapping evolutionary process: a multi-taxa approach to conservation prioritization.

- Sites that each capture a large proportion of the total environmental diversity of the ecoregion in which that site occurs, and/or include exceptionally steep environmental gradients, and thus provide capacity for evolutionary (and ecological) adaptation, even if they do not necessarily contain high biodiversity yet. This could be amenable to thresholds if they are set high[78].

- D1 has been retained as a placeholder for now and requires further development or may be deleted. A process should be developed to define the thresholds under this sub-criterion.

- The wording for sub-criterion D1 was not presented in plenary but has been changed based on notes from the working group sent after the workshop.

Sub-criterion D2

- Stages of the life cycle include migration, breeding, roosting. Examples of aggregations include spawning aggregations in fish, winter concentrations of migratory birds, bottlenecks of species' migrations, breeding bays for some whales.

- A threshold of 1% of the global population at a site aligns with current thresholds in use for IBAs and Ramsar, but requires testing to see if it may be too low compared to proposed threshold B1(a) (20%). Rationale for D2 cf A1 VU: the former trigger Red List equivalents for the relevant stages in their life cycles. A threshold of 1% is actually more stringent than Ramsar, because of the requirement for aggregations (> 2 order of magnitude higher density than average). Thus, a water bird that is concentrated in wetlands in the breeding season and also during migration and also during winter would not be captured. This requires further consideration to ensure that some important sites are not falling through the cracks.

- A suggestion was made after the workshop (Ana Rodrigues) to include an additional clause: OR *(b) more than Y% of the species' entire population goes through the site during the life-cycle stage)*
    - To account for bottlenecks in migration (e.g. Bering's straight for bowhead whales): the species may only have a very small fraction of the population present at any given time but the entire population may go through it and so the site is irreplaceable. Y must be substantially larger than the 1% threshold used when the global population is in the site at any given time (e.g. 10% or 20%).
    - We could consider adding a time window in the threshold (over XX months [or as suggested by Ben Lascelles, using the time of the relevant life-history stage)]
    - There is a risk that entire "corridors" may be triggered by this addition (e.g. gray whales where the majority of the population migrates along the Western US coast from their feeding to their breeding grounds; salmon going up a river), but maybe this can be easily dismissed as being beyond the site-level.

---

[7] Sgró, Low and Hoffmann. 2011. Building evolutionary resilience for conserving biodiversity under climate change. Evolutionary applications 4:326-337.

[8] Cowling RM & RL Pressey (2001) Rapid plant diversification: planning for an evolutionary future. PNAS 98 (10): 5452-5457.

Sub-criterion D3

- The wording for sub-criterion D3 was not presented in plenary but has been changed based on notes from the working group sent after the workshop.

- A suggestion was made after the workshop (Ana Rodrigues) to add the clause *within a moving window of 100 years or 3 generations* to the threshold of significance to account for stochastic variation when populations become temporally restricted/concentrated in ecological refugia (e.g. Australian refugia during droughts, which become key to species' persistence when populations die-off mainly everywhere else) and it will capture "refugia from human activity" for species whose ranges/populations declined a lot but have since recovered (e.g. the starting sites of (re)introductions of species Extinct in the Wild). This should not allow predictions of species distribution models under climate change, which may predict new sites even where species don't currently occur. There must be a confirmed presence of the biodiversity feature and/or of the ecological process responsible for the persistence of the feature.

Notes on Criterion E

- The rationale for developing a criterion E is that there might be sites of significance for the persistence of biodiversity that are not captured through the other criteria. Sites meeting criterion E would be sites that are particularly complementary in terms of their species composition.

- Criterion E would also be important for its calibration role, recognizing that significant contributions to the global persistence of biodiversity can in theory (even if rarely in practice) be comprehensively calculated, as well as approximated by the rules of thumb that we propose in Criteria A–D.

- Sites selected under criterion E threshold would have to increase the probability of persistence by a given threshold. This requires a function that allows for calculating change in probability of persistence of species from the loss of range/population in the site.

- Criterion E would not replace KBA analysis (criteria A to D), but it would be possible for sites to only meet criterion E. Like for other criteria, sites would need to be reviewed, documented, delineated etc.

- Requirements for quantitative analyses of irreplaceability used to identify KBAs under criterion E:
  - Quantify global-based site irreplaceability or another relevant indicator of the value of individual sites to global persistence of taxa identified in criteria A to D.
  - Based on representation targets (for each taxon) that are at least as stringent as those defined in criteria A-D.
  - Based only on data appropriate for assessing global biodiversity importance, rather than deciding management action.

- A suggestion was made after the workshop (Mervyn Lotter) to consider the application of a group of spatial statistic techniques that incorporate grouping analysis to identify statistically significant clusters of threatened species based on Hot Spot Analysis (or other suitable approaches) and displayed using Heat Maps or Kernel Density tools. .This is the approach South Africa plans to take in identifying Important Plant Areas in terms of Global Strategy of Plant Conservation – target 5). It certainly has a lot of merit and can be used where good point data exists for threatened plant species.