Metadata Sheet: Extinction risk
(Indicator No. 9)

Title:	**Biodiversity and Habitat Loss - Extinction risk**
Indicator Number:	**9**
Thematic Group:	**Ecosystems**
Rationale:	*A threatened species is one that is listed under the IUCN Red List Categories as Vulnerable, Endangered or Critically Endangered (i.e. species that are facing a high, very high or extremely high risk of extinction in the wild). Species are included in these categories according to a range of data regarding their abundance, populations, ecology, and the threats they face. Increasing numbers of species assessed as threatened or Extinct represents actual or potential declines in the status of biodiversity. Decreasing numbers of species assessed as threatened, over a suitable time period following management interventions, is strongly indicative of successful conservation measures.* *The Convention on Biological Diversity (CBD) recognises that biodiversity has its own intrinsic value and that biodiversity maintenance is essential for human life and sustainable development through the provisioning of ecosystem goods and services. Although this metric captures trends in one particular aspect of biodiversity (i.e. the rate species are moving towards extinction or becoming extinct) and does not encompass the wider spectrum of biodiversity (e.g. genes and ecosystems), losing species through extinction, or a reduction in the viability of remaining populations, is a particularly tangible and readily understandable component of biodiversity loss and has clear relevance to ecosystem function.* *The IUCN Red List of Threatened Species™ is widely recognized as the most authoritative and objective system for classifying species by their risk of extinction. The 2013 (version 2) Red List contained assessments for 71,576 species for which spatial data exist for just over 45,000 species, including all known species of amphibians, mammals, freshwater decapods, and birds, and for all know species of many other taxa, such as freshwater fishes, in many regions of the world. .*
Interlinkages:	*GW: Many species of freshwater molluscs and fishes are found in groundwater hydrological systems; significant numbers of these species are assessed as threatened on the IUCN Red List, frequently as a result of water abstraction, pollution, and the loss or degradation of habitat. Many of these species have highly restricted ranges therefore increasing their vulnerability to extinction.* *Lakes: Freshwater lakes are key resident and migratory habitats for many freshwater species such as fishes, and bivalve molluscs that depend on migratory fish for reproduction. Lakes, especially those with significant seasonal variations in area, are often significant for migratory and resident birds and support important fisheries.* *LMEs: Coastal and brackish ecosystems are vital to many migratory animals e.g., birds and diadromous fish.*
Description:	The Extinction Risk indicator allows for the identification of transboundary basins with the highest risk of species extinction. It is based on the IUCN Red List Categories and Criteria (IUCN, 2012) for selected freshwater biodiversity taxa.
Metrics:	The IUCN Red List of Threatened SpeciesTM is a database that provides a measure of the extinction risk and distribution ranges for individual species. Source: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. <www.iucnredlist.org>. HydroBASINS is a global river and lake catchment layer derived from HydroSHEDS and the global lakes and wetlands database (GLWD) and is the spatial layer to which all freshwater species are mapped in this analysis. Source: Lehner, B. 2012.

	HydroBASINS Version 1.b. Global watershed boundaries and sub-basin delineation derived from HydroSHEDS data at 15 second resolution. The two main aspects reported when assessing the status of freshwater biodiversity are vulnerability (i.e. threats to biodiversity leading to its loss) and irreplaceability (i.e. the uniqueness or endemism of the biodiversity within a basin) (Margules and Pressey 2000, Brooks et al. 2006). The Extinction Risk indicator uses IUCN Red List data (threat status and distribution maps) only for freshwater species from taxonomic groups for which all described species have had their extinction risk assessed in a basin to avoid any bias in the results. Some taxonomic groups (mammals, birds, amphibians, crabs, crayfish and shrimps) have been globally assessed and are therefore included in development of the indicator for all TWAP RB basins. Other groups (fishes, molluscs, dragonflies and damselflies, and selected aquatic plant families) have, however, so far only been comprehensively assessed for Africa, Europe, several Biodiversity Hotspots (Indo-Burma, Western Ghats, Mediterranean Basin and the Eastern Himalaya), the Arabian Peninsula and New Zealand, and are therefore only included in the indicator development for the TWAP RB basins in these regions. Addition of these taxonomic groups increases the taxonomic breath of coverage and so provides a greater degree of confidence in the results for these regions. These additional taxonomic groups are highly speciose, represent a range of trophic levels and play important roles in supporting ecosystem functioning (and services) of freshwater systems. Assessments are also underway for the Tropical Andes Hotspot and Canada such that the resulting data sets might also be incorporated to further improve the confidence of the indicators developed for these regions. All freshwater fishes of the United States have been assessed. The IUCN Global Species Programme's Freshwater Biodiversity Unit (www.iucn.org/species/freshwater) is currently soliciting for funds to complete the assessments of these additional groups across all remaining regions.
Computation:	Indicator results computation was undertaken in following steps: **Step 1.** Extinction Risk calculations. The extinction risk for each species on the IUCN Red List has been assessed according to the IUCN Red List Categories and Criteria (IUCN 2012). Information collated on each species includes taxonomy, distribution, abundance, population trends, threats, habitat preferences, basic ecology, and current and recommended conservation actions. The IUCN Red List Categories are: Extinct (EX), Extinct in the Wild (EW), Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT) and Data Deficient (DD). All species tagged as 'freshwater' in the 'System' field on the IUCN Red List are included in the analysis. **Step 2.** Collation of species distribution data. IUCN Red List species distributions maps (based on species presence within individual HydroBASINS) were collated for the above mentioned taxonomic groups. Species distribution catchment records coded as 'Presence' 1 (Extant), 2 (Probably Extant), 4 (Possibly Extinct), and 5 (Extinct) were included in the analyses. Map records coded as 'Possibly Present' and 'Presence Uncertain' were excluded from the analysis. Species catchment records marked as 'Origin' 1 (Native) and 2 (Reintroduced) were included. Records marked as 3 (Introduced), 4 (Vagrant) or 5 (Origin Uncertain) were also excluded. Datasets compiled prior to September 2012 employed different geo-spatial frameworks including: Hydro1k, HydroSHEDS, and non-catchment-based polygons. Maps based on these earlier spatial frameworks were subsequently migrated to a standard spatial layer for the TWAP indicator analysis called HydroBASINS at Level 8. Species distributions were migrated using a

combination of R scripts (R Development Core team 2010), ArcGIS 10.1 and Geospatial Modeling Environment v 0.7.2.1 (Beyer 2009-2012). Following migration of maps to HydroBASINS they were checked against original maps for range boundary and attribute consistency, resolution of partial duplicate conflicts (i.e. conflicting attribute values assigned to the same catchment), removal of duplicate records and species names spelling consistency. Where a given species appeared in multiple regional datasets the distribution was combined into a single global distribution and the most recent data were used for any overlapping segments. Species mapped after September 2012 have been mapped directly to the HydroBASINS layer, at either Level 8 or Level 10.

Step 3. Identification of species presence in TWAP basins and BCU's.
A spatial layer with matching extent to the BCU layer was produced for both HydroBASIN Level 8 and Level 10 sub-catchments. The HydroBASIN layers were then intersected with the BCU layer to obtain HYBAS_ID, BCCODE pairs to indicate which HYBAS_ID overlapped with each BCCODE. All species mapped to a HYBAS_ID could then be mapped to the corresponding BCCODE (and subsequently aggregated to the corresponding BCODE). Any intersections with areas smaller than the smallest level 10 HydroBASIN were omitted as a rule as in reality they tended to be shared borders rather than area overlap.

Step 4. Calculation of % threatened species per basin and BCU.
The percentage of threatened species (CR, EN and VU Categories) for each basin and BCU was calculated as a mid-point (MID) estimate, i.e. we assumed the DD species (those species for which insufficient information was available to assess a level of extinction risk) are threatened in the same proportion as the species for which there are sufficient data, as follows:

% threat = (CR + EN + VU) / (total assessed - EX - EW - DD).

The taxonomic groups included in the calculation pf % threatened species for the basins and BCUs in Africa, Europe and south Asia (Eastern Himalaya and Indo-Burma) were freshwater mammals, amphibians, birds, crabs, crayfish, shrimps, fishes, molluscs, dragonflies and damselflies, and aquatic plants. For the other regions of the world with less complete Red List assessments the indicator calculations was based upon freshwater mammals, amphibians, birds, crabs, crayfish, and shrimps only.

A Kendal Correlation test was undertaken to see if there were any significant similarities between the % threat per basin amongst taxon groups. We found that there was no significant positive correlation at the basin level for the level of threat among any of the taxon groups (see table 1). However, two groups showed relatively high levels of (negative) correlation, birds-crayfish and crayfish-shrimps. This finding confirms the importance on broadening the taxonomic scope of the indicator through inclusion of the 'additional' groups (fishes, mollusc, dragonflies and damselflies, aquatic plants) as no one group will accurately reflect (i.e. be a surrogate for) the status of another. Broadening the taxonomic breadth of the indicator through incorporation of the additional groups increases confidence in the result.

Table 1. Kendal Correlations for % threat per basin amongst taxon groups.

	Amph	Birds	Crabs	Crayf	Mamm	Shrimps	Fishes	Moll	Odon	Pl
Amphibians	1.000									
Birds	-0.016	1.000								

Crabs	0.336	-0.065	1.000							
crayfish	0.271	-0.586	NA	1.000						
Mammals	0.226	0.040	0.312	-0.178	1.000					
Shrimps	0.169	0.355	0.069	-0.771	-0.025	1.000				
Fishes	0.156	0.167	0.136	-0.132	-0.040	0.219	1.000			
Molluscs	0.013	0.242	0.055	0.166	-0.175	0.272	0.322	1.000		
Odonata	0.374	0.086	0.387	-0.037	0.219	0.034	0.167	0.124	1.000	
Plants	0.190	0.096	-0.004	0.002	0.059	0.102	0.133	0.117	0.136	1.000

Step 5. Calculate proportion of species endemism per basin and BCU.
All species occurring outside the extent of the BCU were excluded as none could be considered endemic to any single BCCODE or BCODE. The number of BCCODEs occupied by each of the remaining species was calculated and those restricted to single BCCODEs were marked as endemic. The results were then aggregated to test for cumulative levels of endemism at the BCCODE level.

The proportion of endemic species in each basin and BCU was then calculated. The taxonomic groups included in calculation of the endemism scores for the basins and BCUs in Africa, Europe and south Asia (Eastern Himalaya and Indo-Burma) were the mammals, amphibians, birds, crabs, crayfish, shrimps, fishes, molluscs, dragonflies and damselflies, and aquatic plants. The groups included for the rest of the world were mammals, amphibians, birds, crabs, crayfish, and shrimps. The percent of the species that are endemic to each basin and CBU, was then normalised to a 0-1 scale (using the '(value - min)/(max-min)' formula).

Step 6 Calculation of river length per basin and BCU.
An intersect of rivers (U.S. Geological Survey, Digital Charts of the World) with the BCU layer was undertaken to create a river layer for just the TWAP basins. This river layer was then projected to the World Equidistant Cylindrical projection so that each river segment length could be measured (in km) using the ESRI GIS calculate geometry function. A spatial join was then used to join the BCU polygons to the rivers lines layer using JOIN_ONE_TO_ONE, and the river length field was summed for each BCU polygon using the Merge Rule > SUM. The river length was then scaled up for the basin level. The river length (in km) for each basin and CBU was normalised to a 0-1 scale (using the '(value - min)/(max-min)' formula).

Step 7 Application of weighting to the % threatened species score.
Weighting of the percent threatened species score was undertaken by first multiplying the river length normalised score by 0.5, so greater importance was given to endemism as it represents one of the two principles of conservation planning (irreplaceability). Then an average of the two normalised scores (river length and endemism) was taken and multiplied against the threatened species score (using the '(% threatened species score) x (1 + average weighting score)' formula).

Step 8 Assignment of final Risk Categories.
Scores were placed into risk categories from 1 - 5, where 1 represents very low 'risk' and 5 very high 'risk' (see below).

Units:	Proportion of threatened species relative to non-threatened species weighted by percent endemic species and river length in km
Scoring system:	To present the results, the scores were placed into categories (based on the normalised scores) from 1 - 5, where 1 represents very low extinction risk and 5 very

<table>
<tr><td></td><td>high extinction risk. The thresholds were based on a compromise between the ‘natural breaks’ in the results from the river basins and results from the BCU’s (using Jenks approach). Standardising the thresholds between basin and BCU results allows for easier comparison between the two scales.

Overview of results can be seen below:

<table>
<tr><th>Relative risk category</th><th>Range</th><th>No. of Basins</th><th>Proportion of Basins</th><th>No. of BCUs</th><th>Proportion of BCUs</th></tr>
<tr><td>1 - Very low</td><td>0 - 0,09</td><td>73 (42*)</td><td>26%</td><td>140 (30*)</td><td>18%</td></tr>
<tr><td>2 - Low</td><td>0,1 – 0,19</td><td>106 (34*)</td><td>38%</td><td>278 (26*)</td><td>35%</td></tr>
<tr><td>3 - Moderate</td><td>0,2 – 0,39</td><td>88 (51*)</td><td>31%</td><td>290 (133*)</td><td>37%</td></tr>
<tr><td>4 - High</td><td>0,4 – 0,69</td><td>12 (7*)</td><td>4%</td><td>70 (42*)</td><td>9%</td></tr>
<tr><td>5 - Very high</td><td>0,7 - 1</td><td>3 (1*)</td><td>1 %</td><td>7 (4*)</td><td>1%</td></tr>
</table>
* Number of basins/BCUs for which results have been calculated, but bear a lower level of confidence due to computation limitations. See more in section ‘Limitations’</td></tr>
<tr><td>Limitations:</td><td>The major limitation to this indicator is reduced confidence in the results for the 47% of basins where only the globally assessed groups are used. The only way to improve this is to undertake IUCN Red List assessments for the fishes, molluscs, dragonflies and damselflies and aquatic plants globally so that these highly speciose groups that are important for ecosystem functioning and services can be used to inform conservation and development planning. The IUCN Global Species Programme is currently trying to fund projects to fill these taxonomic data gaps.

The river length weighting score incorporates a bias towards the temperate regions, as two basins with equal river length one temperate and one tropical would have the same weighting, but in reality the tropical basin would contain more species. This bias could be reduced in the future by incorporating a latitudinal weighting to the river length score, or river discharge/ or water volume data would be used as a surrogate for species richness. Ideally if all the taxonomic groups were assessed globally (see above point) then no surrogate for species richness would be needed.

Some of the very smallest of basins (4) and BCUs (11) have no data for the Extinction Risk indicator as the IUCN Red List species data is mapped to a larger resolution of basin than the basin/BCU so that species data were not associated with these basins/BCU’s during the automated overlap analysis in GIS.</td></tr>
<tr><td>Spatial Extent:</td><td>Global</td></tr>
<tr><td>Spatial Resolution:</td><td>All analyses were based on species distributions held in level 08 HydroBASINS, and resolution is defined by the size of the individual level 08 HydroBASINS that comprise individual species distributions. Level 08 HydroBASINS range in area from 0.001 km2 to 374,357 km2, with a mean area of 571 km2.

Original species distributions where produced in a variety of formats. (i) Molluscs, fishes, odonata, shrimps, crabs and Aquatic Plants were mapped to level 08 HydroBASINS. (ii) Other species groups (Birds, Mammals, Crayfish, and Reptiles) were originally mapped as irregular polygons and subsequently migrated to the relevant overlapping level 08 HydroBASINS.</td></tr>
<tr><td>Year of Publication:</td><td>Global Red List data are available on the IUCN Red List website (www.iucnredlist.org) and this database is updated annually. The Red List data and maps used in this analysis were as downloaded from the IUCN Red List Version 2.</td></tr>
<tr><td>Time Period:</td><td>2003 (est.) - 2013</td></tr>
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Additional Notes:	The Red List Index or RLI (Butchart et al. 2004; 2007) was originally proposed as the metric for biodiversity loss in the Methodology for the Assessment of Transboundary River Basins (UNEP-DHI, 2011). The RLI is based on the number of species moving between Red List Categories in repeated assessments over time where the change in Category is considered a result of a genuine improvement/deterioration in status (i.e. Category changes owing to revised taxonomy or improved knowledge are excluded). An RLI value of 1.0 equates to all species being categorised as Least Concern, and hence that none are expected to go extinct in the near future. An RLI value of zero indicates that all species have gone extinct. The index shows how the value of the RLI changes over time as species are re-assessed. Additional information on application of the RLI can be found here. Such a metric as the RLI has further potential to illustrate the effectiveness of national, regional and global measures designed to conserve biological diversity and ensure that its use is sustainable, including the measures implemented in fulfillment of obligations accepted under the CBD and under the Millennium Development Goals (UNDESA 2007). In addition, the IUCN's Red List Index is being considered for adoption as biodiversity indicator under the proposed Sustainable Development Goal 9, targets a and b. Given the relatively low temporal resolution of the RLI, with updates every 4-5 years as possible, it is not able to detect rapid changes in biodiversity status and is also relatively insensitive to the slow deterioration of common species as a result of general environmental degradation. The RLI is nevertheless the most widely accepted indicator for temporal change in the global status of biodiversity. **References:** Margules, C.R. and Pressey, R.L. 2000. Systematic conservation planning. Nature 405:243-253 Brooks, T. M., Mittermeier, R. A., da Fonseca, G. A. B., et al. 2006. Global biodiversity conservation priorities. Science, 313, 58–61
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