Documentation form for indicators reviewed for SEBI2010 by Species Expert Group (EG1)

Putting proposed indicator in context:	
Focal Area	Status and trends of the components of biological diversity Related focal areas for which the indicator has relevance:
EU indicator heading	Trends in abundance and distribution of selected species
Related PEBLDS indicator heading (if different)	Trends in abundance and distribution of selected species
Related CBD indicator heading (if different)	As above
Name of specific indicator	Trends in abundance of bat species across Europe
Definition of indicator in few lines.	Annual/periodic change in abundance of bat species per country (which could then be aggregated to higher biogeographical or geopolitical scales).
Indicator Type:	State
Summary / Introduction	All European bat species are protected under the Bern Convention, Convention on Migratory Species – CMS (Bonn Convention) and the EC Habitats Directive (HSD). The Agreement on the Conservation of Populations of European Bats (EUROBATS) was set up as an Agreement under CMS and emphasises the conservation of migratory bats that would benefit significantly from international cooperation. A key part of the Agreement is monitoring the population status of all species within the region. Forty-five species occur within the range of the Agreement, which incorporates 48 Range States, with 31 of those currently signed up as Parties to the Agreement. In addition, 25 of these countries are bound by the legal requirements of the HSD to monitor the conservation status of all bat species listed in the Annexes to the Directive. Bat species are protected because severe declines occurred in most populations throughout the post World War II period (Stebbings, 1988; Ransome, 1990; Harris *et al*., 1995; Racey & Entwistle, 2003; Battersby *et al*., 2005). The latest *IUCN Red List of Threatened Animals* (www.redlist.org) includes 17 European bat species, 10 of which are in decline. Declines have been linked to habitat fragmentation and loss (Yalden, 1992; Ekman & de Jong, 1996; Swift, 1997; Reynolds, 1998; Verboom, 1998; Racey & Entwistle, 2003); Bats utilise a wide variety of habitats for both roosting and foraging (Walsh & Harris, 1996a,b). Different species have different habitat requirements and these requirements vary seasonally. The habitat requirements of females, males and juveniles may be different at different times of year (e.g. Ransome, 1990). Woodlands are key habitats for bats both for foraging and roosting. Those with large mature and dead trees provide a variety of roost sites in both summer and winter (Hill & Greenway, 2005; Racey & Entwistle, 2003). Some species require undisturbed caves, mines and other underground structures for summer and winter roosting (e.g. Ransome, 1990). The loss of roosting habitats in woodlands and underground sites has led some species to make increasing use of buildings and in some cases buildings are now their preferred roosting sites (e.g. *Pipistrellus*

	species – Battersby *et al*., 2005). In other species the loss of natural roosting sites is thought to have been a major contributory factor in their current scarcity (e.g. *Myotis bechsteinii* - Yalden, 1992; *Rhinolophus ferrumequinum* - Ransome & Hutson, 2000). Bats' preference for buildings has brought them into close contact and sometimes conflict with humans. Extensive areas of woodland and woodland edge habitats provide high insect abundance for foraging species as do riparian habitats with bankside trees and vegetation (de Jong & Ahlen, 1991; Racey & Swift, 1985). Wetlands, lakes, ponds and streams are also important foraging areas for many species (Walsh & Harris, 1996a, b). Bats need good connectivity between habitats to enable them to travel safely between foraging and roosting areas (Limpens & Kapteyn, 1991; Limpens *et al.*, 1989; Swift, 1997; Verboom, 1998) as well as connected good quality habitats along migratory routes (Fleming & Eby, 2003). Site based conservation is an important aspect of conserving bats and the 14 bat species listed on Annex II of the HSD have Special Areas of Conservation (SACs) / Sites of Community Importance (SCIs) designated for them. These have usually focused on major roosting sites, but in some cases address foraging habitat. Monitoring and reporting on the condition of SACs/SCIs is an obligation under the Directive. All EU Member States are obliged to collect the necessary information. This could provide a basis for a Europe-wide data source on population trends for the most threatened species. Furthermore, all bats are listed on Annex IV of the Directive. This means that the 25 EU Member States must collect information and report on the conservation status of all bat species within their countries. These legal obligations provide an ongoing source of information suitable for use as an indicator. The dependence of bats on specific habitats for roosting and foraging and the variety of habitats utilised by the different species, provides a scientific basis for the use of this species suite as bioindicators of environmental quality, not just of protected areas, but of the wider countryside. The use of bats as indicators of environmental quality or of biodiversity has been tested in temperate and tropical ecosystems (e.g. Gerell & Lundberg, 1993, Catto et al.., 2003; Clarke *et al*., 2005,) and they have already been adopted as indicators in certain national networks e.g. the UK Environmental Change Network (ECN) (ECN, 1997). Temperature has a major impact on bats' ability to forage, reproduce and hibernate (Ransome, 1990). Many species will thus be good indicators of the effects of climate change. Previous technical challenges to bat studies, nocturnality, and public misconceptions may have contributed to the potential of bats as bioindicators being somewhat overlooked in the past. Following the enormous rise of interest in this group and the dramatic technological improvements that have enhanced our understanding of bat ecology, it is clear that bats are very relevant to many modern environmental issues. It would be timely now to include this important component of the European mammal fauna among mainstream bioindicators.
Relation of indicator to focal area	Bats are highly social mammals and are often extremely visible, particularly during the breeding season when they congregate in maternity roosts to raise their young and emerge at dusk in groups. Their protected status, ecological requirements and the existence of an Agreement covering all European countries makes them ideal candidates to act as bioindicators, for themselves, for other mammals, other taxa and for habitat quality generally.

	The EUROBATS Agreement has been collecting information together on monitoring work carried out in each range state and is producing guidelines on consistent monitoring methods with the intention of developing consistent monitoring across the Agreement area. Bats also have relevance to two other focal areas: Threats to Biodiversity (indicator: impact of climate change on biodiversity) and Ecosystem integrity and ecosystems goods and services (indicator: connectivity/fragmentation of ecosystems)
Relation of this indicator to other indicators	This indicator complements those developed for common and widespread farmland and forest birds by the Pan-European Common Bird Monitoring Scheme (PECBMS), and potentially also a wetland bird indicator, should that be developed. However, it would be very good to have a non-bird indicator to widen the species coverage and provide a reference for the relevance of bird data to other groups. A bat species indicator also complements those developed by the Pan-European Biological and Landscape Diversity Strategy (PEBLDS) that are linked to CBD focal areas. The data collected though bat monitoring schemes forms an important input to assessments of species' conservation status. The trend data used to produce this indicator would contribute to the PEBLDS indicators dealing with the *Change in status of threatened and/or protected species* (e.g. IUCN and National Red Lists) and *Trends in abundance and distribution of selected species*. Because some bat monitoring adopts a site-based approach, this indicator also has the potential to provide information about the *condition of protected areas.* The decline in bat species has been linked to changes and fragmentation off habitats and this indicator would therefore complement and potentially validate the PEBLDS indicator *Connectivity/fragmentation of ecosystems*. As already mentioned bats are sensitive to temperature change and would be good indicators of the effects of climate change and this would complement the PEBLDS indicator *Impact of climate change on biodiversity*. Much bat monitoring in Europe is conducted not by professional bat researchers, but by a huge number of skilled volunteers. This is particularly true in the UK and the Netherlands. Their growing involvement in such 'citizen science' offers a very tangible indicator of *public awareness and participation*. This indicator would also complement those developed by the European Environment Agency (EEA), in particular under the *Species diversity* indicator
<u>Data sources and methodology of proposed indicator:</u>	
Data availability	For bats, most data are held at a national level by monitoring centres and NGOs e.g. the Bat Conservation Trust (BCT) in the United Kingdom. These data include counts of bat colonies in major roosting sites, both over and underground, and information delivered by bat detector survey and ringing programmes. As for many other indicators, there is variation across Europe in the quality of data available and in the data collection infrastructure. Some monitoring programmes are highly developed, for example the UK's National Bat Monitoring Programme (NBMP). It currently produces statistically robust population trends for 11 of the UK's 17 resident bat species. Set up in 1996, trained volunteers collect data annually for the programme at roost and field sites across the UK. Over 2000 volunteers have surveyed over

	3000 roost and field sites since the programme began. On average over 730 volunteers take part every year with over 1400 sites being surveyed. Data are stored on a centralised database and population trend data and information about the monitoring programme are made available through the NBMP annual reports, published on the BCT website. Ongoing capacity building exercises are transferring NBMP type approaches to countries with less developed biological recording infrastructures. BCT has worked, through the UK government Department for Food, Environment and Rural Affairs (Defra) funding, on the following projects: 1. Bat Conservation in Eastern Europe – the outcome is the Romanian Bat Protection Association NBMP run by volunteers. 2. Sharing Knowledge –a series of workshops in Romania, Georgia, France, Moldova and Slovenia sharing knowledge re monitoring techniques and training people in the methods re the NBMP 3. Pan European Project –a workshop in 2005 – outcome was an agreed way forward for a Pan European Monitoring Project to monitor bats in underground sites. At present there is no formal mechanism for collating these data at a European level. However, The EUROBATS Secretariat compiles a regular summary of what is being done at species and country level that includes appropriate contacts. A proposed pan-European monitoring scheme of underground bat sites would hold data at the country level, and aggregate information at European level. The future of this scheme relies on obtaining funding.
Methodology	Several methods are currently used as agreed standard methodologies for monitoring bats and can be used at various local to national scales (Bat Conservation Trust, 2001). These include: counts of emerging bats at summer maternity colonies; counts of bats in hibernation sites; transect field surveys using bat detectors along transects through randomly selected 1km squares or 1km lengths of waterways. The effectiveness of current survey methods is due to many recent technological developments that have transformed the nature of what can be studied, enhanced data reliability and enabled greater participation in surveillance. In the past, bats were considered difficult to survey because they are flying, nocturnal mammals. New survey techniques are rapidly being developed to address species that are technically difficult to identify (Hill & Greenaway, 2005) or for use in regions where the terrain/habitat (e.g. NBMP Woodland Survey) or surveyor availability are issues (see Catto *et al*., 2002 for details of a car survey approach appropriate for monitoring populations of selected species across large areas using only a few volunteers). A key aspect of the production of monitoring guidelines is the standardisation of methods across the range of countries. Counts can be made in the same way at the same sites every season, providing a basis for large-scale long-term population trend analyses. The UK NBMP is recognised across Europe as a good example of how surveillance methods can be put into practice at a countrywide scale.
Evaluation of proposed indicator:	
Main advantages of proposed indicator	**1. Policy relevance:** The proposed indicator is directly relevant to all international legislation that promotes the conservation of European bats e.g. the Bern Convention, CMS and EUROBATS, and HSD. The development of this indicator contributes to compliance with the EUROBATS Agreement and fits directly under 'trends of selected species' on the CBD shortlist of biodiversity indicators. The indicator has policy relevance at two levels. At the species level, it is

by far the most suitable indicator currently available for monitoring the state of bats as an important component of biodiversity. At the habitat/ecosystem level, it also has the potential to inform about the quality of a variety of habitats, including woodlands and riparian habitats and ecological issues such as habitat connectivity.

This indicator would help to answer policy questions raised by the European Environment Agency (EEA), in particular under the *Species diversity* indicator it would help answer the key policy question - *" what is the state and trend of biodiversity?"* and the specific policy question - *"what is the state and trend of birds, butterflies and mammals related to specific ecosystem types?"*. At present the mammal trends focus solely on wolves and bears. Bats would provide an additional but radically different data set.

Under the *Threatened and protected species* indicator it would help answer the key policy question - *"will the loss of biodiversity be halted by 2010?",* and the specific policy question - *"what measures are being taken to conserve or restore biodiversity?"* This indicator is linked to data in the *IUCN Red List of Threatened Animals* and the Annexes of the EC Habitats Directive and the Bern Convention.

More fine-tuning is needed to test and ensure the value of the bat indicator for these purposes, but it could have high policy relevance at national and international levels.

2. Biodiversity relevance: The 45 bat species in Europe represent 23% of the European mammal fauna, a significant proportion of mammals to be considered as one group. All bats are protected and populations have undergone substantial declines in the past. Populations can decline very quickly because of a low intrinsic rate of increase (generally females have one baby per year, although twins are more common in some areas of Europe). As predators, bat density would be expected to be closely linked to the abundance of key invertebrate prey groups. The close association of many bay species with woodland and riparian systems means that bat density would also be expected to reflect changes in the stock, quality and connectivity of these key habitats.
Their sensitivity to change makes bats an ideal group to act as an indicator of change in general environmental quality. In addition, they complement data from other taxa distinctly, being nocturnal foragers on aerial invertebrates.

3. Scientific methodology: Best practice annual monitoring methods, e.g. the UK NBMP, are standardised and incorporate the statistical power to detect change at specified levels. Best practice programmes also incorporate quality assurance procedures. At a European level guidelines for monitoring bats are being produced, giving the best methods to use for each species and information on survey power and statistical analysis of the data.

4. Progress towards target: A significant number of European bats have declined and have an unfavourable conservation status, although there are indications from current monitoring schemes of significant population increases for some species in some countries. It would be meaningful to develop an indicator depicting these changes.

5. Acceptance and understandability: With only 45 species of bats to consider, the whole suite of bat species could be used to indicate general environmental quality (a manageable data collection target). There will of course be some difference in trends between species and across countries, but with a small group of mammals for whichecological requirements are generally known, it should be possible to assess the reasons for differing trends on an individual basis.

The functional diversity within the group could be exploited to give information on specific aspects of habitat change. Some species are more associated with woodland habitats, while others are associated with riparian habitats and others with meadows, pasture and woodland edge, so it may be possible to select a group of species to represent a 'woodland bat indicator' comprising those whose population trends reflect trends in the quality and/or quantity of woodland habitats. The same might be possible for a 'riparian habitat bat indicator'. A downturn in the indicator should indicate deterioration in the habitat, and vice versa. With more work it should be possible to satisfy this condition.

6. Affordability and availability: An indicator based on bats offers excellent value for money, because financial investment is exceeded by the "in kind" contribution of volunteer time. This is illustrated by the NBMP, which is acknowledged by policy makers throughout the UK to be highly cost effective. Between 1997 and 2003 the total cost of the programme was approximately £500,000. The monetary value of the 95,000 volunteer hours donated to the NBMP was estimated to be worth £3.5M. Unmeasured added value includes greater public awareness and support for general biodiversity delivery, through participation in the programme or contact with the programme's volunteers. In respect to a European bat indicator, the most pressing need is for financial support at the level of international coordination, to gather the data and produce the indices.

Several recent capacity building exercises have supported the implementation of these approaches in countries such as Romania. For example, the successful national monitoring programme administered by The Romanian Bat Protection Association uses standardised survey techniques and is delivered by volunteers. This was set up in partnership with the BCT through Defra and EUROBATS. If the UK NBMP model were more widely adopted, then the annual nature of surveys also means that the indicator could be updated regularly.

7. Suitability for modelling: The habitat requirements of most European bats are relatively well known (especially when compared to many other taxa). Based on this knowledge, it is possible to predict the impact of different threats on many individual species relatively accurately. Modelling approaches have been tested in several contexts and ongoing work at various research centres could underpin further developments in this field.

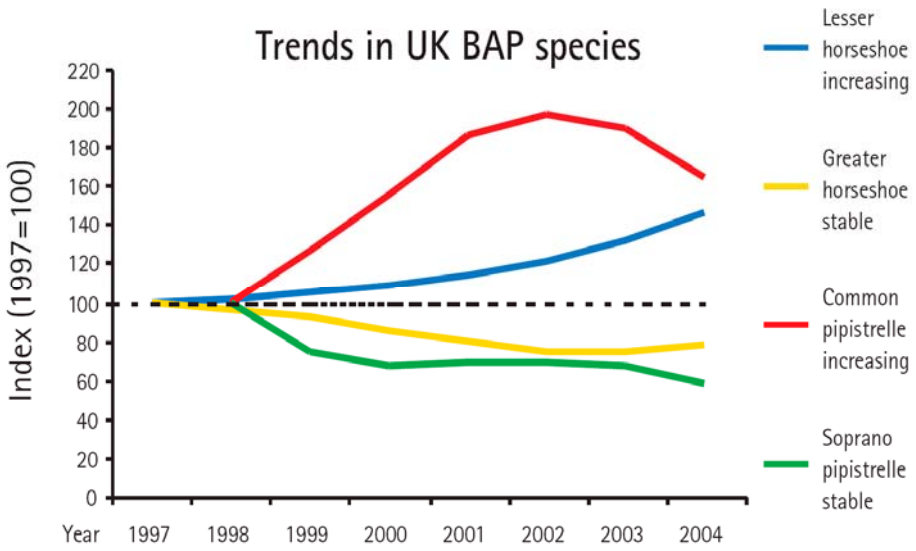
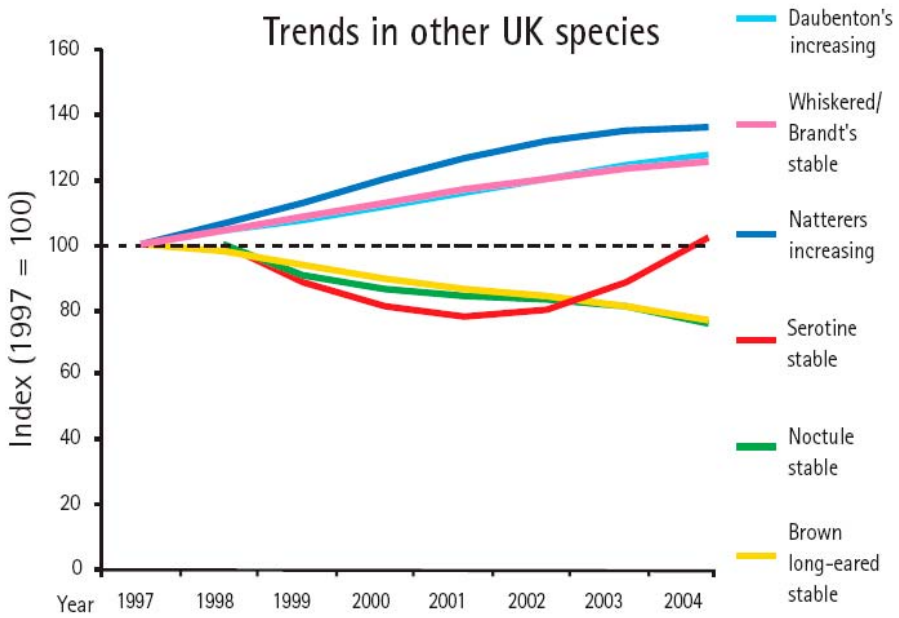
8. Data coverage: Potentially 48 countries in the EUROBATS Agreement, more certainly the 25 EU Member States that are obliged to report on the conservation status of all bats under HSD. Some countries can produce very good information, e.g. UK and the Netherlands. The EUROBATS Secretariat holds a metadata table on monitoring activities in each range state and information on data sources could easily be extracted.

EUROBATS also has a national reporting system, where all Parties to the Agreement and optionally Non- Party Range States, provide information on species in their country and work that is being carried out to conserve them. In the national reports each country provides information on trends for individual species and the Eurobats Secretariat provides a synthesis of the national reports. This information could be used to provide very broad trend information for individual species and a broad overall picture of bat population trends in Europe for 2010, possibly going back to the mid 1990s.

10. Sensitivity: In the UK The benchmark for monitoring sensitivity for mammals generally is that sufficient sites are monitored to detect, as a minimum, a population change of 50% over 25 years (equivalent to the

	Red Alert declines for birds) and ideally the more sensitive measure of 25% over 25 years (equivalent to the Amber Alert decline for birds). A series of power analyses have been conducted on the UK NBMP field, waterway and hibernation surveys that indicated the minimum sample required to detect declines of 50% and 25% over 25 years. These minimum requirements are currently being exceeded by all the UK surveys.
Main disadvantages of proposed indicator	**4. Progress towards target:** While good information is available for many species in many countries, assessment of bat trends across Europe is not, at present, standardised and co-ordinated. This will change as reporting on Favourable Conservation Status under Article 17 of the HSD is developed and as EUROBATS takes on a more central role for reporting on changes in bat populations. The main challenge will be setting-up a new pan-European scheme, and collating and analysing existing data from the various schemes operating in different countries. **6. Affordability and availability:** Although legal obligations and a partial infra-structure for the collection and collation of bat population trend data are in place, the process requires financial investment. The UK NBMP model has shown that high quality bat data can be collected very cost-effectively. Developing this sort of model across Europe would require a dedicated international bat NGO, similar to Wetlands International, to plan surveys and manage volunteer effort. Discussions between existing European mammal NGOs are underway. A formal decision on the structure of the organisation has not yet been taken. Despite this consideration, it would still be possible to produce some information on bat population trends across Europe. This would require sourcing individual country information, using the existing EUROBATS metadata and then carrying out a simple analysis of the results. This work would also need to be resourced. As for many other taxa and environmental data, the quality of data is likely to vary among individual countries. The current data may not be in a format to produce overall trends by 2010. **8. Data coverage:** Many of the 48 countries in EUROBATS are carrying out monitoring of some description of some of their bat populations, but the extent of coverage has not been fully investigated.
Analysis of options	
Suggestions for improvement	The quantity and quality of data on European bat populations will improve over time, given the existence of the EUROBATS Agreement and the reporting of conservation status for the HSD. However, setting up a pan-European monitoring scheme would instigate Europe-wide standardised data collection. Such a scheme would encourage development of monitoring in countries where very little information is available at present. At the same time, collation and analysis of existing data sets would provide some historic information and additional current information. Both these improvements require resources at international level. At the simplest level, improvements in the synthesis and analysis of information provided in national reports by EUROBATS Range States could give a very broad idea of changes in bat populations since the Agreement came into force. Making these improvements and also exploring the opportunities offered by bat data will take time and require resources. But, as illustrated by the advantages outweighing the disadvantages above, there is good potential for a meaningful bat indicator to be developed in the medium to long term.

Presentation:

How the candidate indicator should be presented	 Figure 1. UK example illustrating trends in four UK Biodiversity Action Plan (BAP) species, published in Anon. (In press). The state of the UK's bats: summary report from the National Bat Monitoring Programme. The Bat Conservation Trust, London.  Figure 2. UK example illustrating trends in 6 other UK species, published in Anon. (In press). The state of the UK's bats: summary report from the National Bat Monitoring Programme. The Bat Conservation Trust, London.
How the candidate indicator should be interpreted	Figures 1 and 2 illustrate trends at species level drawn from a number of separate surveys (e.g. winter hibernation surveys, summer field detector surveys). The majority of species illustrated are surveyed by more than one method as part of the UK NBMP, corresponding to different aspects of the species life history / behaviour (breeding,

	hibernating, foraging etc). The trends illustrated represent the most statistically robust data for each species. Trends termed "increasing" represent increases significant at P = 0.05 or below. Trends termed "stable" represent data for which graphical patterns are not significant at this level. The UK approach is currently focused at the level of the species. Amalgamation of trend data for combinations of species, for example, suites of species closely associated with particular habitat types, or environmental "pressures", is a likely future output of the NBMP.
Metadata:	
Technical information on each indicator option (or on the strongest candidates)	This should provide the meta-information as listed in SEBI2010 work plan (but not provided elsewhere in this template) for each (strong) option presented, namely: • **Title:** Trends in abundance of European bat populations • **Ownership:** Individual organisations • **Type:** S (bat population trends); S(woodland/riparian habitat quality); S (general environmental quality) • **Status:** • **Definition:** See above • **Relevant policy questions:** See above • **Description:** See above • **Date source:** EUROBATS and individual Range States • **Reporting obligations:** HSD FCS reporting of Annex II and Annex IV species. National reporting to EUROBATS Agreement • **Geographical coverage:** Pan European • **Temporal coverage:** 1996 onwards • **Update frequency:** Annual • **Data quality:** Variable – some high quality, some unknown • **Methodology:** Various • **Further work required:** See above • **Presentation:** See above • **Assessment of criteria for indicator selection**: See above • **Relation to similar indicators:** bird indicators • **Other stakeholders:** Organisations with data on bats • **Identified experts:**

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