Avocetta 33: 149-156 (2009)

Indicators and conservation policy: the German Sustainability Indicator for Species Diversity as an example

RAINER DRÖSCHMEISTER, ULRICH SUKOPP

Federal Agency for Nature Conservation (Bundesamt für Naturschutz) - Konstantinstrasse 110, D-53179 Bonn, Germany (droeschr@bfn.de)

Abstract – Bird monitoring data provide the basis for biodiversity policy related indicators in Germany. Such indicators focus on informing conservation policy and aim to reduce complex biological information to simple and easily understandable messages of political concern. The leading national conservation policy indicator is the German Sustainability Indicator for Species Diversity (SISD), which reflects the status of sustainability in the main habitat and landscape types. SISD summarizes the trends in abundance of 59 selected, representative breeding bird species. The issue of sustainability becomes part of the indicator construction by defining target values: an expert panel has determined a target value for every single bird species, which should be attained by 2015, provided that the guidelines for sustainable development and nature conservation are completely implemented. After standardisation of the population sizes at 100 % for the 2015 goal for all selected species, the deviation in percentage from those values can be computed for any individual year. Sub-indicators of each habitat type (farmland, forests, settlements, inland waters, coast/sea, Alps) are calculated. The SISD starts in 1990 and is updated annually. For 1970 and 1975, historical reference values were reconstructed. In 2006, SISD was at 70 % in relation to the target for 2015, showing a constant trend. To reach the target in time, sustainability policy must be strengthened significantly. SISD is used for assessment of sustainability and biodiversity issues in the German National Sustainability Strategy, the programme to support rural development (ELER), and the German National Strategy on Biological Diversity.

INTRODUCTION

German bird monitoring programmes have a long history beginning in the middle of the 20th century. Monitoring of common birds started in 1989 and is based on the contribution of volunteers (Flade & Schwarz 1999). Common bird monitoring stands in the context of an emerging conservation issue: the protection of the wider countryside and the reduction of negative impacts on biodiversity caused by high intensity land use practices. Building on their experience and long-term data, the current German bird monitoring programmes (coordinated by the Federation of German Avifaunists, DDA) have been reorganized since 2003 in terms of recording methods, location and shape of plots and organization, with the objective to better answer conservation-related questions. Information on monitoring programmes and results has been improved as well (see Mitschke *et al.* 2005, Mitschke & Sudfeldt 2008).

Bird monitoring makes available information that is relevant, reliable and applicable for multiple purposes:

- to provide advice to politicians,
- to assess the effectiveness of conservation programmes,
- to produce precise information on state and trends of different aspects of biodiversity for conservationists,
- to fulfil international reporting obligations,
- to build the basis for policy-related indicators.

Data from German volunteer monitoring programmes have been used to provide the basis for policy-related indicators in Germany. This paper describes the concept and construction of the leading species-based biodiversity indicator in Germany.

OBJECTIVES OF BIODIVERSITY INDICATORS ORIENTED TOWARDS CONSERVATION

Policy-related biodiversity indicators focus on informing conservation policy. Therefore, such indicators need to reduce complex biological information to simple and easily understandable messages of political concern. This is why

policy-related biodiversity indicators are sometimes criticised by scientists: the development of these indicators is situated in a conflict area between scientific and political demands (Turnhout *et al.* 2007). Good biodiversity indicators aim to fulfil various objectives:

- The conclusions are easy to understand for politicians and the public.
- The indicator is scientifically and methodically sound, like more familiar economic indicators such as price indices and gross national product (GNP) or financial indices (e.g. Dow Jones-Index).
- Indicator results portray real trends in selected elements of biodiversity and are thus highly relevant for conservation issues.
- Underlying monitoring data are precise and reliable.
- The indicator illustrates progress in relation to a target, which can be achieved if suitable programmes following the conservation law and existing guidelines for sustainability policies are implemented in the near future.
- A similar methodology is used for indicators depicting the same aspect of biodiversity at different administrational and political levels, e.g. at national and European levels.

INDICATOR DEVELOPMENT

A prototype of a German species diversity indicator was developed for the National Sustainability Strategy in 2002, and was improved afterwards in terms of both methods and data quality. The prototype consisted of 10 taxa, comprising nine bird taxa and one mammal species (Bundesregierung 2002). Species selection was determined mainly by pragmatism: an indicator had to be developed in very short time, which was only possible by using well-known and easily accessible data sets. Analysis of data subsets using selected indicator species showed many problems. For example, trends of species subsets in selected habitats did not correspond to common knowledge about changes in these habitats; the selection of different reference years resulted in varying overall indicator trends; and the combination of one mammal species with nine bird taxa provoked many discussions on the species selection.

A new concept was developed in the course of two research projects led by the Federal Agency for Nature Conservation (Achtziger *et al.* 2004, 2005a, 2005b, 2007) and resulted in the current Sustainability Indicator for Species Diversity (SISD), which is now the leading species-based national conservation policy indicator (Sukopp 2007, BfN 2008). The SISD reflects the status of sustainable land use in the main habitat and landscape types of Germany and indirectly depicts overall species diversity by means of habitat quality. The indicator summarizes the trends in abundance of 59 selected, representative breeding bird species. German volunteer bird monitoring programmes deliver the data to calculate SISD. Data gathering and analysis is lead by the Federation of German Avifaunists (DDA).

SPECIES SELECTION

For the current SISD, species selection was focused on bird species because of their high potential to act as indicators (e.g. Furness & Greenwood 1993) and because of good data availability from national bird monitoring programmes. The number of indicator species was restricted to around 10 for each habitat type (Table 1) and the species were selected in collaboration with ornithological experts. In order to address environmental variation inside each habitat type, several important gradients were considered and groups of indicator species covering the whole range of these gradients were singled out. For example, gradients of land use intensity, soil moisture and landscape structure were identified for farmland habitats. It was an additional demand that the distribution areas of the entire species set should cover all regions of Germany.

TARGET VALUES

Target values relate biological findings (e. g. about the abundance of bird species) to political or societal processes. Knowledge about the state of nature based on monitoring data does not automatically result in political action. Indicators effectively condense the knowledge, but their message remains arbitrary unless definite target values (e.g. for the size of animal populations) are agreed. In the case of the SISD, target values are an essential part of the indicator construction in order to address the issue of land use sustainability. An expert panel has determined a target value for each of the indicator bird species in an interactive process using the Delphi technique (Stickroth *et al.* 2004, Green *et al.* 2007). To define the target values, ornithologists were informed both about population sizes of each species in 1970 and 1975 under different land use conditions and about current population sizes and trends (abundance or index data of the last decade). The assumption was that target values could be attained by 2015, provided that the existing guidelines for sustainable development and the legislation on nature conservation are completely implemented in Germany. The Delphi technique

Table 1. Indicator species of the German Sustainability Indicator for Species Diversity (SISD) were selected for the six main habitat and landscape types in Germany.

Farmland	Forests	Settlements	Inland waters	Coast / sea	Alps
Black-tailed godwit (*Limosa limosa*)	Black stork (*Ciconia nigra*)	Black redstart (*Phoenicurus ochruros*)	Bittern (*Botaurus stellaris*)	Arctic tern (*Sterna paradisaea*)	Alpine accentor (*Prunella collaris*)
Corn bunting (*Emberiza calandra*)	Black woodpecker (*Dryocopus martius*)	Green woodpecker (*Picus viridis*)	Common sandpiper (*Actitis hypoleucos*)	Common tern (*Sterna hirundo*)	Bonelli's warbler (*Phylloscopus bonelli*)
Lapwing (*Vanellus vanellus*)	Coal tit (*Parus ater*)	House martin (*Delichon urbicum*)	Great crested grebe (*Podiceps cristatus*)	Eider (*Somateria mollissima*)	Capercaillie (*Tetrao urogallus*)
Little owl (*Athene noctua*)	Grey-headed woodpecker (*Picus canus*)	House sparrow (*Passer domesticus*)	Kingfisher (*Alcedo atthis*)	Guillemot (*Uria aalge*)	Golden eagle (*Aquila chrysaetos*)
Red kite (*Milvus milvus*)	Lesser spotted eagle (*Aquila pomarina*)	Jackdaw (*Coloeus monedula*)	Little grebe (*Tachybaptus ruficollis*)	Hen harrier (*Circus cyaneus*)	Nuthatch (*Sitta europaea*)
Red-backed shrike (*Lanius collurio*)	Lesser spotted woodpecker (*Dryobates minor*)	Redstart (*Phoenicurus phoenicurus*)	Marsh harrier (*Circus aeruginosus*)	Little tern (*Sternula albifrons*)	Ring ouzel (*Turdus torquatus*)
Skylark (*Alauda arvensis*)	Marsh tit (*Parus palustris*)	Serin (*Serinus serinus*)	Red-crested pochard (*Netta rufina*)	Oystercatcher (*Haematopus ostralegus*)	Robin (*Erithacus rubecula*)
Whinchat (*Saxicola rubetra*)	Middle spotted woodpecker (*Dendrocopos medius*)	Swallow (*Hirundo rustica*)	Reed warbler (*Acrocephalus scirpaceus*)	Red-breasted merganser (*Mergus serrator*)	Three-toed woodpecker (*Picoides tridactylus*)
Woodlark (*Lullula arborea*)	Nuthatch (*Sitta europaea*)	Swift (*Apus apus*)	Water rail (*Rallus aquaticus*)	Redshank (*Tringa totanus*)	Treecreeper (*Certhia familiaris*)
Yellowhammer (*Emberiza citrinella*)	Willow tit (*Parus montanus*)	Wryneck (*Jynx torquilla*)	White-tailed eagle (*Haliaeetus albicilla*)	Ringed plover (*Charadrius hiaticula*)	Willow tit (*Parus montanus*)
	Wood warbler (*Phylloscopus sibilatrix*)				

resulted in species-specific target values, giving an optimistic but realistic estimation of population sizes achievable by 2015. After standardisation of the population sizes at 100 % for the 2015 goal for each of the selected species, the deviation in percentage from those values can be computed for any individual year.

SUB-INDICATORS AND WEIGHTING

The SISD aggregates six sub-indicators for the main habitat and landscape types in Germany. Sub-indicator values are calculated as the arithmetic mean of the percentage target value attainments of all bird species representing the respective habitat type. The overall indicator value is the mean of the sub-indicator values weighted by the proportion of the area covered by the corresponding habitat type in Germany: farmland (50 %), forests (27 %), settlements (11 %), inland waters (6 %), coast/sea (3 %), Alps (3 %). The rationale for this weighting is that each habitat type contributes to the overall land use sustainability by the proportion of land surface area covered. Political measures in extensive habitat types will therefore result in greater changes in the indicator value than measures in habitat types covering smaller areas.

Other indicators deal in different ways with the problem of weighting, some of them without clear reasons for weighting or non-weighting respectively. For example, the indicator "Trends of selected bird species" in Lower Saxony comprises different numbers of species for different habitats, and the numbers of species correspond roughly with the land surface area of each habitat type (Schlumprecht *et al.* 2001). The European Common Bird Indicator (EBCC 2007; for methodology see Gregory *et al.* 2005) is based on 124 species without any weighting for habitat types, thus focusing on the status of bird species and not on sustainability of land use. Disaggregation of the overall European indicator to habitat types is calculated for farmland and forests with a restricted habitat-specific set of species.

INDICATOR RESULTS

The SISD data set starts in 1990 and is updated annually. For 1970 and 1975, historical values were reconstructed to

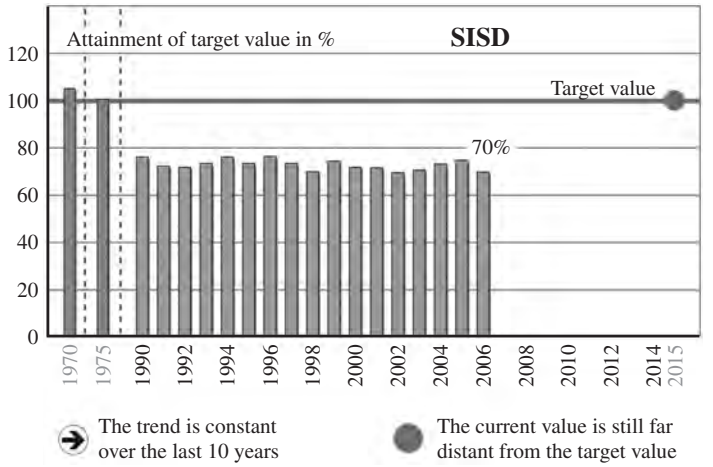

Figure 1. The German Sustainability Indicator for Species Diversity (SISD). The indicator values are updated until 2006. Trend analysis is based on the values from 1997 until 2006 (scheme adopted from Achtziger *et al.* 2007).

provide an earlier reference for bird abundances. Messages of the SISD and its sub-indicators are formulated in a clear and easy to understand way. In 2006, the SISD was at 70 % in relation to the target for 2015, showing no clearly positive or negative trend over the last decade (Fig. 1). This means that without additional efforts the target cannot be achieved by the prescribed date. Therefore, conservation and sustainability policy must be strengthened significantly in the next few years.

Over the last decade before 2006, the sub-indicators for farmland (value for 2006: 67 %), inland waters (value for 2006: 63 %) and the Alps (value for 2006: 62 %) stagnated at a level still far below the target value (Fig. 2). The sub-indicators for settlements (value for 2006: 66 %) and coast/sea (value for 2006: 66 %) show a moderately declining trend over the last decade, while the sub-indicator for forests (value for 2006: 80 %) is slightly increasing during this period.

DISCUSSION OF INDICATOR RESULTS

One conclusion from stagnating sub-indicator values for farmland is that farmland management and subsidies for agriculture, like agri-environmental programmes, need to be focused more strongly on biodiversity conservation (Flade *et al.* 2008, cf. Donald *et al.* 2006, Flade *et al.* 2004, Verhulst *et al.* 2004). Low indicator values and a stagnating trend in the Alps are interpreted as a result of intensive agricultural use and abandonment of traditional stock breeding practices in high mountain ranges (CIPRA 2007, Sudfeldt *et al.* 2007). The sub-indicator for inland waters dropped down to 63 % in 2006 after some promising increases in the late 1990s and at the beginning of the new millennium. It is argued that the positive trends before 2006 are due to generally improved water quality (Achtziger *et al.* 2007) and that management of water quality can effectively enhance biodiversity on the long term (Sudfeldt *et al.* 2007). Nevertheless, improving only one factor (e.g. water quality) is usually not enough to safeguard biodiversity of inland waters (Günther *et al.* 2005). For this goal, the area and condition of adjacent wetland ecosystems has to be improved as well.

The negative trend of the sub-indicator for settlements can be explained by intensive building activity, particularly on fallow land in cities (Günther *et al.* 2005). Loss of orchards and of traditional livestock husbandry are the main factors for declines in villages (Sudfeldt *et al.* 2007). Therefore, all relevant policy areas have to pay more attention to biodiversity conservation in settlements. Declining values of the sub-indicator for coast/sea are assigned to negative effects from recreational activities and fishery (Sudfeldt *et al.* 2007). It must be investigated further, if climate change is already altering the breeding conditions for birds at the coast.

The recently positive sub-indicator trend for forests can be linked to a better protection of many mature forest stands and the increasing average age of Germany's forests. However, population growth of many common forest bird species did not occur predominately or exclusively in forests, but rather in neighbouring areas (Sudfeldt *et al.* 2007).

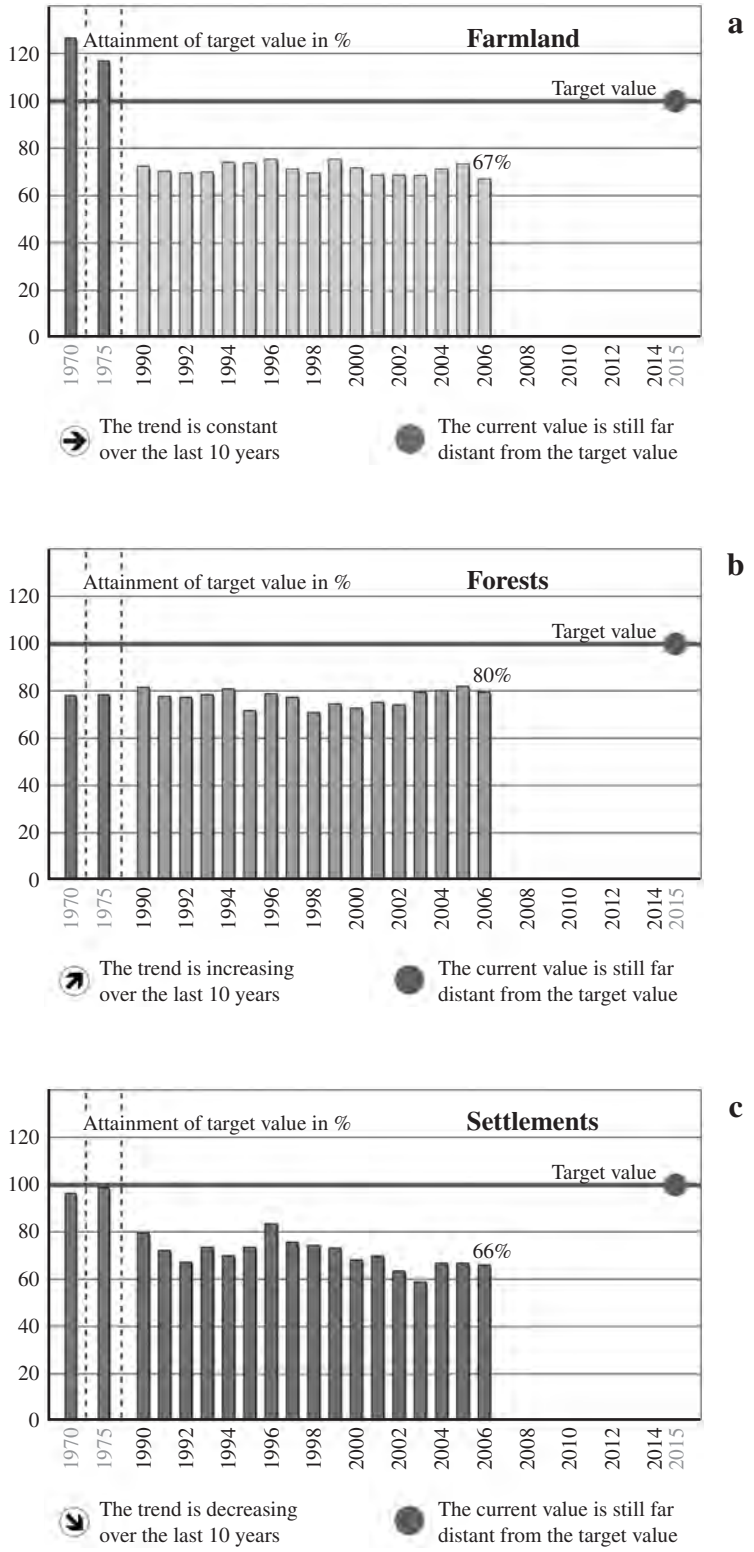

Figure 2 a,b,c. The six sub-indicators (a-f) of the German Sustainability Indicator for Species Diversity (SISD) representing Germany's main habitat and landscape types. The indicator values are updated until 2006. Trend analysis is based on the values from 1997 until 2006 (scheme adopted from Achtziger *et al.* 2007).

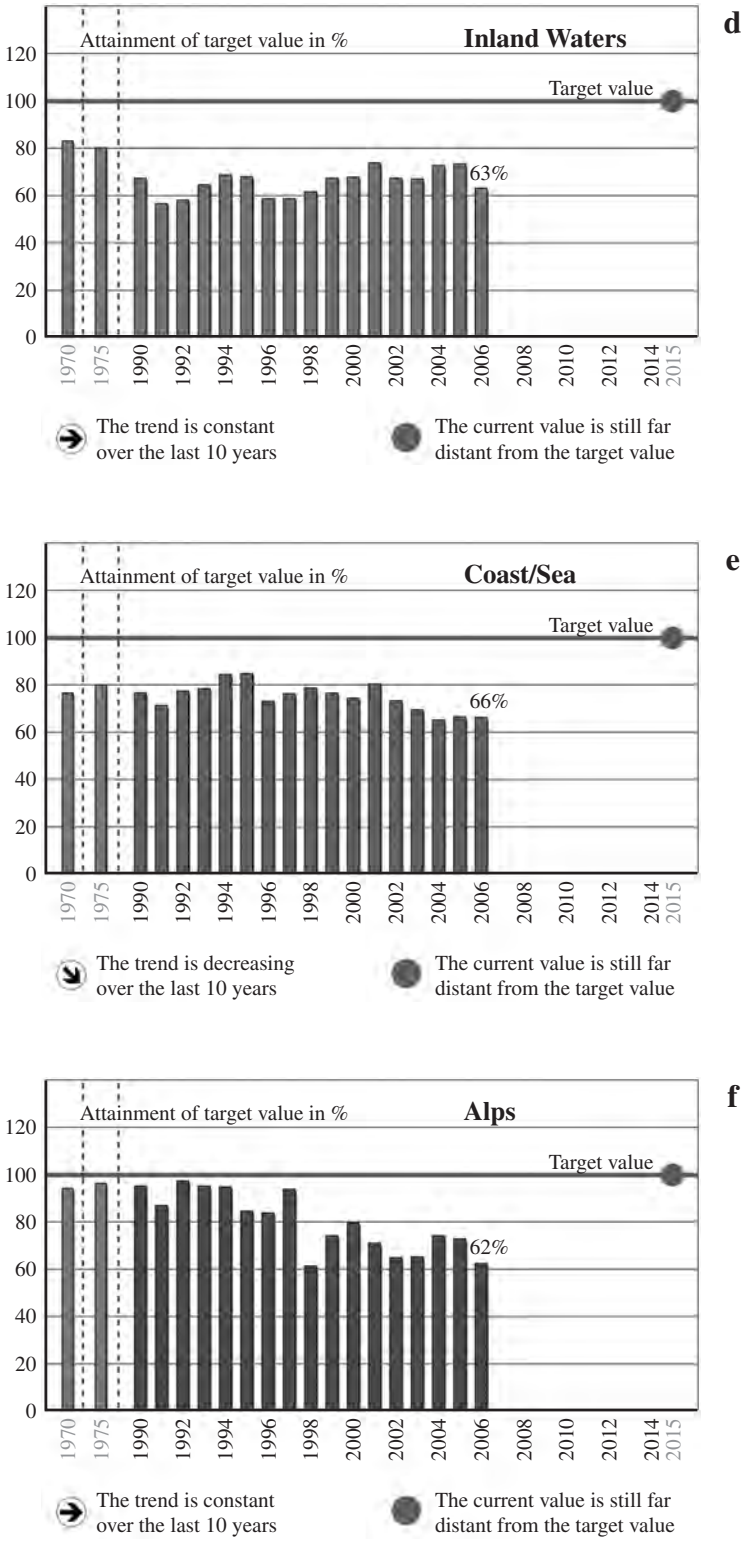

Figure 2 d,e,f. The six sub-indicators (a-f) of the German Sustainability Indicator for Species Diversity (SISD) representing Germany's main habitat and landscape types. The indicator values are updated until 2006. Trend analysis is based on the values from 1997 until 2006 (scheme adopted from Achtziger *et al.* 2007).

USE AND LIMITATIONS OF SISD

Other examples for the use of bird monitoring data and the SISD or its sub-indicators respectively are the evaluation of the German programme to support rural development (ELER) according to council regulation (EC) No 1698/2005 as part of the EU CMEF (Common Monitoring and Evaluation Framework). Reporting two biodiversity indicators on a national scale will be obligatory in the future: the sub-indicator for farmland of the SISD and a high nature value (HNV) farmland indicator. Germany has developed a national biodiversity strategy, which will be regularly evaluated by reporting on a set of 19 indicators comprising inter alia the SISD and other biodiversity indicators, e. g. for land use, non-native species, Red List species, area of protected sites, and quality of Natura 2000 sites.

SISD does not allow for detailed statements on the causes of observed changes; only the analysis of the underlying bird monitoring data can tell about reasons for trends (Sudfeldt *et al.* 2007). However, the sub-indicators can clearly demonstrate in which main habitat and landscape types positive or negative developments are occurring. All statements derived from SISD relate to the entire area of Germany; if regional results are needed (e.g. for each of Germany's 16 individual Länder, or regional states), then the spatial resolution of the underlying monitoring data must be enhanced (cf. Schlumprecht *et al.* 2004). The actual degree of target attainment is strongly influenced by the setting of the target value in the year 2015. Obviously, the more ambitious the target values for all the species were set, the worse the current situation appears.

For the future, it would be desirable and important to have nation-wide monitoring data also on the population sizes of species of other important groups, such as butterflies and vascular plants, and to use those for the calculation of additional indicators. This would be an important step covering more elements of biodiversity and - together with pressure and response indicators - coming closer to a comprehensive biodiversity reporting.

Acknowledgements – Many thanks to all persons involved in the research projects for SISD, especially Roland Achtziger, Helmut Schlumprecht, Hermann Stickroth, Cornelia Wolter and Roland Zieschank. We thank all those thousands of volunteer bird monitors who contributed with their data to SISD; special thanks to the Federation of German Avifaunists (DDA) for their organizational and scientific work in bird monitoring. Thanks to many individuals and organizations that have played a part in developing bird species based indicators in Germany.

REFERENCES

Achtziger R, Stickroth H, Zieschank R 2004. Nachhaltigkeitsindikator für die Artenvielfalt - ein Indikator für den Zustand von Natur und Landschaft in Deutschland. Angewandte Landschaftsökologie 63. 137 p.

Achtziger R, Stickroth H, Zieschank R 2005a. From monitoring to indicators - the German sustainability indicator for species diversity. Verhandlungen der Gesellschaft für Ökologie 35: 412.

Achtziger R, Stickroth H, Zieschank R 2005b. From monitoring to indicators - calculation of the German sustainability indicator for species diversity. Verhandlungen der Gesellschaft für Ökologie 35: 437.

Achtziger R, Stickroth H, Zieschank R, Wolter C, Schlumprecht H 2007. F+E-Projekt „Nachhaltigkeitsindikator für den Naturschutzbereich" - Phase 2. Endbericht Teil A: Nachhaltigkeitsindikator für die Artenvielfalt. Unpubl. report in charge of the Federal Agency for Nature Conservation. 196 p.

BfN (Federal Agency for Nature Conservation) 2008. Nature Data 2008. Landwirtschaftsverlag, Münster. 356 p.

Bundesregierung 2002. Perspektiven für Deutschland. Unsere Strategie für eine nachhaltige Entwicklung. Presse- und Informationsamt der Bundesregierung, Berlin. 234 p.

CIPRA (International Commission for the Protection of Alpine Regions) 2007. Wir Alpen! Menschen gestalten Zukunft. 3. Alpenreport. Haupt, Bern. 301 p.

Donald PF, Sanderson FJ, Burfield IJ, Bommel Fv 2006. Further evidence of continent-wide impacts of agricultural intensification on European farmland birds, 1990-2000. Agriculture, Ecosystems and Environment 116: 189-196.

EBCC 2007. European wild bird indicators 2007 update. http://www.ebcc.info/index.php?ID=291&basket=2a925858ac1c098b79445ef80817ce4a

Flade M, Baumann S, Südbeck P 2004. Die Situation der Waldvögel in Deutschland - Einführung und Synopse. Die Vogelwelt 125(3-4):145-150.

Flade M, Grüneberg C, Sudfeldt C, Wahl J 2008. Birds and biodiversity in Germany - 2010 target. Dachverband Deutscher Avifaunisten, Münster. 55 p.

Flade M, Schwarz J 1999. Current status and new results from the German Common Birds Census (DDA Monitoring Program). Die Vogelwelt 120 (Suppl.): 47-51.

Furness RW, Greenwood JJD 1993. Birds as Monitors of Environmental Change. Chapman & Hall, London. 356 p.

Green KC, Armstrong JS, Graefe, A 2007. Methods to elicit forecasts from groups: Delphi and prediction markets compared. Foresight / The International Journal of Applied Forecasting 2007(8): 17-20.

Gregory RD, Strien Av, Vorisek P, Gmelig Meyling AW, Noble DG, Foppen RPB, Gibbons DW 2005. Developing indicators for European birds. Phil. Trans. R. Soc. B 360: 269-288.

Günther A, Nigmann U, Achtziger R, Gruttke H 2005. Analyse der Gefährdungsursachen planungsrelevanter Tiergruppen in Deutschland. Naturschutz und Biologische Vielfalt 21: 19-605.

Mitschke A, Sudfeldt C 2009. The new monitoring scheme in Germany - the first three years. Avocetta (in this volume).

Mitschke A, Sudfeldt C, Heidrich-Riske H, Dröschmeister R 2005. Das neue Brutvogelmonitoring in der Normallandschaft Deutschlands - Untersuchungsgebiete, Erfassungsmethode und erste Ergebnisse. Die Vogelwelt 126(2): 127-140.

Schlumprecht H, Sachteleben J, Schöpf H 2004. Zielwerte für ausgewählte Vogelarten als Teil der Naturschutz-Indikatoren für Bayern. Ornithologischer Anzeiger 43(3): 251-259.

Schlumprecht H, Schupp D, Südbeck P 2001. Methoden zur Entwicklung eines Indikators Bestandsentwicklung ausgewähl-

ter Vogelarten. Naturschutz & Landschaftsplanung 33(11): 333-343.

Stickroth H, Schlumprecht H, Achtziger R 2004. Zielwerte für den „Nachhaltigkeitsindikator für die Artenvielfalt“ - Messlatte für eine nachhaltige Entwicklung in Deutschland aus Sicht des Natur- und Vogelschutzes. Berichte zum Vogelschutz 41: 78-98.

Sudfeldt C, Dröschmeister R, Grüneberg C, Mitschke A, Schöpf H, Wahl J 2007. Vögel in Deutschland 2007. Dachverband Deutscher Avifaunisten, Steckby. 39 p.

Sukopp U 2007. Der Nachhaltigkeitsindikator für die Artenvielfalt. Ein Indikator für den Zustand von Natur und Landschaft. In: Gedeon K, Mitschke A, Sudfeldt C (eds): Brutvögel in Deutschland. Zweiter Bericht. Dachverband Deutscher Avifaunisten, Hohenstein-Ernstthal: 34-35.

Turnhout E, Hisschemöller M, Eijsackers H 2007. Ecological indicators: Between the two fires of science and policy. Ecological Indicators 7(2): 215-228.

Verhulst J, Báldi A, Klejin D 2004. Relationship between land-use intensity and species richness and abundance of birds in Hungary. Agriculture, Ecosystems and Environment 104: 465-473.