Evidence for shifting baseline syndrome in conservation

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Abstract

Shifting baseline syndrome (SBS) is often referred to as a key issue for conservation, yet there is little evidence for its existence. The presence of SBS could influence the validity of participatory monitoring, local ecological knowledge, community based conservation, and conservation education. We outline two forms of SBS: (1) generational amnesia, where knowledge extinction occurs because younger generations are not aware of past biological conditions and (2) personal amnesia, where knowledge extinction occurs as individuals forget their own experience. Two conditions are essential to the identification of SBS: (1) biological change must be present in the system and (2) any perceived changes must be consistent with the biological data. If age or experience-related differences in perception are then found, generational amnesia may be occurring. Alternately, if individuals believe current conditions also occurred in the past, personal amnesia may be occurring. Previous studies have not fully addressed these conditions, and hence cannot provide indisputable evidence for the existence of SBS. We present three case studies to examine these issues, which demonstrate both forms of SBS. Shifting baseline syndrome is no longer a cautionary tale, but instead is a real problem for those using human perceptions of change to inform conservation policy-making or management.

Introduction

Shifting baseline syndrome (SBS) is a cautionary tale referring to changing human perceptions of biological systems due to loss of experience about past conditions. The concept (partially derived from Pyle 1993) was first proposed by Kahn & Friedman (1995), but given the title "shifting baseline syndrome" by Pauly in 1995, when he suggested using anecdotal evidence to complement other methods to determine baselines in fisheries science. There are two understandings of the term. Generational amnesia describes individuals setting their perceptions from their own experience, and failing to pass their experience on to future generations. Thus, as observers leave a system, the population's perception of normality updates and past conditions are forgotten (referred to as shifting baseline syndrome by Jackson 1997; Folke *et al.* 2004; Huitric 2005). Personal amnesia describes individuals updating their own perception of normality; so that even those who experienced different previous conditions believe that current conditions are the same as past conditions. This could lead to all individuals having the same "current" view of the ecosystem (Simons & Rensink 2005). Although personal amnesia may be less powerful in explaining long-term perception changes, it still may be very important over annual to decadal periods, which are often the conservation-relevant timescale. Environmental perceptions are only one of a number of factors such as emotions and past behavior that can influence conservation behaviors (Carrus *et al.* 2008). Although this article only empirically examines perception, the interaction of these factors should be considered when considering shifting baseline syndrome in the context of conservation behavior.

Other phenomena have also been referred to as "shifting baselines." As originally described, SBS was a social-psychological condition—the setting of values from personal experience. Implicit in this definition is the presence of changing biological conditions, and it is these changing biological conditions that are sometimes referred to as "shifting baselines." Thus, articles refer to shifting baselines when discussing reduced population sizes or loss of biodiversity (Baum & Myers 2004; Grigg 2006; Jackson *et al.* 2007). In some cases, it is assumed that a biological change automatically means that SBS occurs in human perceptions (Jackson 1997; Post *et al.* 2002; Walters 2003; Folke *et al.* 2004; Edgar *et al.* 2005; Ainsworth *et al.* 2008). This use of the term "shifting baseline" can cause confusion, particularly as biological change and human perceptions of this change are so closely linked. Care must be taken that "shifting baseline syndrome" is explicitly used to refer to the social phenomenon.

One of the biggest current issues in assessing the implications of SBS is the lack of empirical evidence that it occurs. Kahn & Friedman (1995) first suggested generational amnesia as a possible explanation for their results on children's attitudes to their environment. They found a lower incidence than expected of children recognizing their environment as degraded, and suggested that the children saw this environment as normal. They did not test this theory, a common theme in the literature on SBS; it is often invoked as a potential problem for conservation (Sheppard 1995; Bjorndal 1999; Roberts 2003), without adequate evidence that it actually occurs.

Current evidence for shifting baselines

Anecdotal evidence for SBS has been presented (Sheppard 1995; Huitric 2005), which although suggestive, lacks rigor on its own. Evidence from diaries of early explorers has been examined by Sáenz-Arroyo *et al.* (2006), suggesting greater past densities of sea life in the Gulf of California. These data are concerned with past biological abundance, and although they show a decrease in abundance and biodiversity in the Gulf of California, they do not demonstrate SBS in the human population. The study of Sáenz-Arroyo *et al.* (2005) on fishers in the Gulf of California does, however, demonstrate shifting perceptions and potential generation amnesia in the population studied. One hundred and eight fishermen were asked to name depleted species and areas, in addition to the best catch and largest Gulf grouper (*Mycteroperca jordani*) they had caught, and in which year. After accounting for older fishers having had more chances to catch fish, they found age differences in all aspects investigated. It was concluded that fish population decline was occurring at a constant rate. This study demonstrated change in fishers' catch and experience of fishing based on fisher age, but did not demonstrate that their perceptions of the system differed with age. The study of Ainsworth *et al.* (2008) went further when it compared fisher perceptions of biological change with fishing data. That article, however, used catch-per-unit-effort data to adjust the fishermen's responses, so it did not explicitly demonstrate SBS. Both these articles use their data to determine species abundance change over time, and show age differences in experience that could suggest generational amnesia. The work of Kahn on perceptions of pollution (reviewed in Kahn 2002) does show potential SBS, but although these studies clearly examine perception in study individuals, comparison to biological data on the polluted environments enquired about is not presented, and the studies largely focus on children's perceptions. Generational amnesia assumes a lack of communication between generations, and lack of other information on past ecosystems, such as photographs and articles (as used by Roberts 2003 and Sáenz-Arroyo *et al.* 2006 to demonstrate biological change). However, there is no reason to believe a priori that communication about past conditions does not occur. No evidence has yet been provided for personal amnesia. Personal amnesia assumes a lack of individual memory about past conditions, and could be either an individual or collective phenomena. Observers do not notice gradual changes in visual scenes in laboratory studies (Simons & Rensink 2005), suggesting that personal amnesia of environmental conditions could occur.

Relating perceptions to biological change

Although SBS is a logical explanation for anecdotal evidence of age differences in observer perceptions of normality, other processes could occur which have no need for such a concept (Table 1). For example, older individuals could inaccurately remember past conditions (psychological processes described by Roediger 1996) and recall change where there was none, or vice versa, termed "memory illusion." Similarly, finding no differences in perception of change does not mean that SBS does not occur if there is a correspondingly static biological system ("accurate static perception" in Table 1). Where people have not noticed change occurring, change blindness is occurring. Although previous literature discussing generational amnesia has suggested that the syndrome is driven by age differences in perception, logic suggests that SBS should occur for different levels of experience rather than different ages. However, experience and age are not always possible to separate.

To demonstrate SBS conclusively, data must be available on observer perceptions of change, and these data must be consistent with independent biological data. So

Table 1 Possible combinations of environmental events and observer perceptions, demonstrating the conditions required for shifting baseline syndrome to occur

	Perception			
	Different by age		Same for all ages	
Environmental events				
No change	**Memory illusion**		**Accurate static perception**	
Change	Consistent with biological data	Inconsistent with biological data	Current conditions reported	Past conditions reported
	Generational amnesia	**Memory illusion**	**Personal amnesia**	**Change blindness**

for example, in the study of Sáenz-Arroyo *et al.* (2005), older fishers reported catching larger catches, longer ago. If we temporarily accept that this is an example of age-related perceptual change, and we also have access to a dataset showing decreasing catches over time, we would have an example of generational amnesia because younger fishers are unaware that their catches are lower than were achieved in the past. If the catch data showed recent catches were larger, however, we would have to conclude that the older fishers were incorrectly recalling the size of earlier catches. Psychologists have demonstrated the power of narratives and expectations to alter memory (Hyman & Pentland 1996; Ylijoli 2005), and if the fishing community had a narrative of depletion, fishers may recall this rather than the real past, termed "memory illusion" in Table 1. Therefore, to be completely convinced that shifting baselines occur, two conditions must be met:

(1) Biological change must be present in the system;

(2a) if age or experience-related differences in perception of trends in the system are found, generational amnesia may be occurring, provided that differences in perception are consistent with the biological data; or,

(2b) if age or experience differences are not found, personal amnesia may be occurring, provided that individuals believe current conditions also occurred in the past.

SBS presents a particular problem when setting conservation goals for ecosystem or species regeneration, as perceptions of past change may influence target setting, particularly when biological data are not available. Accurate assessments of change are required when conservation aims to restore former conditions, and for IUCN Red Listing based on a declining population. Data collected from human observers can be useful (Danielsen *et al.* 2000), particularly in cases were biological data may be unavailable, such as the recently "discovered" highland mangabey (*Lophocebus kipunji*) from Tanzania, which was known to local inhabitants (Jones *et al.* 2005). The use of local ecological knowledge for assessment of system state and dynamics is becoming more common (van der Hoeven *et al.* 2004; Danielsen *et al.* 2000; Jones *et al.* 2008). If SBS does occur, these sorts of data need to be used with caution. Younger observers may under-report change if generational amnesia is occurring, or the entire population may do so if personal amnesia is occurring.

Knowledge of SBS could also be used to inform environmental education and community based conservation programs. If younger or less experienced observers do not acknowledge change, they may be less co-operative with conservation programs. Individual involvement in conservation may be influenced by factors other than experience and memory of the environment, in which case SBS is not a major issue. However, if, as suggested by Pyle (1993), reference to personal or community-level baselines does strongly affect engagement with conservation programs, then investment in activities designed to combat SBS (such as facilitating inter-generational transfer of experience) could have a strong influence on community buy-in to conservation action.

We present three case studies where shifting baseline syndrome has been investigated, to illustrate the differences between age-related phenomena. Two of these, concerning bushmeat, investigate just the social phenomenon as per previous studies. In the third study, we set up the conditions explicitly to search for SBS, ensuring that all conditions are examined. Complete methods and results are given in the Supporting Information; only brief summaries are included here.

Case study 1: Updating perceptions in bushmeat hunters, Gabon

Participatory Rural Appraisal (PRA) was used to assess hunters' perceptions of change in prey species populations in two villages in central Gabon. Coad (2007) suggests that animal populations are decreasing in the area, as there are depleted areas around the villages, but it is not known when these decreases took place. Although no age differences in hunters' perceptions of the

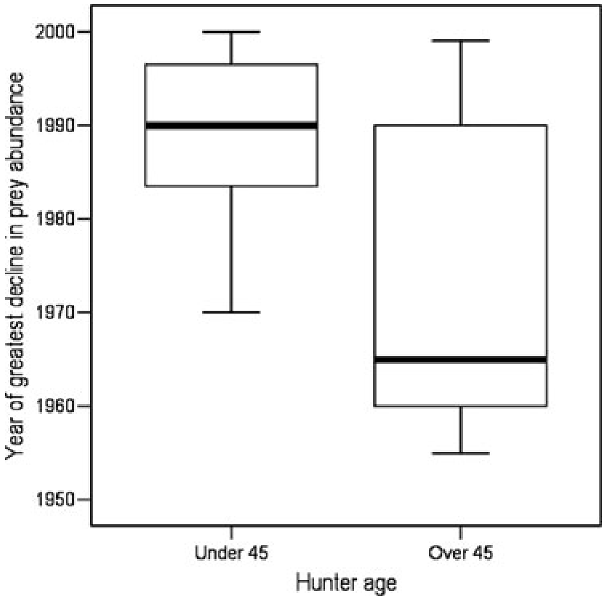

Figure 1 Hunter assessment of year of greatest species decline in the villages of Kouagna and Dibouka, Gabon, shown as a function of age (n = 17).

degree of decrease in prey species were observed, older hunters reported earlier dates when the greatest population decrease occurred than younger hunters (Figure 1). Thus, this study demonstrates the potential for generational amnesia in this population; however, sufficiently rigorous biological data are not available to determine whether these observed differences are consistent with animal population trends.

Case study 2: Changing perceptions of bushmeat hunters, Equatorial Guinea

Forty-seven male bushmeat hunters in mainland Equatorial Guinea were questioned on their hunting behavior and perceptions of prey species population change. All hunters reported increased catches with increased effort (as measured by number of traps set and distance traveled per week), and decreased catches in more recent periods. All hunters reported increased effort through their careers (setting more traps and traveling further), even though some hunters had been hunting for 2 years, and others for more than 50 (Figure 2). Given the decline in reported catch over time, and assuming that reported effort reflects true effort, we can conclude that there is ongoing resource depletion. Furthermore, if we assume that travel distance is equivalent to geographical distance and hunting effort is independent of distance traveled, the increase in reported catch with distance suggests a depleted area around the village and hunting camps. The number of species caught by hunters plateaued at age 35, suggesting that by this age hunters had caught all the different species they were likely to catch in their lifetimes.

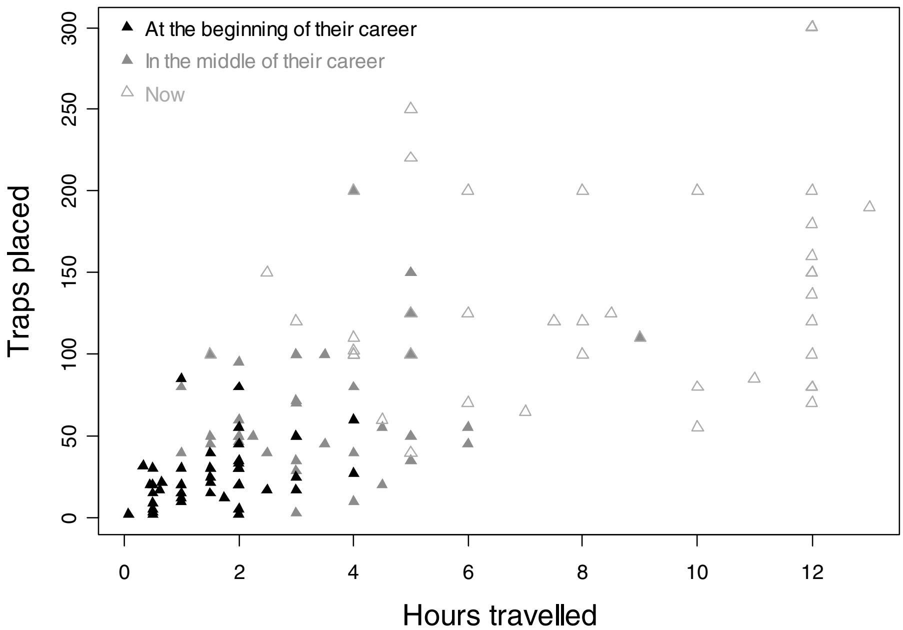

Figure 2 Number of traps set and distance traveled per week in different periods of a hunter's career, in Midyobo Anvom, Equatorial Guinea. Distance traveled is shown here on the x-axis, but it is not possible to determine a causal relationship between these two variables. There was no age-related difference between hunters in how they perceived changes over time in trap numbers or distance traveled.

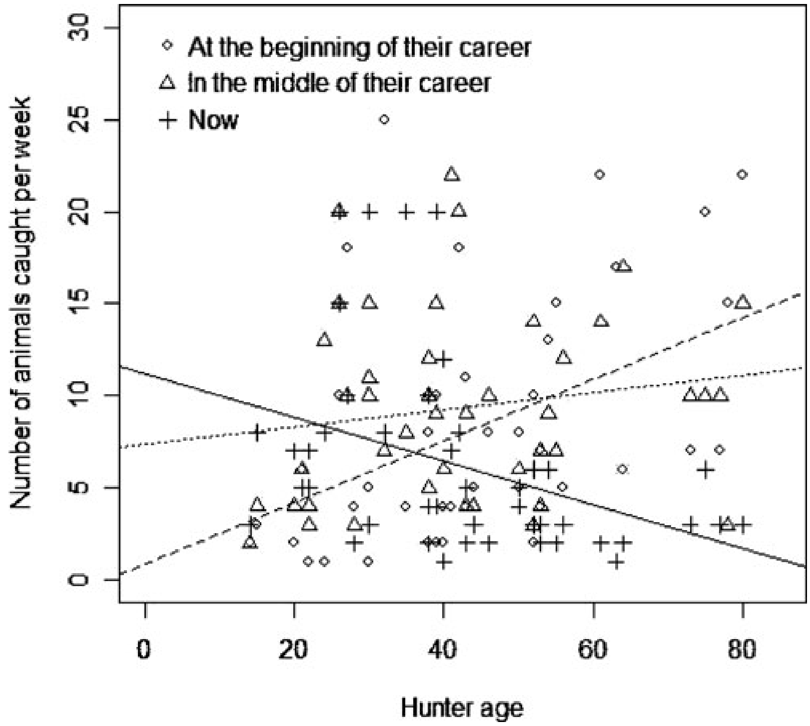

Figure 3 The relationship between hunter age, period of hunting and number of animals caught per week in Midyobo Anvom, Equatorial Guinea. The dashed regression line represents the beginning of hunters' careers, the dotted line the middle of their careers, and the solid line the hunters' current number of animals caught per week.

Older hunters reported catching more animals overall, as did those who undertook more livelihood activities (such as fishing or farming). There is an interaction between age and time period, such that older hunters catch fewer animals now than earlier in their career, in comparison to younger hunters (Figure 3). Although these results do show age-related differences in hunter experience, they do not strictly demonstrate SBS because there was no concrete evidence that these differences related to changes in abundance. Moreover, no age-related differences were found in hunter perceptions of abundance change.

Case study 3: SBS in perception of bird population trends, United Kingdom

Questionnaires were conducted on the perceptions of bird population trends of 50 participants in a rural village in Yorkshire, UK. Data on bird population trends are available for the area, enabling a comparison of perceived and actual trends (see Supporting Information), and focal bird species were chosen with trends both of population increase and decline, to control for prevailing narratives of decline in British bird populations (Newton 2004). Respondents were also asked to name the three most common bird species now and 20 years ago.

For three of the four focal species, accuracy in judging population trend increased with experience (as measured by number of years living in the village). For the question concerning the three commonest bird species, 36% of respondents had a static perception, naming the same three species for both periods, but no variable explained why an individual had a static perception. Interestingly, whether or not respondents had static perceptions was not dependent on attention (proxied by reported interest in birds), although research on change blindness suggests that personal amnesia could be affected by attention (Simons & Rensink 2005). Accuracy of statements about the most common birds was influenced by age when naming the most common birds 20 years ago, but not when naming the most common birds now (see Supporting Information for model results). Thus, older respondents are not more accurate at assessing species abundance per se; rather they are more accurate at doing so for the past.

Individuals with static perceptions were more likely to name species that are more abundant now than those more abundant in the past. Given the changing biological system, this is indicative of personal amnesia. Those respondents who did not have a static perception of bird populations were divided into those who thought that one, two, or three species had changed. Older respondents thought more species had changed than younger respondents (Figure 4).

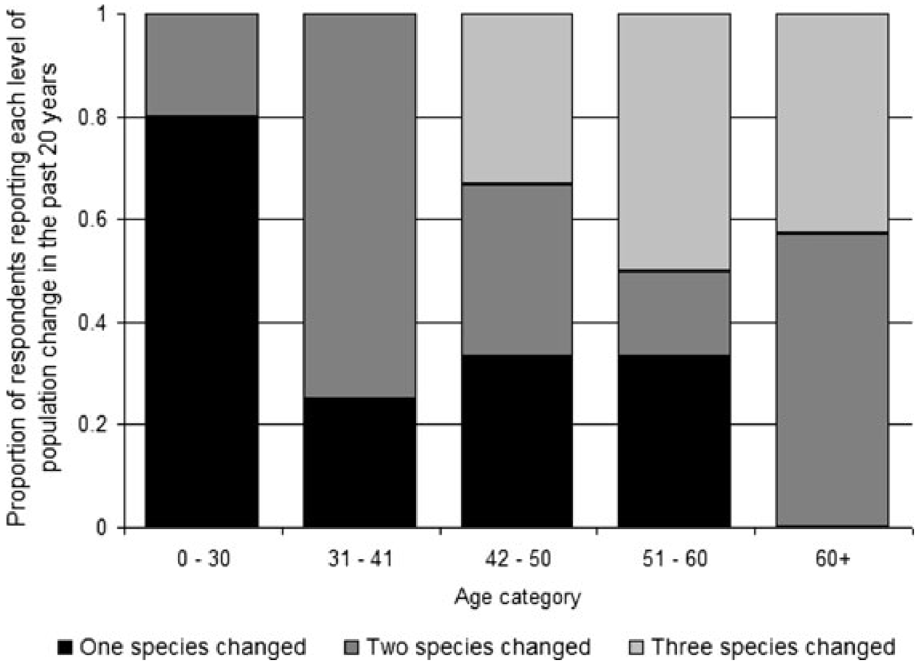

Figure 4 Degree of change in the three most common birds in the past 20 years, as reported by respondents of different ages in Cherry Burton, UK.

Respondents' perceptions of the three most common bird species over time provides the most persuasive evidence of SBS. The finding that older respondents more accurately name the three most common bird species in the past provides proof of generational amnesia. This question is less affected than the questions on population trends in focal species by external information, for example from newspapers. Instead it is closer to asking the respondents their perception of typical "bird life" in the area. We also did not ask respondents explicitly about trends in species composition (which may prompt overestimation of change), but about two separate periods.

The biological data for this case study are less than ideal (questions were asked about bird abundance 20 years ago, yet the BSS only dates to 1994). In addition, biological data were used from the whole of Yorkshire, but the questionnaire was only administered in one village, which may not be typical of Yorkshire. Nevertheless, this study provides the best evidence to date for generational and personal amnesia.

The way forward for studies of shifting baseline syndrome

Design issues, implications of SBS, and future directions

We have presented three case studies to illustrate the issues involved in assessing the evidence for SBS. Our results, like other studies, have problems with data and interpretation, but being clearer about the relationship between social and biological information makes the identification of these problems easier. Case study 3 suggests that both forms of SBS can occur in the same population.

The problems caused by generational amnesia could be countered by ensuring that different generations communicate about changes in their environment and establish an accurate narrative. However, when personal amnesia occurs, no members of a community will remember past conditions, so this approach would not be successful, though photographs and other past records could be used. These approaches for tackling SBS may not be a sufficient substitute for experiencing change personally, however, and as perception and cognition have emotional dimensions, acknowledging that change has occurred may not necessarily affect conservation behavior. Separating "perception" from observation or experience, or even identifying what precisely counts as a perception can be problematic. Furthermore, question design may influence answers; for example, asking about past abundance or conditions may prompt over-reporting of change. Further research could be conducted in an environment where experience and age can be disconnected to determine which is more influential in the development of SBS. For example, Pauly (1995) suggested questioning people on the marine environment. In divers, it would be easier to separate age and experience as diving is a discrete event that can be only be "on" or "off" and there is no leakage into everyday life. Older individuals may have only been diving twice, and younger ones could have been every week for the past 10 years. So, length of experience, amount of experience, and age will not necessarily be as tightly correlated as it may be in other groups.

In the past, shifting baseline syndrome has been invoked without adequate proof of its existence. This study identifies this as an issue and reports three case studies designed to examine SBS. We demonstrate the existence of both forms of SBS (generational and personal amnesia), and present the most comprehensive evidence for SBS so far. This evidence suggests caution when using data from human observers, but the full implications of SBS need further investigation. Ensuring that the term is used with precision, based on the definitions in Table 1, would be a first step towards understanding the prevalence and implications of shifting baseline syndrome.

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Supporting Information

Additional Supporting Information may be found in the online version of this article:

Table S1. Generalised linear model with Poisson errors and log link, with hunter identification as a random effect.

Table S2. Model selection using mixed-effects model with identity link function and normal errors and Akaike's Information Criterion (AICc) to explain the factors that determine log distance travelled (in hours) by hunters at three points in their career (n = 125 with random effects: 44 hunters).

Table S3. Model selection using mixed-effects model with log link function and Poisson errors and Akaike's Information Criterion (AICc) to explain the factors that determine the number of traps set by hunters at three points in their career (n = 125 with random effects: 44 hunters).

Table S4. Model selection using logit link function and binomial errors and Akaike's Information Criterion (AICc) to explain the factors that determine which species hunters have caught at any point in their career (n = 990 with random effects: 45 hunters and 22 species).

Table S5. Percentage change in the Yorkshire population size of the 5 focal species between 1994 and 2006.

Table S6. Model selection using logit link function and Akaike's Information Criterion (AICc) to explain the factors that determine whether an individual can correctly identify the negative population trend in Blue tits (n = 40).

Table S7. Model selection using logit link function and Akaike's Information Criterion (AICc) to explain the factors that determine whether an individual can correctly identify the negative population trend in house sparrows (n = 41).

Table S8. Model selection using logit link function and Akaike's Information Criterion (AICc) to explain the factors that determine whether an individual can correctly identify the negative population trend in starlings (n = 40).

Table S9. Model selection using logit link function and Akaike's Information Criterion (AICc) to explain the factors that determine whether an individual can correctly identify the negative population trend in wood pigeon (n = 41).

Table S10. Model selection using logit link function and Akaike's Information Criterion (AICc) to explain the factors that determine whether an individual has a static perception of bird populations in Yorkshire (n = 41).

Table S11. Linear model selection (transforming proportion correct using arcsine) using Akaike's Information Criterion (AICc) to explain the factors that determine whether an individual can correctly identify the current most abundant species (n = 49).

Table S12. Linear model selection (transforming proportion correct using arcsine) using Akaike's Information Criterion (AICc) to explain the factors that determine whether an individual can correctly identify the most abundant species 20 years ago (n = 49).

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