Shifting baseline syndrome: An investigation

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DECLARATION OF OWN WORK

I declare that this thesis

Shifting baseline syndrome: An investigation

is entirely my own work and that where material could be construed as the work of others, it is fully cited and referenced, and/or with appropriate acknowledgement given.

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Abstract

Shifting baseline syndrome has been fraught with problems, but the ambiguous use of the term and a lack of empirical evidence have not stopped it being invoked as a potential problem in a variety of conservation contexts. This study provides the first empirical evidence of shifting baseline syndrome through the use of two case studies; bushmeat hunters in Equatorial Guinea, and members of a small village in England. Three conditions are identified by this study as being essential to the identification of shifting baseline syndrome;

1) Biological change must be present
2) Age or experience related differences in perception must be present
3) The perception differences must be consistent with biological data.

These three conditions are present in both case studies, and shifting baseline syndrome is suggested by both. Age differences in perceptions of mandrill abundance change, supported by biological data, are found in bushmeat hunters in Equatorial Guinea. Shifting baseline syndrome was also demonstrated in perceptions of abundance change in common bird species in England, and supported by biological data. Observers in England also showed age differences in perceptions of "typical" bird assemblages over a period of 20 years. These demonstrations of shifting baseline syndrome justify the current use of the term in the literature. Positive action is required however, if it is desirable to prevent shifting baseline syndrome. A further problem for conservation practitioners is also unearthed – change blindness is argued here to be a greater obstacle to conservation than shifting baseline syndrome.

Acknowledgements

Firstly, I would like to thank E. J. Milner-Gulland for being an excellent supervisor, and providing the support necessary for undertaking this project. I would also like to thank Janna Rist for collecting data in Equatorial Guinea and her aid throughout the project. I acknowledge Susan Gough at BTO for her aid in obtaining data from the BBS survey, and am particularly grateful to Nils Brunfield and Aline Kuhl for their help with R and mixed-effects modelling. Aidan Keane was an excellent sounding board for ideas, and I am thankful for his continued interest. Thanks as well to all those who have helped in every way, from providing suggestions for questionnaire design, to biscuits when things went wrong. Finally, I am indebted to my parents, for their proofreading, aid in finding respondents for questionnaires, and support throughout this MSc.

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Chapter 1
INTRODUCTION

"It sounds esoteric, like the kind of thing you don't really need to understand, something you can leave to the more technical types."

Randy Olsen on shifting baselines, LA Times, 17th November 2002

'Shifting baseline syndrome' was first introduced by Pauly in 1995, when he suggested using anecdotal evidence to set baselines in fisheries science. Put simply, in a temporally changing ecosystem, those who first saw the ecosystem 50 years ago will have a different idea of "normality" than those who have only experienced it in the past 2 years. These different perceptions of normality are referred to as "shifting baseline syndrome". Kahn and Friedman (1995) also suggested this phenomenon (terming it "generational amnesia") as a possible explanation for the results gained from research in children's attitudes to their environment. They stated that the lower incidence of children calling their environment degraded than they would have expected suggested that the children saw their environment, perceived by Kahn and Friedman to be degraded, as normal. Neither Kahn and Friedman (1995), nor Pauly (1995) have tested this theory and shifting baseline syndrome is often invoked as a potential problem for conservation (Roberts, 2003; Bjorndal,1999; Sheppard, 1995), but currently there is not adequate evidence that it occurs.

Shifting baseline syndrome 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. Bjorndal (1999) has stated in a discussion of conservation targets for turtles that existence of shifting baseline syndrome could mean using longer periods (on the scale of centuries rather than decades) for assessing turtle population change. Accurate and relevant assessments of change are required when conservation aims are to restore former conditions, and IUCN Red Listing where degree of population change contributes to species threat level. In addition to direct conservation applications, shifting baseline syndrome may be used to inform other areas of research, such as participatory monitoring (Danielsen et al., 2000) or Pooled Local Expert Opinion (Van der Hoeven et al., 2004). Both these methods use the knowledge of local inhabitants to estimate environmental conditions, such as degree or resource use, or species population size. Shifting baseline syndrome could also have implications for temporal scale issues in biology, such as the accuracy of historical data in changing systems (Perry and Ommer, 2003). Furthermore, knowledge of shifting baseline syndrome could be used to inform environmental education and community based conservation. If younger or less experienced observers do not acknowledge change, they may be less co-operative with conservation programmes. Shifting baseline syndrome is most relevant in situations where it is necessary to know the degree of change in a system or species in addition to the occurrence of change, and when human perceptions are involved in policy or management.

Aims

This study aims to examine the concept of shifting baseline syndrome and provide a context in which shifting baselines can be conclusively demonstrated, if they occur.

Objectives

1) Examine "shifting baselines syndrome" with particular attention to terminology.

2) Review previous empirical data on shifting baselines syndrome.

3) Identify an appropriate biological system (showing temporal change) for examining shifting baseline syndrome.

4) Review previous methods of measuring shifting baseline syndrome.

5) Determine whether there are differences in perceptions of the natural environment by age or experience.

6) Where differences in perception are present, determine whether these are consistent with change in the biological system to demonstrate shifting baseline syndrome.

7) Where older and younger observers notice change, determine the time period over which they notice it.

8) Make recommendations for future research.

Objectives 1 and 2 will be examined in this chapter, and appropriate biological systems will be identified in chapter 2. Case study 1 (chapter 3) will review previous methods and determine whether there are age differences in perception, and case study 2 (chapter 4) will look at the effects of age and experience, validate these using biological data and examine the period over which change is noticed. Recommendations for future research will be made in chapter 5.

1) "Shifting baselines syndrome" and terminology.

Although shifting baseline syndrome is a very 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. Coad (2007) found that older and younger hunters had similar ideas of abundance for animals in a changing system, as younger hunters based their knowledge on information gained from older hunters. Thus the first assumption of shifting baselines syndrome is lack of communication between generations, and lack of other information on past ecosystems, such as photographs and papers (as used by Sáenz-Arroyo et al, 2006; Roberts, 2003). Furthermore, shifting baseline syndrome assumes that older people accurately remember past conditions. Research has shown that false memories can be induced, (Roediger, 1996, Hyman and Pentland, 1996), so this assumption cannot be justified without evidence. Alternately, it may be that no one notices change, so everyone (even those who experienced previous altered conditions) believe that current conditions are the same as past conditions.

As originally described by Pauly (1995), shifting baseline syndrome is a social condition – the setting of values from personal experience and a failure to pass information about past conditions from one generation to another. Implicit in this definition is the presence of changing biological conditions, and it is this phenomenon that has hijacked the term “shifting baseline”. Thus papers refer to shifting baselines when discussing reduced population sizes or biodiversity (Jackson et al., 2007; Grigg, 2006; Baum and Myers, 2004). In some cases, it is assumed that a biological change automatically means that shifting baseline syndrome occurs in human perceptions (Edgar et al., 2005; Folke et al., 2004; Walters, 2003; Post et al., 2002; Jackson, 1997;). These uses of the term “shifting baseline” can cause confusion, particularly as the two concepts: biological changes, 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 described by Pauly (1995). Furthermore, of all the papers discussing “shifting baseline syndrome”, only one (Sáenz-Arroyo et al, 2005) has used empirical data to attempt to demonstrate its existence.

2) Review of the evidence for shifting baselines

There is very little empirical evidence for shifting baseline syndrome, largely due to a lack of research in the area. Anecdotal evidence has been presented (Huitric, 2005; Sheppard, 1995) which although suggestive, lacks rigor on its own. Evidence from diaries of early explorers has been examined by Sánez-Arroyo et al (2006), and this records 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 shifting baseline syndrome. The most complete attempt to study shifting baseline syndrome is Sáenz-Arroyo et al. (2005) study of fishers in the Gulf of California. 108 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 happening at a constant rate. Although this study demonstrated change in fishers’ catch and experience of fishing based on fisher age, this does not mean there is shifting baseline syndrome in observer perceptions of the system. Although perceptions of abundance may affect fishers’ reports their experience, the paper essentially examines age differences in experience, rather than age-related differences in perception of the system, or shifting baseline syndrome.

Even if the above study were looking at perception differences rather than reported experience, it would have failed to provide conclusive evidence of shifting baseline syndrome. Age related perception changes and comparative biological changes must be demonstrated, to be sure that other psychological processes do not explain differences between older and younger fishers. For example, older fishers could inaccurately remember past conditions (psychological processes described by Rodiger, 1996) and recall change where there was none, termed “memory illusion” (Table 1). Similarly, finding no differences in perception does not mean that shifting baseline syndrome does not occur if there is a corresponding static biological system (“accurate static perception” in Table 1). Thus to demonstrate conclusively whether or not shifting baseline syndrome occurs, perception differences must be examined in a system which has demonstrated biological change. Where differences in perception are found in a system with biological change, shifting baseline syndrome is a potential explanation. Where differences in perception are not found in a biologically changing system, change blindness is occurring[1]. The term change blindness is taken from, and analogous to, studies in visual perception where observers do not notice gradual changes in scenes under experimental conditions (Simons and Rensink, 2005).

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

		Perception	
		Different by age	Same for all ages
Actual events	Change	Shifting baseline syndrome	Change blindness
	No change	Memory illusion	Accurate static perception

To conclusively demonstrate shifting baseline syndrome, social data must show perception differences in observers, and be examined in the context of biological data. Shifting baseline syndrome originally implied a static observer perception of "normality" in systems, but observers can notice change in a system and consider this "normal". Noticing change does not mean that shifting baselines do not occur, for younger generations may state there is less change than older generations, as they recall a different initial baseline. Although previous literature on shifting baseline syndrome has not separated age and experience, logic suggests that shifting baseline syndrome should occur for different levels of experience rather than different ages, but this needs to be further examined. Essentially, a broader understanding of peoples' perceptions must be gained.

<u>**Conditions for demonstrating shifting baselines syndrome**</u>

Even when a biological system does show temporal change, and there are age or experience related differences in perceptions of the system, one final condition must be met before stating that shifting baseline syndrome is present. Observer perceptions must be consistent with biological data. So for example, in the study of Sáenz-Arroyo et al. (2005), older fishers reported catching larger catches, longer ago. If we temporarily accept that decreasing catch size is an example of age-related perception change, and a data set

[1] Arguably, change blindness could be a form of shifting baseline syndrome. If all observers have the same view of a changing ecosystem because they update their knowledge based on current experience and forget past conditions, there is a population wide shifting baseline of normality. However, change blindness also describes circumstances where the whole population views past abundance as normal and hasn't noticed recent change, which cannot be described as shifting baseline syndrome.

on actual catches showed decreasing catches, we would have an example of shifting baseline syndrome. If the actual catch data showed recent catches were larger, we would have to conclude that the fishers were incorrectly recalling the size of catches. Psychologists have demonstrated the power of narratives and expectations to alter memory (Ylijoli, 2005, Hyman and Pentland, 1996), and if the fishing community had a narrative of depletion, fishers may recall this rather than the real past. Therefore, to be completely convinced that shifting baselines occur, three conditions must be met,

1) Biological change must be present
2) Age or experience related differences in perception must be present
3) The perception differences must be consistent with biological data.

This study will use two case studies to provide circumstances in which these three conditions can be met, to assess whether shifting baseline syndrome occurs.

Chapter 2
METHODS

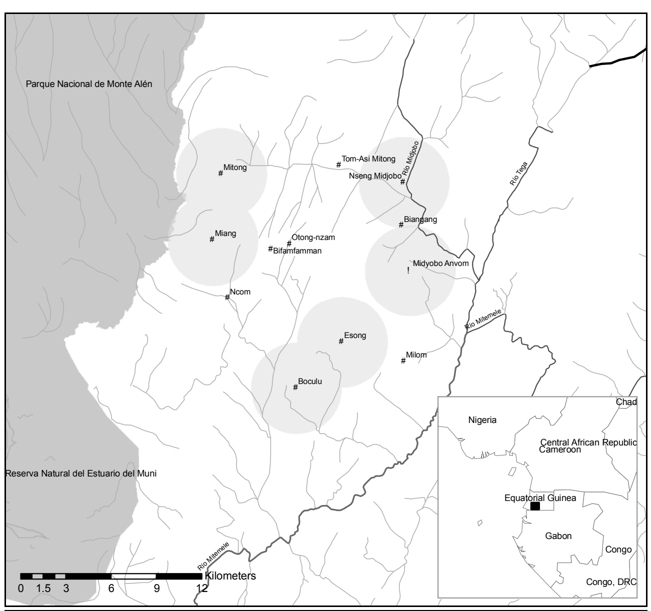
A case study approach was taken to examine shifting baseline syndrome. The first case study used “typical” data applied to demonstrate shifting baseline syndrome in the literature. Case study 2 set up conditions in which shifting baseline syndrome should manifest if it is present.

CASE STUDY 1: Bushmeat hunters in Equatorial Guinea and hunting.

Field Procedures

Data for case study 1 were originally designed to replicate the study of Sáenz-Arroyo et al. (2005) and already collected by Janna Rist, from the village of Midyobo Anyom (1°20N, 10°10E) in the Centro Sur Province of Rio Muni, mainland Equatorial Guinea (Figure 1). All male hunters present in the village (population 150 – 200) over the study period (January to March 2006) were asked a 30 – 45 minute questionnaire about their hunting behaviour (questionnaire in appendix 1). The 34 animals in the questionnaire were selected to give a combination of rare and common animals, as well as those desirable to hunters and those that are not. Hunters use a rotational camp system at Midyobo Anyom (Kumpel, 2006). Camps are used until they become depleted, when hunters move to another camp. Hunters hunt from the village and hunting camps located in the surrounding area (Figure 1). Bushmeat hunting provides cash income in this area, as the majority of catch is sold to dealer who transport the meat to Bata (the capital of Rio Muni) for sale (Kumpel 2006; Fa and García Yuste, 2001). High exploitation levels in the system are relatively recent (Fa and García Yuste, 2001), so there may only be dramatic changes in animal populations since this time, though time series data on population size before 2001 are not available.

Figure 1: The location of the community of Midyobo Anyom in Equatorial Guinea and some main hunting camps (© Janna Rist, 2007).



Questionnaire design

1) Following the methods of Sáenz-Arroyo et al. (2005), information was gathered on catch per unit effort (CPUE) and number of species killed.
2) Hunters were also asked about abundance and abundance change in focal species, in an attempt to improve on the methods of Sáenz-Arroyo et al. (2005).

Imitating the study of Sáenz-Arroyo et al. (2005) on fishermen, hunters were asked about catch sizes. Data on effort were also collected as changes in catch may not reflect changes in natural conditions if there is also a change in effort (Ling and Milner-Gulland, 2006). Hunters were asked the number of traps set, distance travelled and animals caught per week in three separate periods; at the beginning of their hunting career, in the middle of their hunting career, and now. Mixed-effects models with hunter as a random effect were used to control for temporal pseudo-replication in differences in hunting catch and effort, and the reported number of traps set, distance travelled and animals caught were transformed to give a normal distribution. As it not possible to determine *a priori* whether the number of traps set affects distance travelled or if distance travelled affects the number of traps set each was used as an explanatory variable for the other.

Hunters were shown a list of 27 species and asked to indicate which they had killed. Hunters were also asked to rank the current abundance of various species as “very rare”, “rare”, “few” or “many” (for the golden cat a fifth category was added as a number of hunters spontaneously answered that there were no golden cats). Hunters were also asked to indicate whether current abundance was greater, lesser or the same as past abundance.

Statistical analyses

All analyses were performed in the statistical package R version 2.5.1 (R Core Development Team, 2007). By necessity, years hunting was excluded as an explanatory variable in all models as it was highly correlated with age (linear regression, $F_{1,45} = 267$, $p<0.001$, Adjusted $R^2 = 0.8526$), so age and experience could not be separated. Based on the number of animal species killed, hunters were split

Table 2: Main explanatory variables used for the analysis of shifting baseline syndrome in bushmeat hunters

Hunters	**Animals**
Age of hunter	IUCN status from www.iucnredlist.org
Number of livelihood activities undertaken, such as farming, fishing, hunting etc.	Taxonomic order (e.g. primates, ungulates)
Number of camps used throughout hunters lifetime	Population trend from www.iucnredlist.org

into 3 categories for use in non-parametric analyses; under 30, 31 – 50, 51+. For all modelled analyses, tree models were used to select explanatory variables (shown in Table 2). Additional explanatory variables were used in tree models for some hypotheses, for example distance travelled and traps set per week were included when modelling the number of animals caught per week.

CASE STUDY 2: Members of a small village in England.

Field Procedures

A small village in Yorkshire was chosen as the study location because respondents had been residents for relatively long periods, ensuring consistent exposure to the same bird populations over time. Data were collected from Cherry Burton in East Yorkshire (53°52N, 0°30W, Figure 2) in June and July 2007. 50 inhabitants representing 3.4% of the village population of 1,473 (2001 UK census) were asked a 5-10 minute questionnaire about birds in Cherry Burton (questionnaire in appendix 2). Cherry Burton is a small commuter village for York and Hull, and is surrounded by arable fields. Respondents were identified both by knocking on doors and by asking known persons to participate. Some respondents spontaneously suggested other participants and those who didn't were asked to suggest them. This method ensured a high response rate (96% of potential participants asked), and a well distributed age range of respondents. Random sampling was not required as this study is assessing whether individuals exhibited shifting baseline syndrome, rather than if they were typical of the population.

Figure 2: Location of Cherry Burton in East Yorkshire and Great Britain (from www.easyindex.co.uk/maps/map36.gif).

Biological data

Biological data on population change in 5 focal species were obtained from the British Trust for Ornithology Breeding Birds Survey (BBS) 1994 – 2006 (www.bto.org/bbs/index). Data from throughout Yorkshire were used to ensure sufficient sample size. Birds were chosen as the focus of the study as data were available on past abundance, there are population increases and decreases, and the birds themselves are noticeable. Most respondents had lived in Cherry Burton more than 13 years (median=17.5, n=50), so only having data from 1994 was not ideal. When BBS trends are compared with Common Bird Census data (CBC) 1962 – 2000 (www.bto.org/survey/cbc), trends were similar for all chosen birds except the house martin, so where appropriate CBC data were used in conjunction with BBS data to construct a trend in populations over time. The five focus species were blue tits (*Parus caeruleus*), house martins (*Delichon urbica*), house *sparrows (Passer domesticus*), starlings (*Sturnus vulgaris*) and wood pigeons (*Columba palumbus*). As stated by Grigg (1995), most literature on shifting baselines has assumed a negative shifting baseline, but positive shifting baselines can occur as well, thus birds with both positive and negative population trends were chosen (Table 3). This is to control for narratives of depletion in farmland birds (Freeman et al, 2007; Newton, 2004; Summer-Smith, 2003), as shifting baselines should occur with increasing species (the wood pigeon, house martin and blue tit) as well as decreasing ones (house sparrow and starling).

Table 3: Percentage change in Yorkshire population size of the 5 focal species between 1994 and 2006. Upper and lower confidence intervals of change are shown and direction of change for all 5 species is significant. Data is taken from BTO BBS, which undertakes censuses in 1km squares each year.

Species name	Number of squares sampled 1994 – 2006	Percentage change	Is this significant change?	Lower confidence of percentage change	Upper confidence of percentage change
Blue tit (*Parus caeruleus*)	104	+47	Yes	25	73
House martin (*Delichon urbica*)	51	+44	Yes	10	89
House sparrow (*Passer domesticus*)	73	-19	Yes	-33	-3
Starling (*Sturnus vulgaris*)	96	-45	Yes	-58	-30
Wood pigeon (*Columba palumbus*)	114	+44	Yes	22	69

Experimental design

1) Respondents were assessed for age differences in interest or information level on birds, as this may affect perceptions of bird population change.
2) Respondents were asked the three most common birds at present, and 20 years ago. These were asked before questions about the 5 focus species, and are less likely to be dependent on respondents' information levels. This was asked to determine respondents' perception of change in bird populations.
3) Following case study 1, perceptions of abundance change in 5 focus species was assessed, and as data were available for biological change, it was possible to verify results and assign the data to the correct cell in Table 1 (page 14).
4) When respondents stated that abundance of any of the species had changed, they were asked to give a period in which change had occurred, to determine whether younger respondents thought change had occurred more recently.
5) Respondents were asked questions about typical flock sizes in the 5 focal species, to determine whether there are age or experience differences in perceptions of bird flock sizes.

Respondents were asked the 3 most common birds in the village at present, and 20 years ago. They were then asked to identify the 5 focal species from photographs (visual aid 1, appendix 2). Respondents were then asked a series of questions on each focal species, including perceived abundance change (more, fewer, or the same numbers), and questions on flock sizes. Identical pictures with different flock sizes were digitally created to assess differences in perception of flocks. Digital flock sizes of 10, 50, 100, 500, 1000 and 1500 were created to coincide with BTO flock reports (when members see flocks over certain sizes for various birds they are asked to report them). These flock sizes were used as ranked categories for analysis. Respondents were asked to select the image which looked most like the typical flock size for each species, state when they last saw a flock this size (using visual aid 2, appendix 2), and how many times they had seen such a flock since. Respondents were finally asked to indicate flock size when they last saw each species in a flock.

Statistical analyses

All analyses were performed in the statistical package R version 2.5.1 (R Core Development Team, 2007). Age categories used for non-parametric analyses were defined using natural breaks in the data, keeping age groups as equal in size as possible. For all modelled analyses, tree models were used initially to determine which explanatory variables (Table 4) to use in subsequent models. For non-parametric analyses, the years resident in Cherry Burton was divided into categories; 0 – 10 years, 11 – 20 years, 21+ years. Number of years living in the village (representing experience of the system in question) and age were retained as separate explanatory variables. Although they were significantly positively correlated, age explained only 19.22% of the variation in the number of years living in the village (lm, $F_{1,48}$= 12.66, p <0.001).

Table 4: Explanatory variables used for the investigation of shifting baseline syndrome in observers of bird populations in England.

Personal	Interest level	Environment
Age (in years)	Whether respondent has been bird watching (Y/N)	How long respondent has lived in the village (in years)
Sex (Male/Female)	Whether respondent feeds birds in their garden (Y/N)	Whether respondents garden overlooked fields or other houses
Number of times per week respondent walks in the village	Declared interest in birds (Interested/not interested)	Previous address: a) Was it in Yorkshire (Y/N) b) Was it urban, suburban or rural? c) How long respondents lived at previous address (in years) – only included when a) or b) was also shown in the tree diagram

Chapter 3
CASE STUDY 1
Bushmeat hunters in Equatorial Guinea

Research Question 1: Catch per unit effort (CPUE)

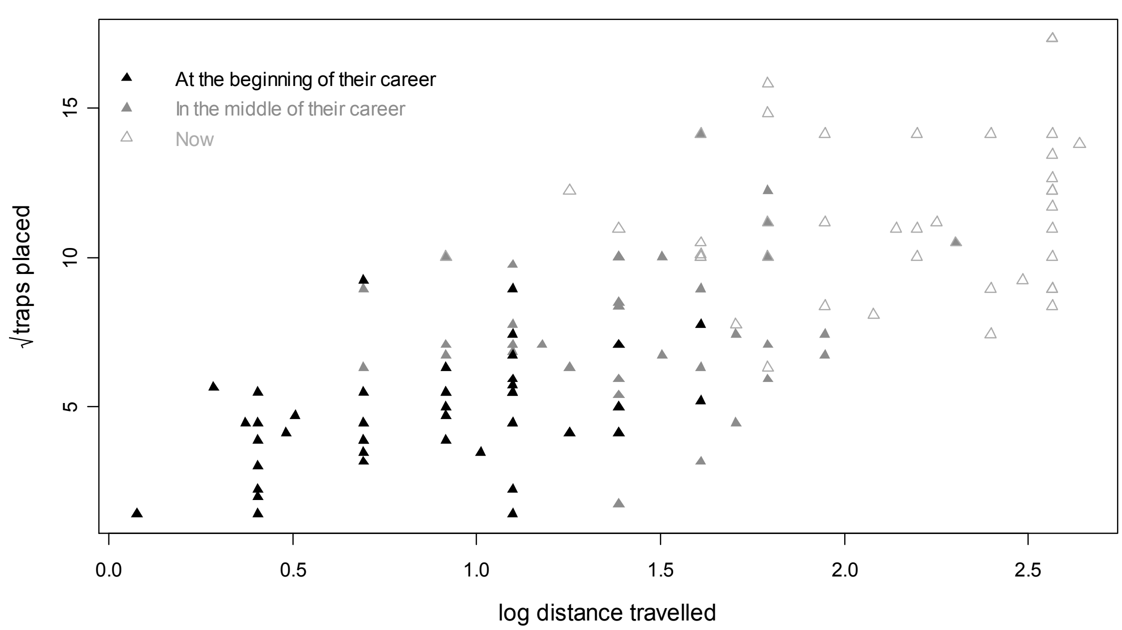
Hypothesis 1) There are no age differences in hunting effort.

17 % of the variation in number of traps set per week (mean = 75.98± 5.49, n=138) was explained by differences between hunters, in contrast to 45% of variation in distance travelled (mean=4.33± 0.318, n=130). Hunters reported fewest traps ($p<0.001$) and least distance travelled ($p<0.001$) at the beginning of their careers; and the most now (Table 5 and Figure 3).

Table 5 Results of modelling number of traps set and distance travelled per week using a mixed effects model with hunter identification as a random effect. Significance is taken from the minimum adequate model.

Traps set per week			**Distance travelled per week**		
Fixed effects in the maximal model	**Minimum adequate model**	**Random effects**	**Fixed effects in the maximal model**	**Minimum adequate model**	**Random effects**
Distance travelled	**P<0.001**	**Hunter ID**	**Traps set**	**P<0.001**	**Hunter ID**
Period	**P<0.001**		**Period**	**P<0.001**	
Hunter age	p>0.05		Hunter age	p>0.05	
(Hunter age)^2	p>0.05		(Hunter age)^2	p>0.05	
Number of activities	p>0.05		Number of activities	p>0.05	
All interactions	p>0.05		All interactions	p>0.05	

Figure 3: Number of traps set and distance travelled per week in different periods. Distance travelled is shown here as the explanatory variable, but it is not possible to determine a causal relationship between these two variables.



As distance travelled and the number of traps laid are positively correlated, and each explains variation in the other, it is not possible to show a potential causal relationship. Interestingly, all hunters reported increased effort through their careers (setting more traps and travelling further), even though some hunters have been hunting for 2 years, and others for more than 50. If this reported effort is a true reflection of effort, and there is no increase in catch, we can conclude that there are depleting resources in the system. There is no decrease in effort for older hunters, unlike other studies (Coad, 2007).

Hunters were asked which camps they had visited in their lifetime (mean = 3.98±0.26). If there is increased recent effort, as found above, we would expect younger hunters to have visited more camps per year of hunting. Since older hunters had more opportunities to visit camps, the number of camps was divided by number of years hunting, following the methods of Sáenz-Arroyo et al (2005). Younger hunters named more camps per year hunting than older hunters (linear model, $F_{1,41} = 19.1$, $p<0.001$, adjusted $R^2 = 0.301$), suggesting an age difference in camp use.

However, as there was no relationship between number of camps visited and age before adjustment (generalised linear model with poisson errors, p = 0.36), there is an alternative suggestion which is more plausible, given the rotational use of camps in the area. All hunters may visit 3 or 4 camps in their first year of hunting, then continue visiting these camps for the rest of their career. Thus "younger hunters name more camps per year hunting" would be an artefact of dividing this constant number of camps by fewer hunting years. We cannot conclude there are any age differences in camp use.

Hypothesis 2) There are no age differences in number of animals caught per week.

The random effect hunter explained 8.8% of the variation in number of animals caught per week (mean=7.85± 0.242, n= 134). The results, summarised in Table 6, show that when hunters travel further, they caught more animals (p<0.001). If we assume they travel in a straight line out of Midyobo Anyom and effort is not correlated with distance travelled, this suggests a depleted area around the

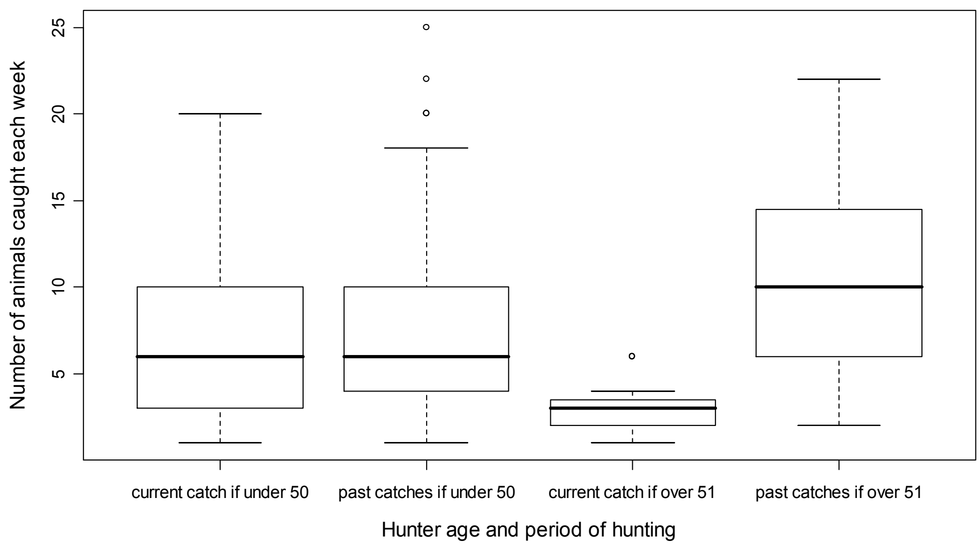
Table 6: Results of modelling number of animals caught per week using a mixed effects model with hunter identification as a random effect. Significance is taken from the minimum adequate model

Fixed effects in the maximal model from a tree model	Value of b, minimum adequate model	Significance in the minimum adequate model	Random effects
Distance travelled	0.604	**P<0.001**	**Hunter Identification**
Time period	0.017	p>0.05	
Hunter age		**P=0.003**	
Number of activities	0.112	**P=0.020**	
Hunter age and time period		**P<0.001**	
All other interactions		p>0.05	

village. Hunters over 51 reported catching more animals than those under 50 (p<0.003). Finally, the more activities undertaken by a hunter in the past year, the more animals he caught (p = 0.020). We would expect the opposite to be true as those hunters who undertake fewer activities should have more time for each one, but data on time budgets for activities was considered inaccurate.

One interaction remained in the minimum adequate model – hunters over 50 caught fewer animals now than they did earlier in their career (p<0.001, Figure 4). Although all hunters' report increased effort now compared with the past, only older hunters' report changes in catch.

Figure 4: The relationship between hunter age, period of hunting and number of animals caught per week. Note that hunters over 50 currently catch fewer animals than hunters under 50, but report greater past catches.



Hypothesis 3) Hunter age has no affect on the species killed.

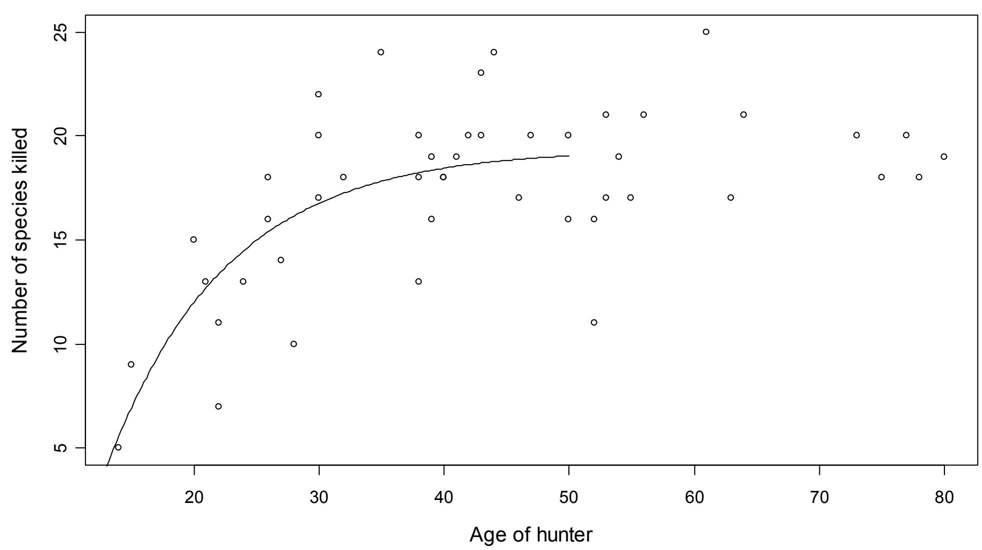
If the numbers of species available to hunt is decreasing in addition to catch size decreases, we would expect fewer younger hunters to have killed threatened species (as assessed by IUCN status and population trend). The random effect species explained 85.96% of the variation, hunter explained 9.65% and only 4.39% was explained by the fixed effects (values from quasi-binomial model, summary shown in Table 7). Hunter age had an effect when hunters were less than 35 years old (p<0.001, figure 5), but there is no interaction between IUCN status or population trend and age. Thus by age 35, hunters have killed all the species they are likely to encounter. This suggests hunter saturation rather than a decrease over time in species available for hunting.

Species listed by the IUCN red list as endangered were less likely to have been killed than species with other IUCN statuses (p = 0.002). Ungulates, rodents and primates were more likely to have been killed than other animals (p<0.001), which is consistent with previous studies of hunting off-take composition (Fa and García Yuste, 2001; Fa et al., 1995)

Table 7: Modelled analysis of the species killed, using a mixed effects model with species and hunter identification as random effect. P values are taken from the minimum adequate model. All explanatory variables in the maximal model are shown, and variables retained in the minimum adequate model are highlighted in bold text, showing p values.

Maximal model fixed variables derived from a tree model	Minimum adequate model	Random effects
Hunter age	**P<0.001**	**Hunter identification**
IUCN status	**P=0.002**	
Animal taxon	**P<0.001**	**Species**
Population trend	p>0.05	
All interactions between explanatory variables	p>0.05	
Model fit with a mixed effects model with binomial data using lme4 package		

Figure 5: The effect of age on the number of species a hunter has killed. The curve showing predicted species killed at every age asymptotes at 18, so is not shown past this point.



Research Question 2: Abundance of specific species

Hypothesis 1) There are no age differences in perceived abundance of species populations.

Perceived abundance of species did not vary as a function of age (spearman's rank, $p > 0.05$ for all 30 tests). However, this question asked about species abundance without giving any period for assessment. We would expect to find no significant age differences in perceived abundance as they are all assessing the current population size. In order to determine whether there is a shifting baseline, it is necessary to look at hunter perceptions of abundance in the past.

When hunters were asked about changes in abundance over time, only two significant results were revealed from 81 tests. Younger hunters thought there were more mandrill (*Mandrillus sphinx*) (spearman's rank, rho = 0.304, S = 9872.19, p = 0.045, figure 6) and Red River hog (*Potamochoerus porcus*) (spearman's rank, rho = 0.409, S = 8392.79, p = 0.006, figure 7) 10 years ago than there are now, whereas older hunters were more likely to think there are the same numbers or fewer now. Fa and Garcia Yuste (2001) report unsustainable hunting of mandrill (IUCN red listed as "vulnerable") and significant depletion in their numbers may be more noticeable as they congregate in large groups (Abernethy et al., 2002). The Red River hog is IUCN listed as least concern, but is a preferred meat type in the area (East et al, 2005). As hunters preferentially hunt in areas of higher Red River hog density (Kumpel, 2006), decline in the Red River hog may also be more noticeable to hunters. Age differences in abundance for these two species were reported for 10 years ago, but not 5 years ago, suggesting that abundance change occurred 5 to 10 years ago. Kumpel (2006) analysed changes in off-take data and concludes both mandrill and Red River hog have decreased in this period. Black colobus (*Colobus satanus*) and golden cats (*Felis aurata*) are known to have decreased in the area (Kumpel, 2006; Fa and Garcia Yuste, 2001), so age differences in perceptions of their abundance may be expected, but were not found. If we accept significant tests to reveal true significance rather than type I errors as a result of 81 tests, these results suggest evidence of shifting baseline syndrome.

Figure 6: The effect of hunter age on perception of abundance change in the mandrill (*Mandrillus sphinx*). Older hunters were more likely to think that the mandrill had decreased in the past 10 years.

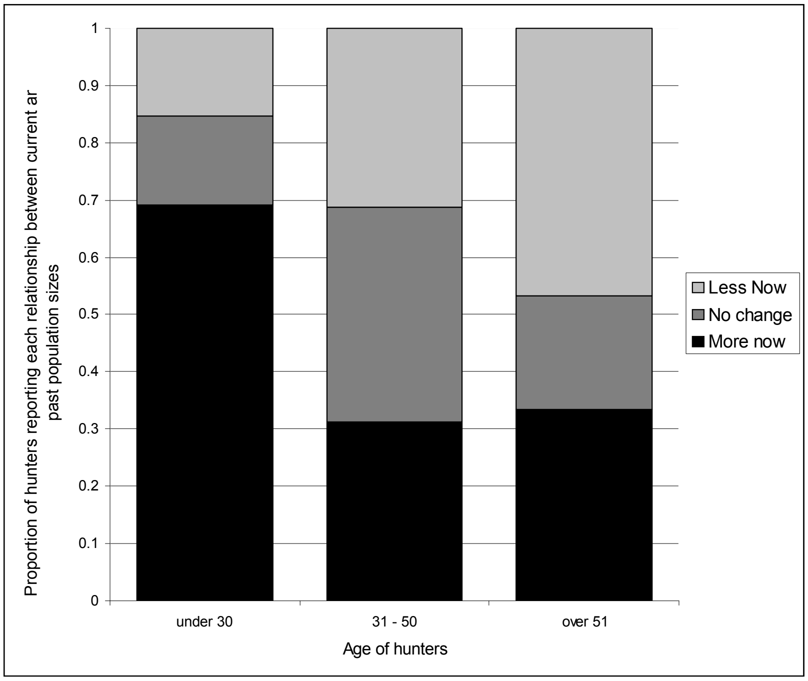
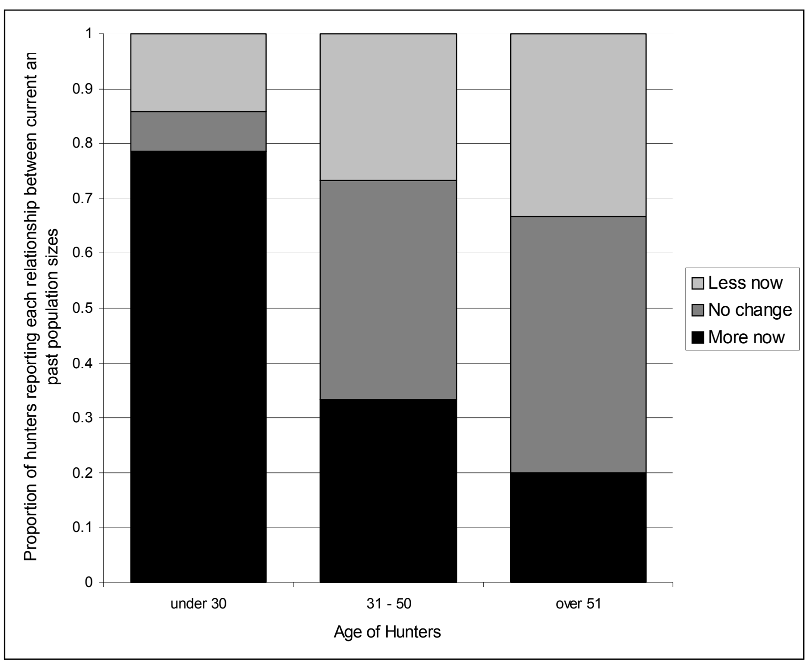


Figure 7: The effect of hunter age on perceptions of abundance change in the Red River hog (*Potamochoerus porcus*). Older hunters were more likely to think that the Red River hog had decreased in the past 10 years.



Case study 1 follows some of the methods of Sáenz-Arroyo et al (2005). Initially, this was to provide further evidence of shifting baseline syndrome, but examination of the conditions required to demonstrate shifting baseline syndrome (chapter 1) has shown that these type of data are insufficient. Data on CPUE showed that although hunter effort has increased, only older hunters report reduced catches. This is hunters reporting their own experience, not shifting baseline syndrome. Younger hunters are unable to report larger past catches if they were not hunting then, but they may still recognise that decrease in catch size has occurred. Like the study data on catch sizes by Sáenz-Arroyo et al (2005), this part of case study 1 asked hunters their experience of the biological system, rather than their perception of it. The data does suggest depletion in this system though, which contrasts with previous research on bushmeat hunting around Midyobo Anyom (Kumpel, 2006).

To better examine whether shifting baseline syndrome occurs in these bushmeat hunters, all hunters were asked about the abundance of various species. Age differences in hunter perceptions of abundance change were found, although there were no age differences in perceptions of current abundance (which provides validation of the results). Differences in perception of abundance 10 years ago were found in the mandrill and Red River hog. This fulfils criterion 1 for demonstrating shifting baseline syndrome, but unfortunately criterion 2 can only be fulfilled for the mandrill. Kumpel (2006) reports mandrill decreases in off-take data, suggesting decreasing population size. Although this verifies the reports of hunters, with 81 tests performed, we would expect 4 results to be false positives (type I error) when 95% confidence is used. As only 2 significant results are found caution must be taken, so it is inadvisable to definitively conclude that shifting baseline syndrome is occurring.

Thus this case study suffers from two problems in common with other studies in the literature. Firstly, CPUE data was unable to discover hunters' perceptions, and secondly, where hunter perceptions were discovered, insufficient biological data were available to determine the existence of shifting baseline syndrome. Although unable to demonstrate the existence of shifting baseline syndrome, this case study can reveal problems associated with shifting baseline syndrome studies. Information from this case study was used to inform case study 2, and can be used to inform future research into shifting baseline syndrome.

Chapter 4
CASE STUDY 2:
A small village in England

Preliminary Research Question) There is no age difference in interest or information levels

Although there are no age differences in declared interest, older respondents were more likely to feed birds or go bird watching, which suggests a higher level of interest. This may be because older respondents have more time or money to pursue their interest. As older respondents behave in a way that suggests that they were more interested, it may be found that they are more knowledgeable.

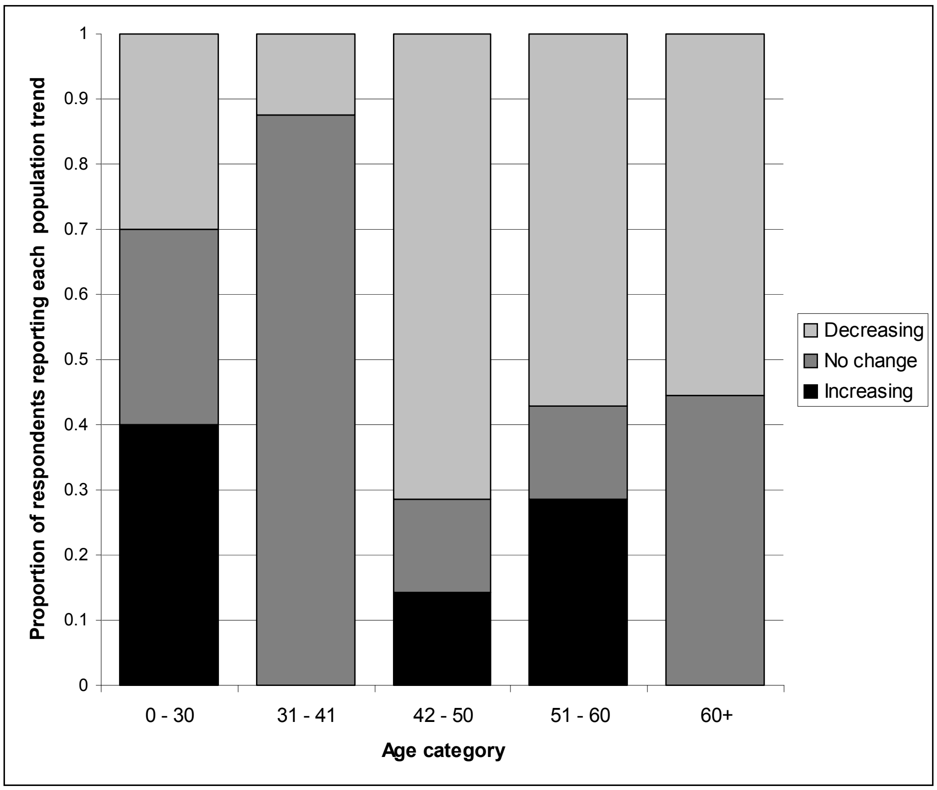
Older respondents reported seeing all species more recently, and more regularly. It is possible that older respondents are reporting sighting regularly from past, rather than present conditions. However, they report seeing all birds more regularly even though the house martin, blue tit and wood pigeon were less abundant in the past. In addition, they report seeing all species more regularly, so it seems more likely that older respondents pay more attention. This is perhaps as they are more likely to feed birds thus see all birds more regularly, or notice them in their garden.

Older respondents were more accurate at naming the 5 focal species, and were more likely to have prior information on the two decreasing species, the house sparrow and starling. Respondents who had lived longer in Cherry Burton were more likely to have prior information on the 3 increasing species – the house martin, blue tit and wood pigeon. For full results, see appendix 3

Research Question 1) There is no difference in perceptions of abundance change

Respondents were asked whether there were more, fewer or the same number of each of the 5 focal species since they moved to Cherry Burton. The only species with age differences in perception of abundance change was the house sparrow, and older respondents are more likely to think that sparrow population has decreased (spearman's rank, rho = -0.310, S = 15035.06, p = 0.049, n = 41, Figure 8).

Figure 8: The effect of age on respondents' perception of population trend in the house sparrow (*Passer domesticus*).



Those living in Cherry Burton longer were more likely to think that the wood pigeon had increased (spearman's rank, rho = 0.343, S = 8105.89, p=0.026, Figure 9) and the house martin had decreased (spearman's rank, rho = -0.491, S = 12580.44, p=0.002, Figure 10).

Figure 9: The effect of years resident in Cherry Burton on perception of population trend in the wood pigeon (*Colomba palumbus*).

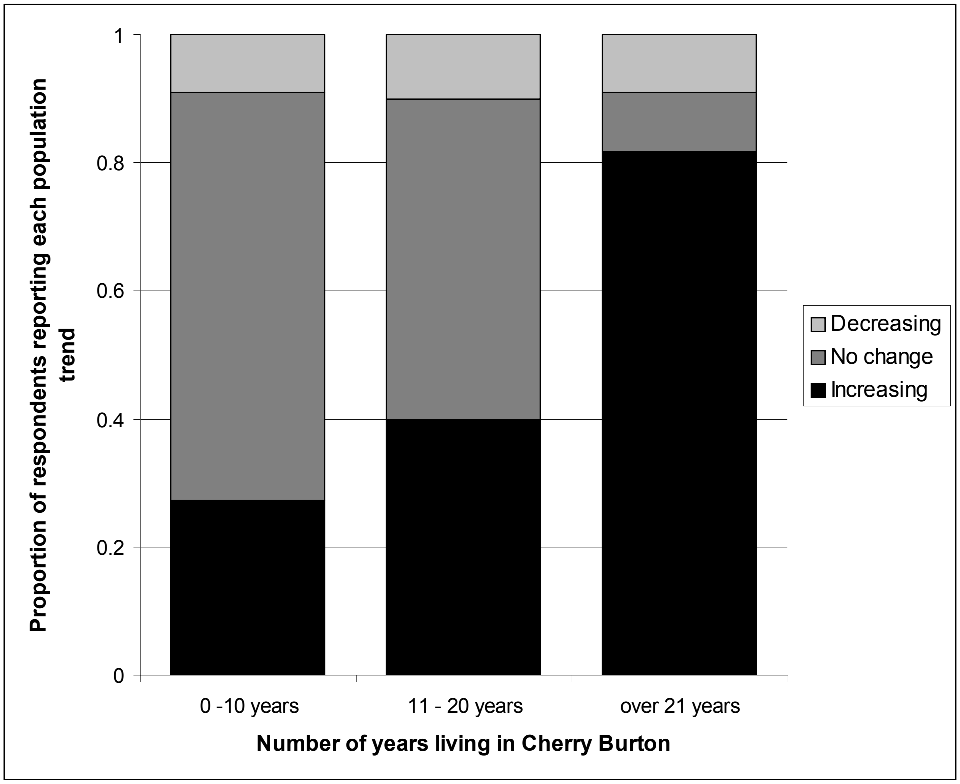
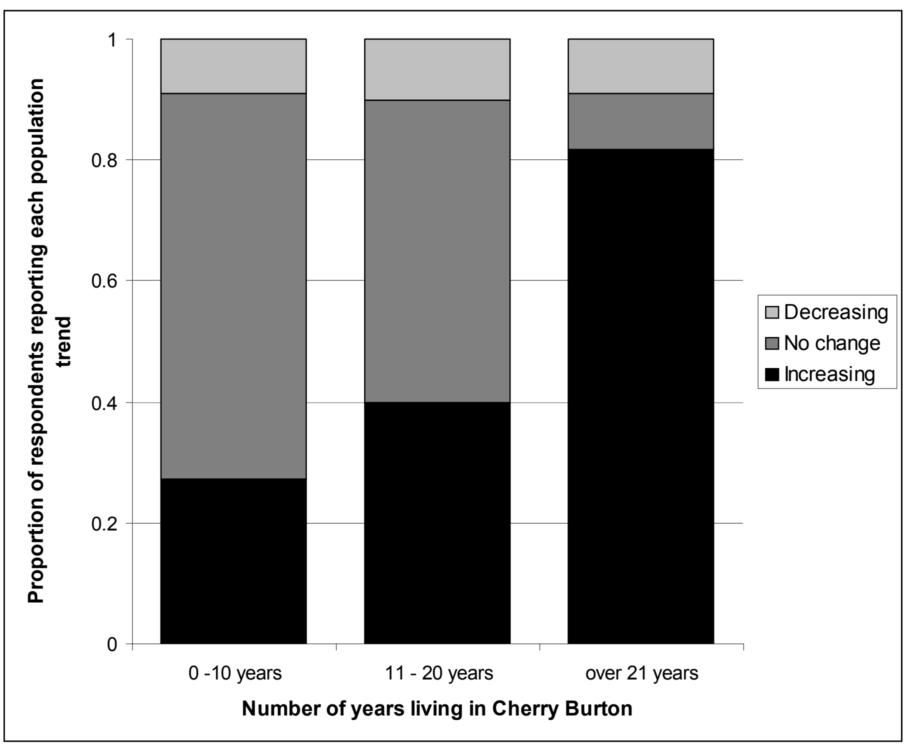


Figure 10: The effect of years resident in Cherry Burton on perception of population trend in the house martin (*Delichon urbica*).



Respondents were scored using BTO census data on whether the answers they gave for abundance change for the blue tit, wood pigeon, starling and house sparrow were correct or not, with the year respondent moved to Cherry Burton as the reference point for change. Responses about the house martin were not assessed as CBC data did not correlate with BBS data. Only with the blue tit did any variable explain accuracy, respondents who had lived longer in Cherry Burton were more accurate (Table 8). As interest and information levels did not influence accuracy, we can conclude these results are relatively independent of respondents hearing of population changes in these species.

Table 8: Modelled analysis of the explanatory variables that are related to the accuracy of respondents' perceptions of abundance change in 4 focal species. Explanatory variables to use in the maximal model were determined using tree models and are shown in the table. Significant p values (shown in bold text) are taken from the minimum adequate model.

	Age	Years living in Cherry Burton	Sex	Times walking in Cherry Burton each week	Feeding birds or owning a bird table	Interactions
Blue tit		**P=0.0035**	P<0.05	P<0.05		P<0.05
House sparrow	P<0.05	P<0.05	P<0.05			P<0.05
Starling	P<0.05	P<0.05			P<0.05	P<0.05
Wood pigeon	P<0.05	P<0.05				P<0.05

When respondents were scored on the total number of species where they correctly assessed population change (corrected for unanswered parts), older respondents score better, but this was not significant (lm, $F_{1,47}$ = 0.5359, adjusted R^2 = -0.0097, p = 0.4678).

Research Question 2) There is no difference in length of time since perceived change

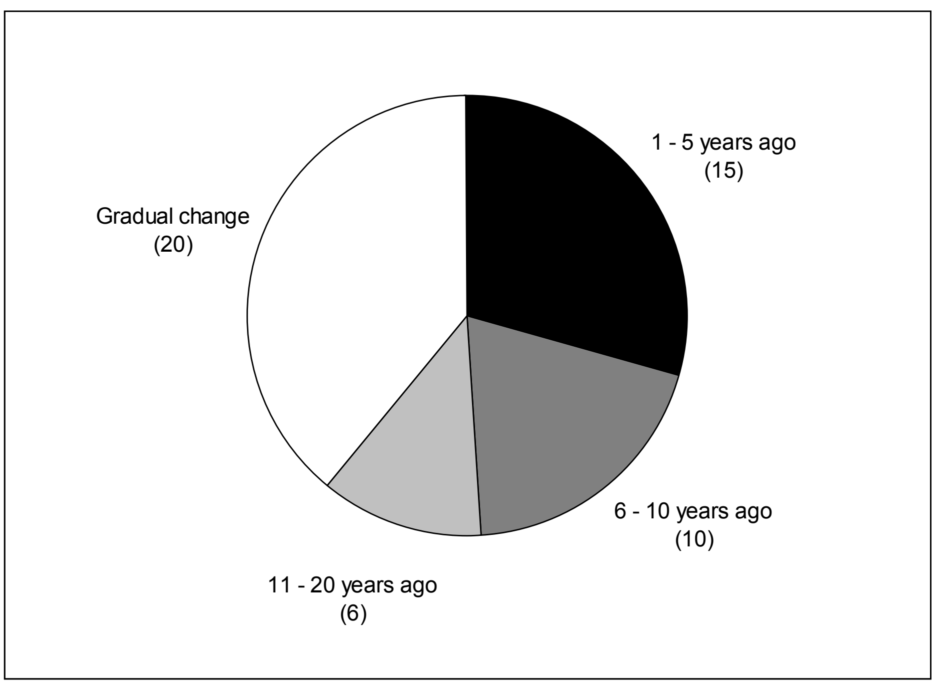
Some respondents who reported population change were able to give a period over which this change had occurred. For the house martin, older respondents were significantly more likely to be able to give a period over which population change had occurred (glm with binomial errors, p = 0.028, summary in Table 9).

Table 9: Generalised linear models for each focal species, can a respondent give a period over which abundance changes have occurred? Explanatory variables to use in the maximal model were determined using tree models and are shown in the table. Significant p values (shown in bold text) are taken from the minimum adequate model.

	Age	Years living in Cherry Burton	Times walking in Cherry Burton	Sex	Previous address in Yorkshire?	All interactions
Blue tit	p>0.05	p>0.05				p>0.05
House martin	**P=0.028**	p>0.05	p>0.05			p>0.05
House sparrow		p>0.05		p>0.05	p>0.05	p>0.05
Starling	p>0.05	p>0.05				p>0.05
Wood pigeon		p>0.05	p>0.05			p>0.05

Unfortunately, it was not possible to assess whether age of respondent affected time since reported depletion, as there was insufficient data to assess each species individually. Time since population change began was pooled for all species, and most respondents reported gradual change, but all exact periods mentioned were in the last 20 years, with most change reported in the last 1 to 5 years (Figure 11).

Figure 11: Reported times for the start of abundance changes, pooled for all species. Number of respondents giving each category is in brackets.



Research Question 3) There is no difference in perception of flock sizes

No age or experience (measured using years living in the village) differences were found for any response variables (spearman's rank tests, $p>0.05$). A fifth response variable was created by comparing typical flock size to the flock size last seen for each respondent, to determine if perception of typical flocks differed from personal experience. Age and experience differences were not found (Pearson's chi squared tests, $p>0.05$).

If differences had been found, this could have been a good measure of a shifting baseline, as it is a quantitative measure of bird populations. These results are not unexpected though as flock size does not vary with population density (Ewert and Askins, 1991), and so we may expect little change in flock size for either the increasing or decreasing bird species. As there is no biological data on flock sizes of these 5 species, it is not possible to state that this is definitely the case, but lack of differences between observers does not mean that shifting baseline syndrome does not occur.

Research Question 4) There is no difference in perceptions of the three most common birds now and 20 years ago.

Respondents' answers for the three most common birds now and 20 years ago were compared, and respondents were divided into those who thought these were the same and thus had a static perception of these birds, and those who did not (Figure 12). The minimum adequate model (Table 10) showed that respondents who lived in Yorkshire (p = 0.021), or an urban area (p = 0.023) prior to moving to Cherry Burton were more likely to have a static perception of the 3

Figure 12: Respondents reporting static and changing bird populations in the past 20 years.

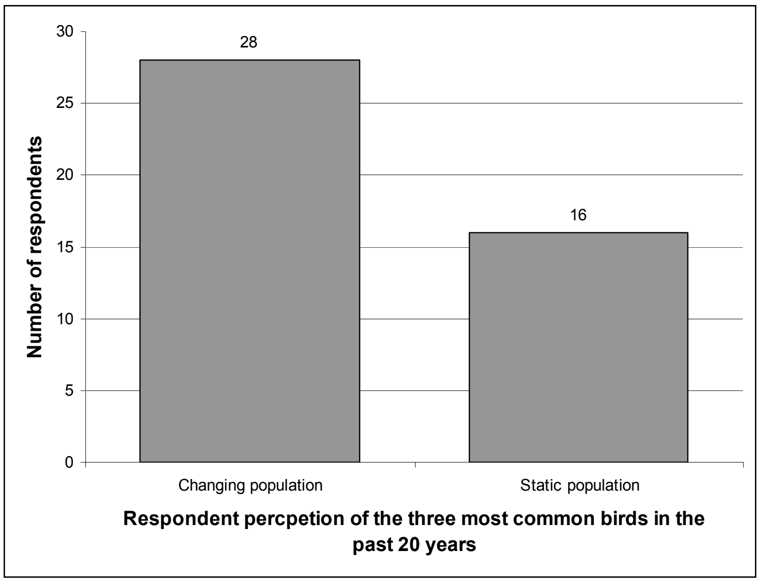


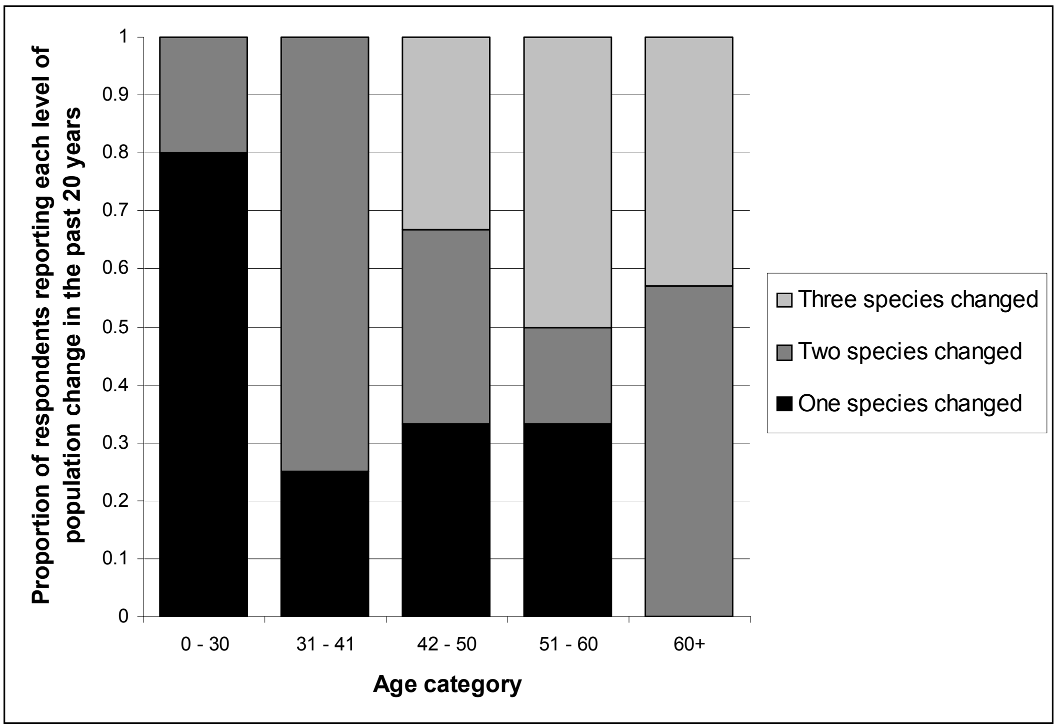
Table 10: Generalised linear model with binary response of determinants of static perceptions of bird populations (Adjusted R^2 = 0.753). Significant variables in the minimum adequate model are shown in bold.

	Variables				**Interactions**
Maximal model	**Age**	Year living in Cherry Burton	**Is previous address in Yorkshire?**	**Is previous address in a rural or urban area?**	**All interactions**
Significance (minimum adequate model)	P >0.05	p>0.05	**P = 0.021**	**P = 0.023**	**Age and rural/urban p = 0.013**
Value of b	-0.047		1.908	-7.897	
Collapsed categories				Rural and suburban	Rural and suburban

most common birds. Younger people from non-urban areas and older people from urban areas were more likely to have a static perception (p=0.013). Median time living in the village is 17.5 years, thus most respondents did not live in the village 20 years ago. Most respondents must be guessing from extrapolation or comparing where they used to live with Cherry Burton.

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 (spearman's rank, rho = -0.514826, S = 1772.826, p = 0.0051, Figure 13). Provided the analysis below confirms the accuracy of these statements, this result demonstrates clear evidence of shifting baseline syndrome.

Figure 13: Degree of change in the three most common birds in the past 20 years, as reported by respondents of different ages.



The accuracy of the current three most common birds were scored using BTO breeding birds survey, 2006. For each species mentioned by a respondent, scores were calculated by dividing the count of the mentioned species by the count of the most common species, the wood pigeon. This gave a value between 0 and 1 for the prevalence of each species. Prevalence values were summed for the three species reported by each respondent, to assess the accuracy of their statement. The summed score for accuracy (mean = 1.261±0.053, n = 49) could vary between 2.18 (most accurate) and 0 (least accurate). The same method was used to score the accuracy of the three birds reported as most common, although unfortunately data were only available for 1994, rather than 1987. The starling was the most common bird, and 1994 data were used as a rough proxy for abundance levels 20 years ago. Scores (mean=1.036± 0.088, n=50) could vary between 2.30 (most accurate) and 0 (least accurate).

The minimum adequate model (Table 11) showed that respondents who walked in the village more often had lower scores for current bird populations (p = 0.042), as did those whose houses backed onto fields (p=0.032). It could be expected that those who walked in the village were more exposed to bird populations would more accurately name the 3 most common birds. It may be however, they found it more difficult to determine the 3 most common birds as they saw a greater variety of birds through walking. Respondents whose houses look onto fields may see different species composition than those houses overlook other houses, potentially explaining their difference in scores. The only explanatory variable which explained respondent accuracy 20 years ago was age, with accuracy increasing with age (linear model, $F_{1,48}$ = 5.065, adjusted R^2 = 0.077, p = 0.029). No age differences were found in naming the three most common birds now, so older respondents are not more accurate at naming birds per se, rather more accurate at doing so in the past, giving evidence of a shifting baseline.

Table 11: Linear models of the accuracy of respondents' perceptions of the 3 most common bird species. Models for bird populations now and 20 years ago are shown. Variables listed are those from tree models and used in the maximal model. Significant variables from the minimum adequate model are highlighted in bold text.

Currently		**20 years ago**	
Maximal model	**Significance of variables in the minimum adequate model**	**Maximal model**	**Significance of variables in the minimum adequate model**
Age	p>0.05	**Age**	**P= 0.029**
Sex	p>0.05	Sex	p>0.05
Previous address: rural or urban	p>0.05	Previous address: rural or urban	p>0.05
Number of times walk in the village each week	**P=0.042**	Number of times walk in the village each week	p>0.05
Does respondents house back onto fields	**P=0.032**	Number of years respondent has lived in the village	p>0.05
All two-way interactions	p>0.05	All two-way interactions	p>0.05
Minimum adequate model statistics: $F_{2,46}$ =3.588, p = 0.03564, adjusted R^2 = 0.09734		Minimum adequate model statistics: $F_{1,48,}$ = 5.065, p = 0.029, adjusted R^2 = 0.0766	

This case study demonstrates age and experience differences in perception of abundance change in a system with known biological change, which fulfils the first two criterions for shifting baseline syndrome to occur. Those who had lived longer in the village were also more likely to believe that the wood pigeon had increased and house martins had decreased. Older respondents were more likely to think that house sparrow populations had decreased. Though for the house sparrow and wood pigeon these age and experience differences are consistent with the BTO trend data, all respondents were equally likely to correctly identify their own experience of change in these species. This is an excellent example of shifting baseline syndrome. Unfortunately, BBS and CBC data were not consistent for house martin trends, so it not possible to determine whether house martins have decreased.

Although the above results suggest shifting baselines do occur, there are confounding factors. Older respondents have a higher level of interest and information on the focal species, are more likely to notice the current bird population, to have heard about them, or engage in activities involving birds (such as leaving food for them in the garden or going bird watching – though this may be because they have had more opportunities to bird watch). This may influence their answers on individual species, as (for example) they are more likely to have heard something about the well publicised house sparrow decline (Summers-Smith, 2003). But all respondents (regardless of age), are equally likely to correctly report population trends of the wood pigeon and house sparrow, which provides excellent evidence for shifting baseline syndrome. A study on house sparrow population sizes was conducted in the village in 2005. Local residents were asked to report sightings of ringed house sparrows to the local agricultural college for an unpublished undergraduate thesis. The presence of this study in the village and the well-publicised decline of the house sparrow cast doubts on the independence of the house sparrow result from outside influence.

The results on respondents' perception of the three most common bird species 20 years ago and now provide the most persuasive evidence of shifting baseline syndrome. This question does not suffer to such a degree from previous levels of information, as it is not asking about specific species. Instead it is closer to asking the respondents their perception of typical "bird life" in the area. As Sheppard (1995) suggested that younger divers think that recent algal dominated reef systems are normal, rather than the variety remembered by older divers, so younger respondents may see current bird species as normal for the past. We find no age differences in whether respondents had static perceptions of species composition, which is indicative in this changing biological system of change blindness. Interestingly, whether or not respondents had static perceptions was not dependent on attention (in this study shown by interest levels). This is particularly surprising as research suggests that whether or not observers will display change blindness is dependent on attention levels (Simons and Rensink, 2005)

We find that older respondents more accurately name the three most common bird species 20 years ago. Older respondents' idea of past abundance is more accurate than younger respondents, whereas age and experience have no effect on accuracy of naming the three most common current birds.

Thus older respondents are more accurate about past species composition and state there is greater change than younger respondents, as we would expect from shifting baseline syndrome. These results are achieved not by asking respondents explicitly about change in species composition (which may prompt over estimation of change), but by asking about two separate periods. Although this could implicitly imply that change is expected, many respondents stated that the three most common species in the two periods were the same.

Though this case study is an improvement on the previous case study, it still has problems. It was not possible to obtain data on flock sizes, so it was not possible to determine whether the lack of age differences in perception of flock size was due to static flock sizes, or an example of change blindness. Also insufficient information was available about when respondents thought that change had occurred. Finally, the biological data available were for the whole of Yorkshire, but the questionnaire was only asked in one village, which may have had changes in bird populations that were not typical of Yorkshire.

Chapter 5
DISCUSSION AND CONCLUSIONS

Discussion

In the introduction, three conditions were identified for demonstrating the existence of shifting baseline syndrome:

1) Biological change must be present
2) Age or experience related differences in perception must be present
3) The perception differences must correlate with the biological data.

Although both case studies provide some suggestive evidence of shifting baseline syndrome, neither is able to conclusively demonstrate them. This is largely due to two problems; firstly, separating "perception", from observation or experience, and secondly demonstrating that perceptions are consistent with biological data. The first problem is a problem with experimental design, and identifying what precisely is perception. The second problem in this study was partly due to the identification of perceptions, but also due to unavailable data (for example, as BTO data were not available before the survey commenced, case study 2 asked questions about 20 years ago, yet the BSS only dates to 1994).

Further problems were inherent in questionnaire design. Asking about past abundance or conditions implies you wish to identify change, which may prompt increased reports of change. The first case study was unable to separate age and experience. Although the second study attempted this to some degree, age and experience of bird populations will be highly correlated. Further research could be conducted in an environment where experience and age can be disconnected. An example of this would be returning to the original suggestions of Pauly (1995), and questioning people on the marine environment. For example, in recreational divers, age and experience would be more discretely separated. Divers could be asked exactly how many times they had dived in a particular location, and how many locations they had dived in. As respondents could not experience the underwater environment unless they were diving, there could be no "leakage" of experience as participant's age.

The data collected here suggests that shifting baseline syndrome occurs and information about past conditions is not shared, but these age and experience related differences in perception only occur in some circumstances. This data also suggests there is an even greater problem for conservation than shifting baseline syndrome; the updating of peoples perceptions so that even those who experience change do not remember it. Such "change blindness" could be a greater problem than shifting baseline syndrome, as there would be no observers who remembered past conditions. The problems caused by shifting baseline syndrome could be countered by ensuring that different generations are communicating about their environment, in particular about the changes in it. Where change blindness occurs though, no members of a community will remember past conditions, so this approach would not be successful. There is hope for combating change blindness: Simons and Rensink (2005) suggest that incidences of change blindness decrease when observers have more information or awareness of a scene, suggesting conservation education as a possible solution for change blindness in biological systems

As mentioned in the introduction, lack of awareness about past conditions can have implications for the way in which conservation action is implemented. Shifting baseline syndrome recommends caution when using questionnaire data or participatory monitoring to draw conclusions about biological conditions. 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). It is important to ensure in such cases that shifting baseline syndrome or change blindness does not bias results. Although these concepts could cause problems for conservation action programs, most conservation practitioners can use the syndrome as a cautionary tale to ensure good communication and good biological data.

Future research on shifting baseline syndrome could build on the research conducted in this project, though there are many areas for improvement. Improved questionnaire design and case study choice could separate experience and age and use of long-term biological data would improve the strength of conclusions. Also, the use of methodology applied by psychologists would provide more accurate measurement of observers' perceptions. Finally, future studies in shifting baseline syndrome must remember that social and biological data is needed, and the two must be consistent with each other.

Conclusions

In the past, shifting baseline syndrome has been incorrectly cited without adequate proof of its existence. This project has identified these problems and designed research to assess whether shifting baseline syndrome occurs. Following the outline in the introduction, a suitable biological system was identified, and differences in perception by age and experience were identified. Finally, these perception differences were demonstrated to reflect the biological changes in the system. Although this research is fraught with problems, and further research is necessary, it presents the most comprehensive evidence for shifting baseline syndrome so far. This evidence for shifting baseline syndrome suggests caution when using data from human observers, but the full implications of shifting baseline syndrome need further investigation. This research also suggests there are additional problems that may occur, namely change blindness, that are also worthy more detailed research.

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APPENDICES

Interview of the hunters

Name of hunter:	Hunter code:
Date:	Questionner:
Age / date of birth:	Age / year he began hunting:

Instructions: The questionaire has three sections. Explain to the hunter that it is going to take half an hour to 45 minutes to complete the interview. The interview has to be done with the hunter alone, without other people.If a hunter does not answer one of the questions, give one of these reasons: does not want to respond, does not know, does not understand.

Section A – Questions on the state of animal populations

1. *Instructions: Use the cards with pictures of the animals to ask the hunter about each animal in turn and write the answers in the table below.*

a) Have you killed *name of animal*? Write *Yes or No*

b) How many times have you killed it? *Write the number of times he has killed it. If he can't remember, write "doesn't know".*

c) When was the last time you killed it? *Write the answer he gives*

d-f) Do you think that *name of animal is more abundant, less abundant or the same now compared with 10 years ago, 5 years ago and 2 years ago? Write more now, less now or the same now for each time.*

#	Name of animal	a) Killed?	b) How many times?	c) When last?	d) Abundance now/ 10 years	e) Abundance now/ 5 years	f) Abundance now/ 2 years
1	Elephant						
2	Blue duiker						
3	Bay duiker						
4	Porquipine						
5	Marsh cane rat						
6	Red river hog						
7	Buffalo						
8	Small pangolin						
9	Giant pangolin						
10	Sitatunga						
11	Gorilla						
12	Water chevrotain						
13	Black Colobus						
14	Putty nosed monkey						
15	Chimpanzee						
16	Moustashed monkey						
17	Leopard						
18	Mandrill						
19	Golden Cat						
20	Yellow-backed duiker						
21	De Brazza's monkey						
22	Grey-cheeked mangabey						
23	Crowned monkey						
24	Dwarf antelope						
25	Black-fronted duiker						

APPENDIX 1: Questionnaire used in Equatorial Guinea (translated from Spanish).

26	Ogilby's duiker						
27	Bushbuck						

2. How many camps has the hunter used in his life and how many times has he used each one?

Name of Camp	Number of times used by the hunter
1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	
9.	
10.	

3. *Instructions: Ask the four questions for each period and write the answers in the table below.*

a) How many traps did you set per week? When you began hunting, in the middle of your profession and now?

b) What distance (in hours walking) did you travel to hunt when you began hunting, in the middle of your profession and now?

c) How much time (days per week) did you spend hunting each week when you began hunting, in the middle of your profession and now?

d) How many animals did you catch per week when you began hunting, in the middle of your profession and now?

	When he began to hunt	In the middle of his profession as a hunter	Now
a) How many traps?			
b) Distance *(hours walking)*?			
c) Time (days)			
d) Number of animals per week?			

Section B – Hours spent on activities during the year
Instructions: We want to know the time given by the people to various activities during the year. Ask if he does each activity in turn, and in which months. For the months in which he gives, write how many days per week (one to seven) he spends on the activity?

Type of activity	Does he do it? Yes /*No*	January	February	March	April	May	June	July	August	September	October	November	December
Hunts with shotgun													
Trapping (sleeping in a camp)													
Trapping (sleeping in village)													
Fishes													
Working on the farm													
Produces art works													
Working at a bar or store in the village													
Paid work													
Another activity (what?)													
Another activity (what?)													
Another activity (what?)													

APPENDIX 1: Questionnaire used in Equatorial Guinea (translated from Spanish).

Section C – Questions on the ease of capturing animals and the value of the catch
Instructions: We want to know which animals are easy and difficult to capture, and their value to the hunter. Use the cards of the animals and ask the hunter to put them in order depending on their ease of capture with traps and then shotgun, the value to the hunter and their abundance. Then there is a section for explanatory notes if necessary.

#	Animal	**Ease of capture with trap** (F=easy, D=difficult, MD= very difficult, N=never)	**Ease of capture with shotgun** (F=easy, D=difficult, MD= very difficult, N=never)	**Value of catch** (NQ= I don't want it, I=Indifferent, B=well?, 4=Very happy)	**Abundance** (MR= very rare, A=there are some, P=few, M=many)	Notes
1	Elephant					
2	Blue duiker					
3	White-bellied duiker					
4	Porqupine					
5	Giant pouched rat (emin's rat)					
6	Red River hog					
7	Buffalo					
8	Small pangolin					
9	Big pangolin					
10	Sitatunga					
11	Bushbuck					
12	Water chevrotain					
13	Black colobus					
14	Putty nosed monkey					
15	Chimpanzee					
16	Moustashed monkey					
17	Crowned monkey					
18	Mandrill					
19	Northern talapoin					
20	Yellow backed duiker					
21	Dwarf antelope					
22	African palm civet					
23	Genet					
24	Mongoose					
25	Leopard					
26	Crocodile					
27	Gorilla					
28	Marsh cane rat/grasscutter					
29	Golden cat					
30	Tortoise					

APPENDIX 1: Questionnaire used in Equatorial Guinea (translated from Spanish).

Do you live in Cherry Burton?	**How long have you lived in Cherry Burton?**
Postcode/Household:	**Does your house overlook fields?**
Where did you live before this?	**How long did you live there?**
Are you interested in birds?	**Have you ever been bird watching?**
Do you have a garden?	**Do you have a bird table or put food out for birds?**
How many times do you walk in the village in a typical week?	
Age:	**Questioner:**

1. **What do you think the three most common birds in Cherry Burton are?**

2. **What do you think the three most common birds in Cherry Burton were 20 years ago?**

3.

Species	**1**	**2**	**3**	**4**	**5**
1) Can you name these birds? (see visual aid 1)					
2) Have you ever seen these birds in Cherry Burton?					
3) When did you last see each bird in Cherry Burton? (visual aid 2)					
4) How regularly do you see these birds in Cherry Burton? (visual aid 2)					
5) Order of abundance, where 1 = most abundant					
6a) If you saw these birds flocking, which of these pictures best describes the size you would typically expect to see. (visual aid 3)					
6b) When did you last see a flock					

APPENDIX 2: Questionnaire used in England

this size? (visual aid 2)					
6c) How many times have you seen a flock this size in the time you've been in Cherry Burton? (visual aid 2)					
8) If you cast your mind back to the last time you saw this bird in a flock, what size was this flock using these categories? (visual aid 3)					
7a) Do you think there are more, less or the same numbers of each bird since you moved to Cherry Burton?					
7b) Can you pinpoint the start of any changes in numbers to any particular time period?					
8a) Are you concerned about the current population size or trend of any of these birds?					
8b) Why?					
9) Have you heard anything about these birds on TV, internet or radio?					

Any Comments?

APPENDIX 2: Questionnaire used in England

VISUAL AID 1

Male

Female

Species 1

Species 2

Species 3

Species 4

Species 5

VISUAL AID 2

1) When did you last see this in Cherry Burton?

Today	This week	This month	In the last three months	In the last six months	In the last Year	More than a year ago	Don’t know

2) How regularly do you see these birds?

Every day	Every week	Every month	Every three months	Every six months	Every Year	Less than every year	Don’t know

2) How regularly do you see a flock of this size?

Every day	Every week	Every month	Every three months	Every six months	Every Year	Less than every year	Don’t know

3) How many times do you think you’ve seen a flock this size?

1-5	6-10	11-20	21-50	51-100	101-500	501+	Don’t know

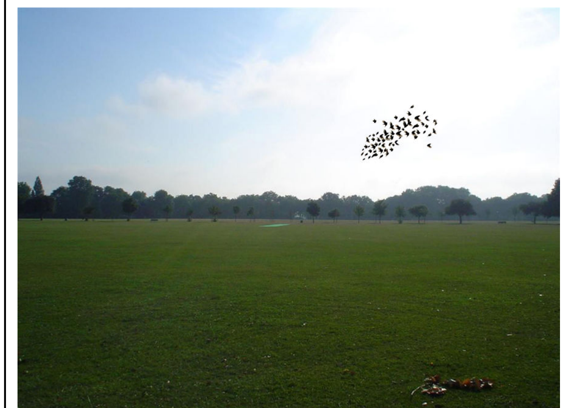
A. I haven't seen this bird in a flock

VISUAL AID 3

B

C

D



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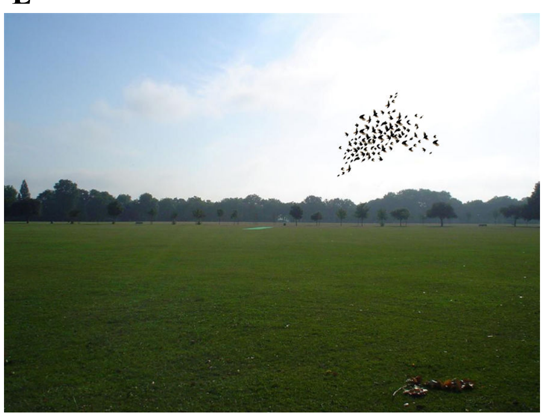

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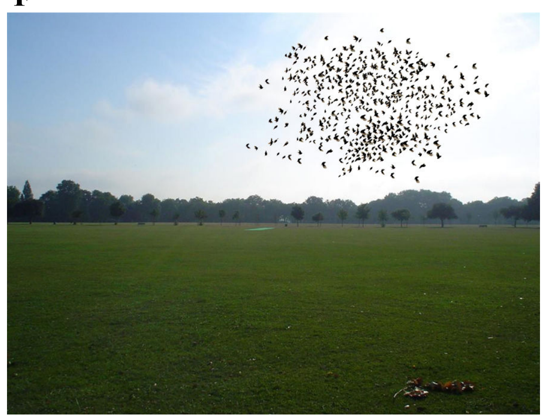

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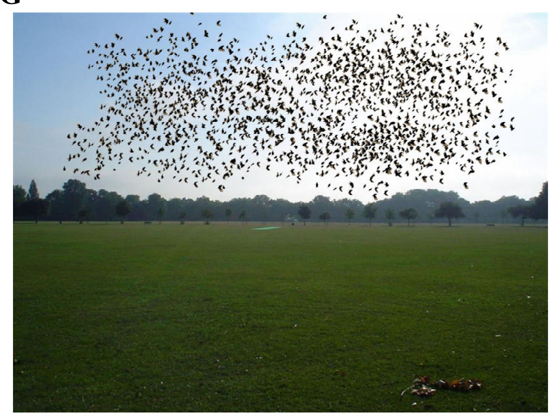

Age differences in interest level

Older respondents were more likely to feed birds and have been bird watching than younger respondents (Table 12). This may however be because they are older and so have had more opportunities to go bird watching.

Table 12: The relationship between age and interest levels in respondents questioned on bird populations

	Declared interest	**Feeding birds**	**Bird watching**
Analysis	Glm with binomial errors	Glm with quasibinomial errors	Glm with quasibinomial errors
	Z= 1.328	T = 2.098	T = 2.699
P value	0.184	0.041	0.0096
Value of b		0.039	0.053
Adjusted R^2		-0.905	-0.854

Age differences in observation of environment

Respondents were asked to state when they had last seen each bird, and how regularly they saw them (categories in appendix 2). Older respondents reported seeing all species more regularly, and more recently (Table 13)

Table 13: Spearman's rank tests for relationships between respondent age and how regularly they saw, and when they last saw, the focal species.

Bird species	When did you last see this species?		How regularly do you see this species?	
	Rho	P value	Rho	P value
Blue tit	-0.373	0.021	-0.560	<0.001
House martin	-0.358	0.034	-0.523	0.002
House sparrow	-0.622	0.002	-0.394	0.009
Starling	-0.377	0.018	-0.458	0.003
Wood pigeon	-0.319	0.032	-0.401	0.007

Age differences in information level

i) Naming birds

Respondents were given scores out of 5 for the accuracy of the names they give birds – 1 point was given for a correct answer, for example "house sparrow", and half a point for a partially correct answer, for example "sparrow", or "either a starling or a blackbird". The only variable which influenced the score of a respondent was whether they had been bird watching, with those who had having higher scores (lm, $F_{1,48} = 8.247$, adjusted $R^2 = 0.1288$, $p = 0.006$). This suggests that there is no cumulative knowledge about birds as respondents' age, but rather interest levels may determine knowledge.

ii) Prior knowledge

Respondents were asked whether they had heard anything about any of the 5 focal species.

Table 14: Minimum adequate models showing which explanatory variables are associated with reported prior information levels. All explanatory variables used in the maximal model are shown for each species, with significant results from the minimum adequate model highlighted using bold text

Explanatory variables	Blue tit	House martin	House sparrow	Starling	Wood pigeon
Age		p>0.05	**P=0.0713**	**P=0.00224**	p>0.05
Sex	p>0.05	p>0.05			
Year living in the village	**P=0.00538**	**P=0.01974**	p>0.05		**P=0.01190**
Fields	p>0.05				
Bird watching	p>0.05				p>0.05
Bird table	p>0.05	p>0.05	**P=0.00946**		
2 way interactions	p>0.05	p>0.05	p>0.05	p>0.05	p>0.05
Adjusted R2	0.644	-0.848	-0.643	-0.725	-0.786

Interestingly, for the 3 birds that are increasing in population size, those who have lived in the village longer are more likely to have heard something about the species. For both the decreasing species, the house sparrow and the starling, older respondents were more likely to have heard about the species. This may be because older respondents have had more time to hear about population change, and decreasing species are more widely commented upon. The only other variable that affected whether respondents had heard about a species was those who fed birds were more likely to have heard something about the house sparrow - possibly due to interest levels.