UNDERSTANDING THE HUMAN VALUE FOR LOCAL WILDLIFE AND HOW A CONNECTION WITH NATURE CAN CONTRIBUTE TO WELL-BEING

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ABSTRACT

The most popular way environmental economists have quantified the worth we hold for wildlife has been through calculating a value for conservation or preservation practices. These typically focus upon endangered or charismatic species, and to an existence or non-use value which somebody holds for the creature in question.

This thesis recognises that our value for wildlife may be more diverse than this. Indeed, it is highly feasible that people can derive an important yet cognitively disparate benefit from the animals and plants which they experience every day and which reside within close proximity to their homes.

Using a combination of inter-disciplinary theories and techniques, this doctorate seeks to explore how mankind receives 'nature connectivity' value from local wildlife. This work implies that by undertaking a 'warden-style' role when interacting with the flora and fauna which resides upon our doorsteps, humans can satisfy a separate and distinct aspect of their subjective well-being from that which they establish through classic conservation mechanisms. Furthermore, this satisfaction may act as a substitute for other local social activities which are dwindling in modern UK society, including the participation in community or religious groups.

The potential impact of these findings are that we may want to rethink the ways we approach the natural world if people are to maximise the participation in and welfare derived from their engagement with it. This includes attending to the behavioural and social infrastructure which can facilitate the opportunities for people to express and enjoy a connection with nature.

More generally, the conjectures made here indicate the importance of understanding not only if values exist for environmental entities, but comprehending when these will be dampened or elevated. Until this can be done successfully, environmental economists will forever be fighting a losing battle to retain natural resources at socially optimum thresholds.

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* * *

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SECTION 1

INTRODUCTION

Researchers have typically sought to value the environment for one of two reasons. On the one hand, a worth has been derived through a recognition that natural resources hold pecuniary value and can enable financial prosperity through their extraction or utilisation. In what many environmental economists now term ‘Payment for Ecosystem Services’ (PES), these quantifications recognise the economic benefit of ‘useable’ natural assets (Miller & Hobbs, 2002; Louv, 2008; Farmer et al, 2013; Gibbons et al, 2014; Clucas et al, 2014;). The alternative focus has been to value the environment with regards to its existence or conservation value, and has looked to establish the worth people attribute to the preservation or enhancement of rare, charismatic or aesthetic environmental features under circumstances where they will have little or no future contact with these (Loomis & White, 1996; White et al, 1997; Dunn et al, 2006; Morse-Jones et al, 2012). It must be appreciated that few environmental attributes sit at one extreme or the other, and existence and use values are indeed “seldom separable” (Jacobsen & Hanley, 2009 p.139). For example, recreational values hold characteristics attributable to both of these fields. Although these two schools might attend to different styles of environmental worth, a common theme is that the valuation attempts to reflect the benefits people gain from the natural world and its resources.

However, it is important to recognise that the prosperity which can be established through environmental retention or improvement can occur on a variety of levels. Indeed, it seems feasible that a small-scale interaction with the natural world could contribute as heavily to the individual and/or wider society to which they belong as large-scale action. A good example of this arises if we assess the benefits which humans can extract from their engagement with nature. This relationship takes a wide variety of forms and happens in an array of different situations. ‘Engagement with nature’ ranges from visiting farms and country parks (Perino et al, 2014) to the undertaking of safari holidays and zoological experiences (Navrud & Mungatana, 1994; Kontoleon & Swanson, 2003) to gardening and tending to the flora and fauna which reside upon our doorsteps (Rappe, 2005; Cameron et al, 2012). Even this variety of activities pertain to a narrow form of nature, namely wildlife, and the list is considerably expanded when we imagine the activities which individuals pursue that involve environmental landscapes, settings and ecosystems. Not only are these types of interaction vast, but there is ever increasing evidence to show how widely proliferated the channels of benefit are for mankind from immersing themselves within the environment. Indeed, connecting with the natural world has been described to have a plethora of advantages. Whilst some of these could involve pecuniary gains, for example farming and fruit harvesting, the spectrum of internal benefits which humans can extract from nature is also considerable. These range from improving our psychological well-being, our health and ability to recover and recuperate from stress, and physicality in the form of exercise and access to clean environments (De Vries et al, 2003).

Given the inference that natural assets are able to enhance our utility and therefore serve as an instrument to improve our happiness, environmental economists are presented with the challenge of finding ways to accurately quantify these benefits. Many natural resources "do not show up in market prices of financial returns" (Hanley et al, 2003 p.123), meaning the ascertainment of their worth becomes less easy. This in itself is not critical and in many circumstances it would actually be unnecessary or even illogical to derive an exact 'price' for an asset which give humans satisfaction. However, because economic prosperity can so often be achieved at the expense or sacrifice of environmental entities, it becomes clear that inventing sound methods to calculate this worth is essential if the natural world is to receive an appropriate and adequate weighting in the policy or decision-making processes which involve their potential destruction or degradation. A good analogy is that which ensures that those who prosper are not those who simply 'shout loudest'. In this case, we should not forsake or forget the benefits which the environment can bequeath to us simply because the quantification of these advantages are less visible than the market-based prices which GDP calculations can issue through the (*ex-post*) over-extraction or utilisation of natural capital.

The most common environmental valuation techniques fall into two main categories; revealed preference and stated preference methods. A comprehensive overview of these methods and early examples of each can be found in Carson et al (1996). The former involves measuring the direct monetary costs which are incurred by people through the actions they undertake to enjoy improvements in environmental goods and services. These can then be used as a lower bound in representing their willingness to pay for the good in question. Classic examples involve hedonic assessments, investigating how market prices adjust in the presence of none other than environmental improvement, travel cost measures, calculating the time and/or monetary impositions people endure so as to receive more of a particular natural asset and production function methods, assessing the contribution of an environmental amenity when it is used to create commodities. Stated preference techniques are a less subtle form of value derivation, and typically involve asking people for their values regarding an environmental entity under hypothetical circumstances. Given that policies are often looking to adjust the provision of the commodity, these studies typically seek to elicit people's marginal willingness to pay for an improvement in the resource, or their willingness to accept a level of compensation for its loss or reduction. Whilst an overview of the various techniques can be found in Bateman et al (2002), the two most famous forms of stated preference methods remain that of Contingent Valuation, which directly asks whether a given respondent would be prepared to pay or accept particular sums of money for environmental alterations, and choice experimentation, which instead present candidates with a range of possible options and asks them to indicate the one which they most prefer.

Whilst disagreement exists as to which set of methods produce the most reliable results in determining environmental value, it is generally appreciated that economists are more trusting of revealed preference studies. The reason for this is because these methods tend to involve the use of factual market data and are therefore devoid of biases which can occur when people are being asked to provide preferences in a hypothetical arena. In this sense, hedonic analyses and travel estimations are not susceptible to exaggeration or inflation because they are based upon events which have actually occurred. We therefore might expect the individual in question to be more greatly informed and rational as they make their choice to undertake these corresponding actions. Even if such rationality is to be believed, the range of environmental resources where valuations can be uncovered via revealed preferences are exhaustive, and many such entities exist where no handy economic instrument is present to neatly illustrate the extent to which society values it.

When these conditions arise, environmental economists and researchers must become more inventive and use a method of stated preference which can reliably predict the value of an asset, but at the same time do so through a means which retains credibility and realism in the mind of those being interviewed. This ensures that they issue honest answers from which monetary calculations of worth can be found.

Wildlife is a good example of an environmental asset where hedonic approaches are not always readily available as a tool to estimate human value. Whilst admissions to zoological parks and museums or donations to wildlife charities can issue a researcher with some direct monetary values for the species that these payments relate to, the animals which are encapsulated by this system of payment reflects only a small fraction of the total biodiversity which humans interact and extract benefit from. The consequence of this is that if one were to concentrate exclusively on this measure for ascertaining the value for 'wildlife', we would see a bias in favour of creatures either where conservation and preservation is needed, or towards the type of 'charismatic species' which Jacobsen et al (2008) refer to, where the public feel a particular affiliation towards and so to which environmental charities revolve their fund-raising campaigns around. Whilst studies have explored the valuation differences which may arise between creatures perceived as common versus those deemed rare (for example Christie et al, 2006), one consequence of this bias would be that too little attention is paid to 'everyday' species, or to key organisms within an endangered habitat which do not stimulate the interest of mankind due to their less striking or bold appearance and habits but without whom the whole ecosystem, including those classified as charismatic, would fail to exist.

This thesis will illustrate a range of ways in which we can show that humans not only hold a positive value for this type of 'overlooked' creature, but entertain the notion that this worth may actually satisfy a different element of human well-being than that which is ignited by the standard valuation methods mentioned above. The reason proposed for this is that payments for zoo admissions or donations to conservation charities typically refer more to preservation or existence values. Although we receive a level of contentment from contributing to these causes, there is often a distinct lack of opportunity to physically interact with the animals to whom this payment involves. Let us instead contrast this against the type of accentuated benefits one might receive from engaging with local or common wildlife. The natural world around us provides a direct use value, enabling us to care for the animals and plants on our doorstep in a role akin to that of a carer or 'warden'. This relationship, which we term our connectivity with nature, is more comparable to the utility-enhancement we can receive from our local community, family and other social groups (Dutcher et al, 2007; Diener & Biswas-Diener, 2008). It creates an opportunity for us to interact with a wider network and therefore deliver us a satisfaction from our belief that we form part of something bigger, issuing a stability and safety which we value highly. Moreover, our deployment as a warden within the local environment could mean that we can derive pleasure from a combination of the responsibility and purpose that this provides, alongside the repetition which comes with partaking in a routine interaction with everyday nature.

In the first of the three papers set out in this dissertation, we use choice experiments to elicit the value that people hold for garden birds. We focus upon this group of creatures for two main reasons. The first is that they are a good example of animals from which humans can potentially receive warden-type utility. Through actions such as dispensing bird food or erecting nest-boxes, there are clear opportunities for us to engage in a direct and repeated interaction with garden birds. Moreover, these species emit a sense of vulnerability which, through the action of feeding, can allow humans to fulfil the chance to act as a protector. The activity of feeding birds itself gives rise to our second major reason for concentrating upon these species. Given that bird feeding is an extensive social practice in the UK (our country of focus), this paper utilises a rather unique chance to explore the values people hold for local and common wildlife through the use of a payment vehicle which retains a strong credibility and degree of familiarity with participants of the study. Whilst the main survey was conducted through the stated preference format of choice experiments, this style of payment also gave an opportunity to test the findings via an external validity check. This mapped real seed purchase data to the inter-species values which had been elicited from respondents in the initial survey. The results of this paper provide evidence which suggest the idea of nature connectivity could exist, and potentially informs us of a new and distinct channel through which people can derive happiness from the natural world around them.

One intriguing aspect of this study was realising the interplay between the private enjoyment that people report to obtain from seeing birds feed in their private garden and their realisation that undertaking this act holds benefits for others. These 'others' might refer to birds and the survival of them and their species or one's neighbours through the public benefits which accrue from elevated wildlife populations in the local area. The logical question to ask from this is whether such private and competitive motivations (like that of attracting birds to *your* garden) might constitute a realistic catalyst to deliver an otherwise under-provided public good. As such, the second paper delves more deeply into the theoretical underpinnings of our value for local environmental amenities.

This second study builds upon the findings of the first paper by constructing a model motivated by the example of neighbours choosing to decide how much seed to dispense (which represents the effort they must employ) in order to attract wild birds to their garden. Consequently, this piece builds a world which describes how humans vie for an environmental impure public good. It thus seeks to compare how one's tendency to free-ride upon the contributions of others might adjust when the setting under which private use values are obtained hold competitive properties. Crucially, we combine these economic theories of public goods and contests with that of Ideal Free Distribution. This describes how, by employing Nash Equilibrium strategies, creatures adjust to changes in food concentration so as to maximise their survival chances. The model's corresponding analyses indicate that classic free-riding can be offset by the human desire to over-dissipate effort in light of a competitive atmosphere. The extent to which this offsetting creates an under- or over-exertion of effort relative to the first-best outcome is determined by the relative returns to scale which can be realised in response to seed placement. When applied to our motivating example of garden bird populations, this result is quite insightful and such scalar returns could represent the impact of reproductive success in a dynamic model. This may imply that people would exert a greater degree of effort when they feel that their role as a warden delivers visible benefits to the animal and/or its local population. Equally, returns to scale might suggest that the *type* of bird and their associated feeding habits are a critical component in determining the subsequent value which humans place upon them.

Through our analyses in both the first and second papers, we use an example, bird feeding, where warden tendencies constitute an action which by and large complements wider environmental objectives. In this case, the 'carer' satisfies their personal desire to view birds thriving in their garden by dispensing bird feed or erecting bird boxes. These same actions also enable the avian populations to be sustained and hence mitigate against other human processes which are detrimental to the species' numbers (for example brownfield urban construction). Within environmental economics, this vital role of personal action and behavioural motivation is not exclusive to wildlife interaction. For example, the cognitively-fuelled stimuli to recycle or act in a 'green' way not only satisfy the individual through social, financial and/or moral ways, but also help achieve wider environmental efforts to prevent costly damage to the natural world. However, there are circumstances where nature connectivity does not so neatly coincide with such broader aims. The third paper, which explores the human attitude to culling, defines an intriguing example where warden-type emotions might actually present a barrier to achieving other desirable environmental objectives.

This final paper of the thesis returns to choice experimentation. In this case, we ask people to indicate their preferences over deer population control when told this is necessary in order to provide high quality and sustainable woodland in the UK. Whilst revolving around a completely different set of creatures, this paper still focusses upon establishing our value for wildlife which resides within close proximity to us. By conducting the choice experiment under these conditions, we can test how respondents 'construct their preferences' regarding the management of an environmental habitat in the knowledge that culling and other forms of population control typically evoke strong emotional and ethical responses. The term 'preference construction' is regularly used in economics, yet here the term is of particular interest because this study wanted to investigate whether people have pre-defined or 'sacred' views regarding ethical topics. This would imply that in fact their choices are not produced through some form of learning or education. By contrast, it seems quite plausible that for topics such as those in environmental economics where people's understanding is based on partial or uncertain foundations, they could quite conceivably 'build' upon their stance for issues such as culling and therefore construct a set of preferences as new information is presented to and processed by them.

The prior belief here was that individuals would care much more about the procedure by which deer numbers were going to be reduced to as opposed to their choices being driven by either population reduction or habitat quality outcomes *per se*. As such, two alternative theories were tested alongside rational choice theory as a means to assess which would most closely resemble the stated choice preferences from our sampled population. These two rival theories were intentions-based reasoning, aligned with hypotheses of procedural fairness in behavioural economics, and the philosophically-founded Doctrine of Double Effect. Whilst little evidence was found to support the latter of these, the study does suggest that including behavioural elements such as intention can improve our understanding of how individuals make decisions. This being said, no one theory could successfully explain the elicited preferences of our sample. One of the most logical explanations for this returns to our belief that humans feel a warden-style sense of obligation to protect creatures in their local environment. In this setting, participants become highly preoccupied by the *way* in which an individual deer's welfare is impacted upon. This would lead to them prioritising how 'kind' the method by which deer die seems above the well-intended long term environmental objectives which their death would allow. If such reasoning is true, this would suggest that a failure to assemble or convey a policy thoughtfully will create public opposition to animal control regimes which could form a major obstacle for sustainable woodland management.

This work takes tentative first steps to show how 'everyday wildlife' can provide people with a real and tangible level of well-being. The contribution and impact of these studies transfer nicely into the policy arena, where recognising and embracing this new school of thought could prove highly beneficial for relevant decision-makers. If the conjectures presented here prove robust, authoritative bodies should respond by giving the nature which resides at our doorsteps a sufficient and appropriate weighting within any proposal where the interconnectivity between human communities and their local environment are projected to be impacted upon.

SECTION 2:

A COMMON BIRD IN YOUR GARDEN IS WORTH TWO RARE ONES IN THE WOODS:

CONSUMPTION AND ENGAGEMENT VALUES OF LOCAL WILDLIFE

2.1: INTRODUCTION

Engagement with the natural environmental holds the potential to substantially enhance human well-being in numerous ways. Many of these benefits depend on active exposure to if not direct interaction with the natural environment. This study focuses on this 'intimacy' and concentrates on the values associated with our engagement with 'backyard wildlife' in the form of common garden birds. This is in contrast to valuation studies which instead focus on rare or endangered species or sites with special characteristics. Not only eliciting the values people held for different species, this study also includes attributes which attempt to disentangle elements of use and existence value and their associated weight in motivating an individual to engage with nature, an aspect which may significantly differ when people consider an interaction with local as opposed to endangered species of wildlife. Capturing these values explore some of the intricacies of the human relationship with nature, and a major motivation for this research is to gain an understanding not just of whether valuation occurs *per se*, but also *why* it might exist and differ, both across species and between individuals.

Engagement with the natural world exhibits many of the qualities identified as beneficial to lasting life satisfaction within the literature on Subjective Wellbeing (SWB). Many studies within the literature have cited the 'interconnectedness' one receives from building a relationship with their local environment as a crucial component to achieve this (Miller & Hobbs, 2002; Dunn et al, 2006) and this attribute is common to many SWB enhancing actions, including involvement with religion (Frey & Stutzer, 2010), community (Dutcher et al, 2007) and wider society. Furthermore, the repetition associated with 'everyday wildlife' interactions potentially induce positive feelings of responsibility (Rappe, 2005; Jacobssen et al, 2008), routine (Diener & Biswas-Diener, 2008) and achievement of success under uncertainty (Dolan et al, 2008). Exploring our behavioural motivations for interacting with the natural world serves to help assess how 'nature connectivity' (Dutcher et al, 2007) might contribute physically, emotionally and/or psychologically towards our wellbeing (Cameron et al, 2012). Other studies have suggested local nature can have economic and social benefits. These include increased property prices (Farmer et al, 2013) or the preservation of landscapes for future generations (Miller & Hobbs, 2002). The implications of this work may be of substantial interest in areas such as planning policy. The current UK procedure prioritises 'brownfield' and urban in-fill development ahead of that on 'greenfield' or rural sites, yet such a stance might be inefficient if people value 'backyard and everyday' wildlife more heavily than that which is endangered or located in habitats further afield. Capturing this local worth would complement existing work which investigates the values of English nature (Gibbons et al, 2014), UK domestic gardens (Cameron et al, 2012) and Urban Greenspace (Perino et al, 2014).

This study also holds the potential to generate findings that are applicable to other areas in economics. One of the greatest puzzles for behavioural economists is to understand our human desire to contribute to public goods. This often defies standard 'rationality' because, by contributing to a common cause, individuals choose a strategy which seemingly fails to maximise their private utility. One suggested explanation proposes that individuals make a contribution when the good is 'impure'. By this, it is proposed that through the act of contributing people can derive a private benefit. This could take many forms, including material or monetary advantage, adhering to a social norm, through perceived reciprocity or via psychological means such as 'warm-glow' altruism. Although an intense research field, surprisingly few impure public goods studies are applied to an environmental setting, although Kotchen (2005; 2009) does provide two papers in this area. Feeding garden birds is an environmental action which can be readily described through an impure public good structure. It contains a privately attainable benefit, namely the enjoyment from feeding and viewing birds, and a public goods externality, directed either towards the neighbourhood through the raised bird populations it creates (and thus to those neighbours who value the presence of garden birds) or through inter-species altruism

(Andreoni, 1989; 1990). We include attributes of nutritional value of the seed, visibility of the birds fed and donation opportunities for endangered species in order to separate these various influences and thus investigate the reasoning underlying a person's decision to feed birds. Furthermore, by studying these facets, we may begin to establish how the private and public aspects of utility interact. For example, whilst people may willingly contribute to a public good through feeding birds, there may remain a need to retain some private benefits in doing so. The notion of 'nature connectivity' described above, and the way we extract utility from such engagement may be inherent to this.

A range of both revealed and stated preference techniques have been used to elicit both general wildlife and individual species' valuations. Examples include the estimated worth of US mega-fauna (Loomis & White, 1996), the role of flagship or keystone species in Africa (Navrud & Mungatana, 1994; Morse-Jones et al, 2012), Asia (Kontoleon & Swanson, 2003) and Europe (White et al, 1997) and the importance of familiarity in establishing valuation for species (Christie et al, 2006; Dunn et al, 2006; Jacobsen et al, 2008).

Many of the aforementioned studies use a choice modelling format and demonstrate the ability of this methodology to extract the human worth for individual or groups of species. Yet, a recurring obstacle persists when trying to calculate such value. A crucial component when extracting monetary quantifications from choice experimentation is to include a credible payment vehicle. Akin to many environmental entities, wildlife can rarely be presented as a marketed good and it can be difficult to find a realistic and credible payment mechanism. Many studies are able to overcome this problem by using either charitable donations or taxation as the method by which respondents should assume they pay.

Whilst the adoption of choice experiments to species valuation has been fairly prevalent over the past decade, a major impact of this constraint is the inability for researchers to elicit the value of the many species where credible payment mechanisms are scarce. By using bird seeds that differ in their ability to attract wild birds to people's gardens, we believe that this paper exploits a unique and intuitive payment vehicle to elicit valuation for 'everyday wildlife'. Clucas et al (2014) have recently published the results of a study with a very similar focus to ours. As with our research, they use the responses from the public to elicit the value people hold for native urban songbirds. However, we note a number of differences regarding both the methodology and aims between our paper and theirs. Regarding results, their study seeks to compare two species of garden bird in order to derive an estimation of the aggregated benefits local songbirds may provide society. By contrast, our study wishes to discover how values differ between species of garden bird and suggest why this might be so. Furthermore, we use a hedonic approach which explores actual purchase decisions using a secondary dataset from a seed wholesaler. In the Clucas study, stated responses from the sample are used in order to calculate revealed values. Whilst these clear differences appear between the papers, we are encouraged that such studies exist, strengthening our belief that uncovering our worth for local nature holds a clear and necessary function.

The flexibility contained within choice modelling is highly beneficial for researchers. Firstly, it permits the testing of multiple research questions simultaneously. For us, we can use nutritional, donation and avian attributes to extract the value respondents attach to motivations of pure altruism, philanthropy and self-interest, alongside that of species diversity. Secondly, the repetitive nature of choice experimentation assures respondents of multiple opportunities to indicate their true preferences. Compared to a 'one-shot' valuation study, some instances of ethical objection can be removed because the researcher offers each respondent multiple opportunities and settings from which they can express their environmental preference. With this particular choice experiment, we are afforded the chance to test these hypothetical responses by comparing the valuations we derive here with those established from the analysis of bird seed sales data. This enables us to conduct an external validity check on our results which (broadly) confirm the findings of the DCM.

The remainder of the paper is structured as follows. Section 2.2 outlines the survey itself, before Section 2.3 describes the corresponding attributes in greater depth. Section 2.4 presents the model and associated econometric procedure. Section 2.5 presents the results and explores socio-demographic variation within our findings. Section 2.6 discusses these findings, whilst Section 2.7 contains a revealed preferences external validity test to complement the work contained here. Section 2.8 concludes and suggests some directions for future research.

2.2: THE SURVEY

The Survey Structure

The survey contained three sections; the choice modelling exercise, an ornithological quiz testing each respondent's avian knowledge and a questionnaire to collect socio-demographic information and to elicit respondents' attitudes to bird-feeding.

An 'efficient' choice model seeks to "maximise the amount of information… to identify the estimates of vector β" (Scarpa & Rose, 2008, p.257), where "β" measures and weights the characteristics which a person values in their utility function. When designing a choice experiment of this nature, consideration must be given to ensure that a survey holds both 'statistical' and 'behavioural' efficiency (Scarpa & Rose, 2008). For the former, achieving pure statistical efficiency had to be partially compromised in our model because of the constraints which ornithological habit presented regarding credibility and realism. Such instances, such as Robin territoriality, are described in more detail through Section 2.3. Despite these complicating factors, several possible designs were devised through a 'column-based' structure, achieving an orthogonal and fully balanced choice exercise.

Once these designs had been produced, each were tested in Microsoft Excel. Here, we follow recommendations from the literature (see Scarpa & Rose, 2008 p.265-266) and apply a utility function which estimated attribute values under *a priori* beliefs on their relative worth. These 'simulated responses' were then run through a conditional logit model, the purpose of which was to test and compare how well each of our designs could replicate the assumed utility function by providing robust coefficients and valuations.

The two strongest of these designs were then presented to independent focus groups, providing a pilot test that could examine the second element of successful design – behavioural efficiency. Here, all aspects of the survey were combined in order to assess the duration and ease with which respondents could complete the task. 'Respondent Efficiency' also required an assessment of how often clarity was sought and, following existing literature, considering whether any 'unrealistic' cases arose which may confuse or perplex members of the focus group (Scarp & Rose, 2008; Colombo et al, 2013). Whilst neither survey seemed to create any major instances of uncertainty, the chosen design was selected based upon a slightly faster and more positive response from its pilot group.

1. The Choice Experiment

Constituting the main part of the survey, this section offered each respondent 16 bird-feeding 'cases'. Shown in Figure 2.1, each such case presented two bird food alternatives and a constant baseline not to feed. Presenting three-alternative sets in this way is believed to improve model robustness (Bennett & Rolfe, 2009) and because people were asked to express both their first and second preferences, a complete ranking was established for every choice set.

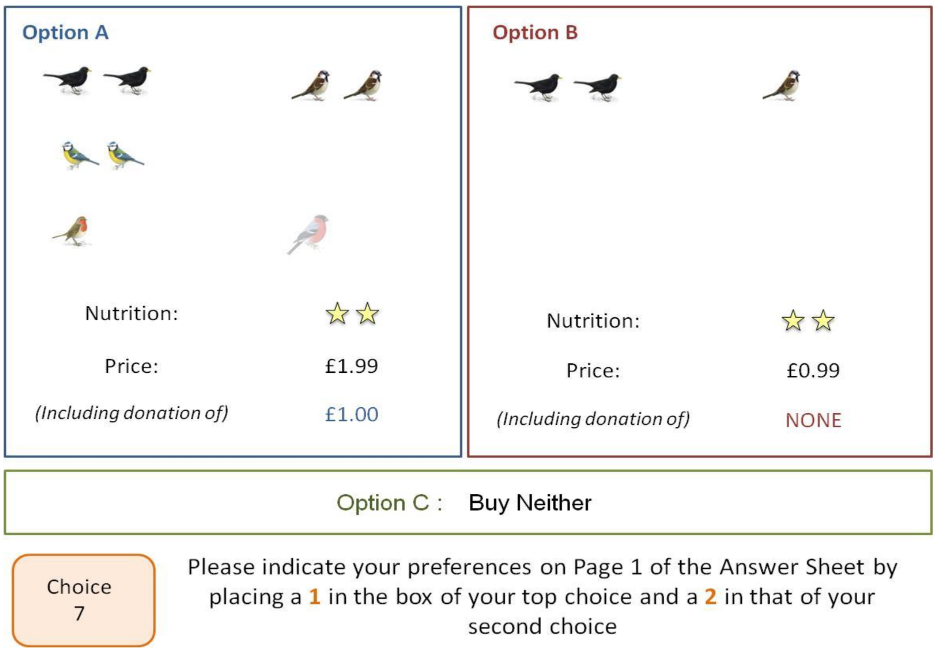

Figure 2.1: A Sample Choice Set

A description of the baseline (shown in Figure 2.2) was given at the instructions stage, and a copy was available on each respondent's desk for them to review if necessary. The Baseline always showed one blackbird and one sparrow, and for simplicity a feeding alternative never issued these species at a lesser frequency than occurred in this no-feeding scenario.

Figure 2.2: The Baseline Option

Whilst answer sheets were paper-based, the instructions and survey were presented on computer screens. A researcher read the tutorial-style instructions aloud to subjects in order to overcome any issues of illiteracy or ambiguity. A laminated copy of the tutorial was also available on a respondent's desk for later reference if required.

2. The Ornithological Quiz

This tested each respondent's knowledge of garden birds. It was a short exercise where the six bird species were labelled A-F. Given in Appendix 2.3, participants were asked to try and match the letters to the correct bird names from a list of 16 possible options.[1] The identification quiz sought to test whether any relationship existed between knowledge and valuation. Previous studies (Metrick & Weitzman, 1994; Lundhede et al, 2014) have proposed that knowledge is a key determinant of value, although for 'everyday wildlife' this assertion is less obvious given that here people have first-hand experiences with the species. It is worth noting at this stage that a respondent's knowledge of bird names may

[1] Although actually asking respondents to write the birds' names would have overcome any confounding issues of blindly guessing, the chosen format did not unnecessarily extend the survey completion time, and also avoided any ambiguity from misspelling or illegible answers.

not necessarily align to their level of experience. Indeed, it is quite plausible that the role of 'recognition' is more crucial here, as individuals can interact with and experience local wildlife without having any environmental or scientific knowledge of the creatures themselves (Czajkowski & Hanley, 2009).

3. Socio-demographic and Behavioural Questionnaire

Contained in Appendix 2.4, this comprised a standard tick-box survey to discover both people's attitudes to bird-feeding and socio-demographic data. The behavioural section enquired as to the type and regularity of feeding individuals undertook, and whether they contributed to environmental charities. Understanding why people engage in bird feeding is crucial to exploring the exact relationship which is established through nature connectivity (Jones, 2011) and so this section also enquired about an individual's bird-feeding motivation. This asked them to rate a range of plausible reasons for engaging in the action on a 1 - 5 Likert scale. Socio-demographic questioning established each respondent's gender, age and post-tax household income. Individuals were assured this data would remain both anonymous and complicit with data protection laws.

Conduct and Execution of the Survey

The optimal number of cases to present participants with is widely debated and considerably different stances exist within the field (Swait & Adamowicz, 1997; Adamowicz et al, 1998; Brazall & Louviere, 1998; Scheufele & Bennett, 2012). This survey issued respondents with 16 choices. Whilst at the upper bound of the recommended range, the familiarity that participants hold with the topic suggests a dampened effect of such cognitive burden. The experiment was also praised by focus groups as being simple and easy to follow, and such an interface-friendly dimension is another factor which can enable more cases to be presented in a given survey (Colombo et al, 2013).

Through a combination of the voluntary nature of survey completion and the desire to have a sample experienced in both household budgeting and outdoor activities, it is appreciated that the valuations that would be derived from the survey could not be used to fully represent those of the entire East Anglian or indeed UK population. Surveys were conducted at a Norwich garden centre in mid-July 2012. In this location, it was reasonable to assume the sample base would hold an interest in garden-related issues and therefore were well positioned to partake in the experiment. To ensure that any potential respondent felt they could decline participation, a garden centre location also formed a sensible non-obligatory environment in which to conduct the survey. Whilst conducting surveys in multiple locations or indeed multiple garden centres may have increased the ability to extend the transferability of WTP values, it was felt that conducting the survey through this format would allow for the most efficient use of research funds and time.

2.3: THE ATTRIBUTES

The Bird Species

Figure 2.3 displays the six bird types which were selected. Selection was based upon the 2012 RSPB's Big Garden Bird Watch (BGBW) Survey. This is the largest wildlife data collection scheme in the UK based on public participation. Annually, it invites the public to log both the diversity and frequency of bird species witnessed in their gardens for one hour over a pre-determined weekend in January. Our survey was conducted in the city of Norwich, and data from its associated county (Norfolk) could be isolated from the main RSPB database thanks to the survey's geographical species mapping.

"Rank" relates to frequency estimations as calculated by the BGBW data collection, with five species achieving a rank associated with the most common Norfolk garden birds in 2012. Respondents were expected to be familiar with these species and, if interested, could potentially watch and interact with these regularly. By contrast, the bullfinch ranked a lowly 32^{nd}. Norfolk residents were about sixty (twenty-three) times more likely to encounter blackbirds (robins) in their gardens than bullfinches. This disparity was deliberately used to test if a characteristic of rarity induced a heightened valuation, as has been supposed by other stated preference studies (Hanley et al, 1998b).

Figure 2.3: The Bird Species and their Rank based on Observed Occurrences in Norfolk Gardens (RSPB 2012).

Aesthetic judgements were another dimension used to try and discover the worth respondents held for the birds, and whether a species is visually pleasing is another previously supposed indicator for valuation enhancement (Metrik & Weitzman, 1994). The three birds on the right-hand side of Figure 2.3 possess a greater degree of vibrancy in their plumage, which we use as a proxy for more aesthetically pleasing options. Woodpigeons are widely perceived as a pest species among gardening and agricultural communities, and so it seemed worthwhile to include this 'undesirable' bird.

In line with recommendations from the literature (Kontoleon & Swanson, 2003; Bateman et al, 2009), alternatives were displayed through visual images. Using coloured pictures of the birds gave each choice set a more realistic ambience, facilitating participants to visualise these bundles in their own gardens. Furthermore, the use of imagery did not exclude or restrict participants whose lesser knowledge would otherwise have inhibited an ability to express well-informed preferences. Overall, an image-based design was seen to broaden the experiment's accessibility.

Figure 2.4 describes how bird numbers were represented in the experiment (Appendix 2.2 gives full experimental instructions). Another ornithological consideration was to ensure that choices only showed birds at levels concurrent with their social behaviour. For instance, robins are highly territorial and so constructing a choice set which included more than a single bird might have been seen as contradictory to this element of their behaviour.

Rating	Description
	This species will not come to your garden
	Expect **1** bird of this species to come to your garden
	Expect an average of between **2 and 5** birds of this species to come to your garden

Figure 2.4: Bird Frequencies and their Visual Representation in the Experiment.

The survey was also designed to investigate the extent to which people's values were derived from *watching* birds feed. To achieve this, individuals were told that sometimes birds may be fed but not seen. This deprives them of the personal visual benefits accrued through bird-feeding, which may constitute a sizeable portion of their private incentive to engage in the practice. However, such a description conveys that birds still benefit from their action. Another possible explanation is that feeding these birds still enables other parties, such as neighbours, to benefit from the increased bird populations drawn to the vicinity. Thus, this characteristic could assess if somebody contributes to bird-feeding through impure public goods motivation. Here they would be expressing value for their aiding of wildlife and/or the wider community even if they receive little or no private utility.

There was an added importance in including this variable. It can be directly compared to more traditional existence values that people hold for more remote environmental assets, as described through the 'donation' attribute. This contrast is potentially quite insightful, and may feed back into our notion that an existence value is accentuated when people feel a greater connection or obligation to creatures living in close proximity to them. Of course, use values are not always distinct and separable from existence values and the way in which these may enter an individual's utility function may in reality be far more complex than described here. However, the inclusion of this attribute does allow us to grasp some concept of the relative weight which a direct use values holds in a person's decision to feed.

Figure 2.5: Instructions Regarding Visibility and Local Existence Value

Instructions stated that the presence of a 'faded' bird implied a "feed but not see" situation. Figure 2.5 reinforced this message, highlighting the difference between images in full and faded colour. For simplicity, we restricted the number of birds subjected to this treatment to just two: - woodpigeon and bullfinch. These display starkly different characteristics, the former a common, pest and plain species with the latter possessing *a priori* positive qualities of colourfulness and rarity.

Nutrition

The role of our nutrition attribute was to discover whether respondents were willing to spend money on a characteristic of the seed for which they would not appear to be the primary beneficiaries. To explore the relationship between humans and nature, the construction of such an attribute, suggestive of inter-species altruistic behaviour, seemed pertinent[2].

Each alternative contained a 'nutritional star rating', ranging from basic nutrition (one star) up to very nutritious (three star) levels. A positive coefficient on high ratings implies, *ceteris paribus*, a willingness to purchase nutritious seeds without witnessing

[2]Classic economic literature on altruism identifies a range of plausible motivations, including reciprocity (Sugden, 1982), moral satisfaction (Kahnemann & Knetch, 1992) and warm glow (Andreoni, 1989; Andreoni, 1990). However, the extent to which we can identify an act as 'purely altruistic' (Hardin, 1977) is, psychologically, indeterminable. This is because even if your intended action is to aid another, there is no guarantee that, even inadvertently, you do not simultaneously assume increments in your own utility. This psychological debate regarding pure altruism is not within this paper's focus, yet remains an important consideration whenever the term 'altruism' is used.

greater volumes of birdlife. Put another way, the private gains from seeing the birds remain unchanged, meaning a willingness-to-pay for seed with a higher nutritional value must be driven by alternative motivations. This could be an altruistic gesture aimed at the avian wildlife, or could raise one's private utility through other means, be it public goods contribution or caring attitudes.

It seems important to highlight the individual contribution of this attribute above that for our 'feed but not see' birds. One additional use is that people are much more familiar with nutritional quality as a credible measure of regarding product differentiation, and high quality seed is an aspect which is highly marketed. For our purposes, another important distinction is that whilst for the faded birds respondents have the opportunity to discriminate in their decision of which birds to feed, a seed which is 'high quality' will be nourishing to any of the birds which are shown to feed on a choice option, regardless of whether people value all of these birds equally, or indeed at all.

Price and Donations

Including a cost attribute is essential for any stated preference study. It allows for a trade-off between desirable attributes and the consumption of other goods, thereby enabling the computation of willingness-to-pay measures (Colombo et al, 2013). As previously mentioned, many wildlife valuation studies have done this through expressing payment via donations or a tax levy.

These forms of payment vehicle are perfectly sensible to apply within environmental settings, and can often lead to respondents taking on a more social perspective when deriving value (Jacobsen & Hanley, 2009) or, in the right setting, enable more honest answers to be elicited (Vossler et al, 2012). However, two potential drawbacks can occur using these standard measures. The first involves the constraints placed on the types of wildlife which can be credibly valued through either taxation or donation systems. Because a researcher needs to defend why the levy or donation used is required to respondents, wildlife valuation studies tend to concentrate upon species which are perceived to require conservation or preservation. Be it on local, regional, national or international scales, this is generally recognised as one of the more justifiable reasons for a government to intervene via a taxation system or for a charitable organisation to actively seek donations.

Secondly, taxation holds the potential to impact detrimentally on participants' responses. For some, the mandatory nature of taxation causes a disassociation from the research topic (Rosen & Small; 1979), whilst for others the complexity of the taxation system prevents them from appropriately estimating the budgetary implications of their decisions. Other issues may arise concerning respondents who feel their existing taxation is already too high, or those who have concerns over the distribution of tax contributors. This being said, the use of taxation as a cost parameter is both a perfectly legitimate and widely applied tool in non-market valuation, and many of the concerns detailed above can be offset by ensuring that survey design, instruction and testing is thorough.

Nevertheless, by using bird seed as a payment vehicle, this study is able to simply express cost in terms of the market price which must be paid to acquire a given bag of bird food. In line with current market products, typical prices in the experiment ranged from £0.99 to £4.49 per one kilogram bag. Prices were spread across this spectrum in £0.50 increments.

The final characteristic was the donation. Respondents were informed that sometimes the price of an alternative included a contribution to a wildlife charity. This would seek to restore wetland habitats in East Anglia, the region where the experiment was conducted. The endeavour of such work would be to raise bittern populations. This species was chosen for its regional recognition as a flagship species for conservation and tourism. Furthermore, individuals were reminded that the bittern is a rare and elusive species, meaning that their contribution would be unlikely to reward them with a greater chance of actually *seeing* bitterns in future years.

This attribute aimed to gauge whether respondents possessed a more stereotypical existence value. Furthermore, this offered the opportunity to compare and contrast this form of non-use value with the local one, given by Figure 2.5. This could provide an assessment of the priorities people hold for wildlife and create first thoughts on how this might resonate with policy areas such as planning and conservation.

2.4: THE MODEL

Based on Lancaster's Characteristics Approach (Lancaster, 1966), discrete choice experiments assume that a good's value can be established through its constitutive attributes. The value of each characteristic is assumed to be independent of how they are collectively bundled. In our case, the 'attributes' are the species and number of birds attracted by a particular bird seed, whether the birds fed are observed by the person feeding, the seed's nutritional value, the price of the seed and donations made to the conservation of a regionally occurring endangered bird species.

Variable	Description
$\mathbf{Blackbird^{mult}}$	With all other attributes remaining constant, this is the probability change in choosing an option because the 'two blackbirds' picture appears instead of the baseline one blackbird scenario. The associated valuation is weighted on the assumption there is an equal chance that 2, 3, 4 or 5 birds are seen instead of the one.
Bullfinch	With all other attributes remaining constant, this is the probability change in a respondent choosing an option because one Bullfinch appears on the choice alternative.
$\mathbf{Bullfinch^{(e)+}}$	With all other attributes remaining constant, this is the probability change in choosing an option because one Bullfinch appears on the choice alternative, yet this appears in a faded version to reflect the fact that this bird is fed but not seen by the feeder.
Robin	Holding all other attributes constant, this is the probability change in a respondent choosing an option because one Robin appears on the choice alternative.
$\mathbf{Sparrow^{mult}}$	With all other attributes remaining constant, this is the probability change in a respondent choosing an option because the 'two sparrows' picture appears instead of the baseline one bird scenario. The associated valuation is weighted on the assumption there is an equal chance that 2, 3, 4 or 5 birds are seen instead of the one.
Tit	With all other attributes remaining constant, this is the probability change in a respondent choosing an option because one Blue Tit appears on the choice alternative.
$\mathbf{Tit^{mult}}$	With all other attributes remaining constant, this is the probability change in a respondent choosing an option because the 'two blue tits' picture appears. The associated valuation subtracts the probability associated with 'Tit' from this number, and then is weighted on the assumption there is an equal chance that 2, 3, 4 or 5 birds are seen instead of the one.
Woodpigeon	With all other attributes remaining constant, this is the probability change in a respondent choosing an option because one Woodpigeon appears on the choice alternative.
$\mathbf{Woodpigeon^{(e)+}}$	With all other attributes remaining constant, this is the probability change in a respondent choosing an option because one Woodpigeon appears on the choice alternative, yet this appears in a faded version to reflect the fact that this bird is fed but not seen by the feeder.
Nutrition	With all other attributes remaining constant, this is the probability change in a respondent choosing an option because that option has a one-star more nutritious rating.
Donation	With all other attributes remaining constant, this is the probability change in a respondent choosing an option because the donation associated with that bag of feed has increased by one penny (£0.01).
Nutnum	With all other attributes remaining constant, this is the probability change in a respondent chooses more nutritious seed given that the number of birds benefitting from that feed is changing.
Price	With all other attributes remaining constant, this is the probability change in a respondent choosing an option because the cost of obtaining that bad of bird seed has risen by one penny (£0.01).

Table 2.1: A Description of the Coefficients

Characteristics were presented across alternatives in a way which ensured choice-set orthogonality. Table 2.1 confirms that many bird species did not appear in the choice experiment at all of the frequency levels stated in Figure 2.4. Because of their presence in the Baseline option of not feeding, the coefficients for sparrows and blackbirds only enter the regression at the highest ('two bird') tier. Variable 'Nutnum' involves an interaction term, multiplying the nutritional content of an alternative by the number of birds which would be seen. This is estimated using the frequency key of Figure 2.4. Whilst other interaction terms were examined through the analysis stage, many failed to register any statistical significance within the model and so were omitted from the final regression.

The Empirical Model

The data is analysed using a conditional logit model[3]. Algebraically, this means that the utility person n derives from alternative j is assumed to take the form characterised by (1.1).

$$U_{nj} = \beta_n' x_{nj} + \varepsilon_{nj} \qquad (1.1)$$

Here, x_{nj} constitutes the variables which are observed by a participant for any given choice option and which are pre-determined by the researcher through the survey's design. β_n then relates this to the person n's personal preferences over the attributes at these particular levels. These models apply a Gumbel distribution to the random element of people's utility (ε_{nj}), which is deemed appropriate when included, as above, as an additive element to the utility function (McFadden, 1974; Louviere et al, 2000; Hoyos, 2010). Consequently, it is possible to establish the projected probability change for a participant's selection of a given alternative i based upon the rule that person n will only select option i if that derives them the greatest utility relative to any other option (j) available to them in a given and fixed choice set. The formula demonstrating this is shown below:

$$Prob\ (ni) = \int \left(\frac{exp^{\beta' x_{ni}}}{\sum_j exp^{\beta' x_{nj}}} \right) \qquad (1.2)$$

[3] Our econometric specification does not deviate from that which is used widely in the literature, yet much of the notation and descriptions are adapted from Train (2009).

Attribute coefficients thus represent the respondent's change in probability for choosing an option if, *ceteris paribus*, there is a unit change in that attribute's level when described as a discrete variable, or through its presence relative to a base case for dummy (0-1) coded attributes (Bennett & Blamey, 2001). The coefficient on price (β_{price}) represents the marginal utility of income, which for such environmental commodities is assumed to remain constant and negative (Hanley et al, 1998a). Determining an attribute's marginal valuation then involves taking a ratio of its coefficient against that of price (Hoyos, 2010).

$$WTP_x = \frac{-\beta_x}{\beta_{price}} \quad (3)$$

Participants were asked to state both their top and second preferences, essentially creating a ranking of the three alternatives for each choice set. Our econometric specification is able to appreciate that each individual is making multiple choices and therefore can identify any participant-specific patterns in decision-making. Our regression does just this, grouping responses by choice set whilst clustering these over individuals.

2.5: RESULTS

200 questionnaires were completed and subsequently prepared for statistical analyses. A paper-based survey did not restrict our sample to those with computer literacy. Furthermore, a face-to-face format also enabled participants to engage orally with the researcher with respect to the topic. A response rate of approximately 50% exceeds the average for either electronic (Cook et al, 2000) or traditional (Heberlein & Baumgartner, 1978) surveys, and stated reasons for decline typically related to time constraints as opposed to miscomprehension or subject disengagement. Whilst uptake was roughly consistent across genders, 119 (59.5%) of respondents were female.

The survey location was selected so as to capture those both responsible for a garden area and typically in charge of household budgeting. Consequently, much of the UK's younger demographic, such as students or financially dependent adults, were not prime survey candidates. Table 2.2 decomposes our sample's age profile, and compares this to Norfolk population data as derived from the 2011 Census (www.norfolkinsight.org.uk). We reject the null hypothesis that our sample holds the same age distribution as the regional population and witness a significant difference between these two groups (z = 4.015, $p(z)$ = 0.0001). This occurs predominantly through an under-representation of those from lower age brackets (particularly those aged 26-45) and an excessive number of respondents aged above 56 (more than 60%).

Age Bracket	Sample Population (%)	Norfolk Representation (%)
18-25 years	11/200 (5.5%)	52/681 (7.6%)
26-35 years	15/200 (7.5%)	96/681 (14.1%)
36-45 years	11/200 (5.5%)	105/681 (15.4%)
46-55 years	42/200 (21%)	118/681 (17.3%)
56-65 years	46/200 (23%)	114/681 (16.7%)
Over 65 years	75/200 (37.5%)	196/681 (28.7%)

Table 2.2: Age Profile Comparison

Table 2.3 provides the income profile of the sample. 12% of respondents chose not to share this information. We see a broadly representative (z = 0.823, $p(z)$ = 0.4108) income distribution based against that for Norfolk generally (www.norfolkinsight.org.uk). The slight under-representation of those among the lowest income brackets may potentially correspond to the aforementioned low proportion of younger respondents.

Income Bracket	Sample Population (%)	Norfolk Representation (%)*
Under £20,000	55/200 (27.5%)	39%
£20,000 - £29,999	48/200 (24%)	21%
£30,000 - £39,999	25/200 (12.5%)	24%
£40,000 - £49,999	18/200 (9%)	
£50,000 - £59,999	9/200 (4.5%)	
£60,000 - £69,999	7/200 (3.5%)	
£70,000 - £79,999	3/200 (1.5%)	16%
£80,000 - £89,999	2/200 (1%)	
Above £90,000	10/200 (5%)	
Preferred not to disclose	24/200 (12%)	N/A

**Data approximations from Norfolk Insight (CACI), 2010*

Table 2.3: Income Profile Comparison

As mentioned when detailing the survey's location, we wanted to ensure that our sample represented a population who were responsible for household budgeting and who were also familiar with outdoor activities. As a consequence, the age and income profiles above do not appear discordant to this target population.

The coefficients of Table 2.4 are obtained by running a conditional logit model on the responses from the DCM[4]. Species of the highest frequency level (see Table 2.1) are indicated by the presence of the '**mult**' notation in Table 2.4, whilst those with an $(e)^{+}$represent our local existence value birds which were fed but not observed by the feeder (refer to Figure 2.5). Original regression outputs for the four models below can be found at Appendix 2.5.

	Full Sample *Model (1)*		**Give to Environmental Charity** *Model(2)*		**Bird Knowledge** *(Model (3))*		**Altruistic Feeders** *(Model (4))*	
	Coef.	*P>|z|*	*Coef.*	*P>|z|*	*Coef.*	*P>|z|*	*Coef.*	*P>|z|*
Blackbird$^{\mathbf{mult}}$	0.398	0.000	0.255	0.112	0.715	0.001	0.601	0.000
Bullfinch	0.504	0.000	0.656	0.000	0.404	0.018	0.648	0.000
Bullfinch$^{(\mathbf{e})^{+}}$	0.404	0.000	0.418	0.005	0.524	0.031	0.146	0.304
Robin	0.667	0.000	0.604	0.000	1.083	0.000	0.751	0.000
Sparrow$^{\mathbf{mult}}$	0.410	0.000	0.352	0.004	0.741	0.000	0.500	0.000
Tit	0.364	0.000	0.275	0.001	0.602	0.000	0.353	0.000
Tit$^{\mathbf{mult}}$	1.268	0.000	1.413	0.000	1.814	0.000	1.347	0.000
Woodpigeon	-0.126	0.182	-0.318	0.020	-0.117	0.602	-0.214	0.089
Woodpigeon$^{(\mathbf{e})^{+}}$	-0.178	0.060	-0.340	0.019	-0.452	0.037	-0.022	0.859
Nutrition	0.575	0.000	0.771	0.000	0.612	0.000	0.669	0.000
Donation	-0.002	0.013	-0.001	0.434	-0.003	0.046	-0.001	0.410
Nutnum	-0.055	0.000	-0.048	0.005	-0.076	0.001	-0.058	0.001
Price	-0.001	0.000	-0.001	0.005	-0.001	0.048	-0.001	0.018
Model Fit (χ^2)	202.53	0.000	157.97	0.000	158.91	0.000	157.55	0.000
Pseudo R^2	0.1777		0.2460		0.2647		0.2497	
Observations	16000		8800		5040		9920	
Participants (n)	200		110		63		124	

Table 2.4: The Conditional Logit Regressions

Model (1) estimates coefficients for the complete sample. For each of their cases, a respondent was providing a full preference ranking. Subsequently, each choice gives five 'choice observations'; this can be decomposed into the 'top choice' where one alternative is selected of the initial three, and the 'second choice' where one option is chosen of the remaining two alternatives. Whilst 16000 observations are recorded here, an 'observation' relates to an option as opposed to a separate choice incident. In fact, for each of their 16

[4] Data input and analysis were performed using $STATA_{11}$.

cases, each respondent made 2 choices from 5 'observations'[5] meaning that in reality the data in Model (1) is formed from clustering 200 individuals' 32 separate choice decisions. Models (2), (3) and (4) regress the same explanatory variables but from a subgroup of respondents who hold particular or distinct characteristics. Model (2) selects those who confirmed they had donated to an environmental charity (n = 110). The intuition is that these participants represent those who feel a greater degree of environmental responsibility. Model (3) isolates those who correctly named all six of the species in the bird identification quiz (n = 63). By selecting this group, we explore whether a superior avian knowledge has a distinct impact on valuation. Finally, Model (4) shows the values for those who scored highly on motivations which allude to altruism (n = 124). These referred to respondents whose aggregated Likert score for the motives ranked 2nd, 3rd and 4th in Table 2.6 exceeded 12 (of a possible 15). Table 1 of Appendix 2.6 shows that whilst some statistical differences do exist between the coefficients of these three subsamples and that of Model (1), the general pattern with respect to the size and scale of attribute parameters seem consistent. In particular the price attribute retains a constant magnitude, which is key when considering the robustness of WTP values.

Given the results of Table 1 in Appendix 2.6, we proceed to check some further specification tests, but this time applying these to Model (1) only. Whilst there is significant evidence that respondents are dissuaded by the status quo ($\chi^2 = -7.43, p = 0.000$), Table 2 of Appendix 2.6 confirms that whilst this does seem to reduce the WTP estimates for most of the bird attributes, by and large accounting for these Status Quo effects do not appear to alter the *relative* values (i.e. ranking) that people place upon different local wildlife species. The model does not pass the Independence of Irrelevant Alternatives (IIA) test ($\chi^2 = 147.33, p = 0.000$), yet we add two caveats to this result. The first is that alternatives are unlabelled and so our interpretation of omitting an 'option' does not hold the usual meaning which is applied to the IIA test. Furthermore, this test is widely seen as inappropriate for clustered models like the conditional logit (see McFadden, 1973, p.243). Likelihood ratio tests do confirm the joint significance when multiple attributes are omitted

[5] This is because each respondent gave a top preference (one choice from three options) and then a second preference (which is then one choice from the two alternatives they declined to choose as their top choice).

from the regression[6]. This is a further reason why alternative models were pursued, with the results of these specification tests given later.

For each model, Table 2.5 gives an implied monetary worth, expressed in pounds sterling (£). Described in Table 2.1, the valuations for the highest frequency ('**mult**') species is established by applying a weighting to assume with equal probability that between 2 and 5 birds would be seen.

The first finding which we derive from the data relates to the bird valuations themselves. Across all four models, species valuations follow a widely consistent pattern; the robin, bullfinch and blue tit evoke the greatest worth, with all three holding a significantly elevated value over the next most valued bird of the sparrow[7]. By contrast, valuations for the woodpigeon are either insignificant or negative. This result is conducive with the prior intuition that people could value aspects such as colour or associated aesthetics when interacting with wildlife. With the exception of Model (2), the 'rarer' bullfinch species fails to evoke a greater worth than either the robin or blue tit[8]. This 'valuation ladder' is intriguing. Appearance apparently plays a critical role in deriving worth, yet the aspect of rarity cannot be assumed to enhance this value further still, as we might have anticipated. We shall return to this aspect later.

	Full Sample *Model (1)*	**Gives to an Environmental Charity** *Model(2)*	**Strong Bird Knowledge** *(Model (3))*	**Altruistic Feeders** *(Model (4))*
	All values are expressed in pounds Sterling (£0.00)			
$\mathbf{Blackbird^{mult}}$	*0.08	0.05	*0.12	*0.12
Bullfinch	*0.21	*0.25	*0.14	*0.26
$\mathbf{Bullfinch^{(e)+}}$	*0.16	*0.16	*0.18	0.06
Robin	*0.27	*0.23	*0.36	*0.30
$\mathbf{Sparrow^{mult}}$	*0.09	*0.07	*0.13	*0.10
Tit	*0.15	*0.11	*0.20	*0.14
$\mathbf{Tit^{mult}}$	*0.19	*0.23	*0.21	*0.20
Woodpigeon	-0.05	*-0.12	-0.04	-0.08
$\mathbf{Woodpigeon^{(e)+}}$	-0.07	*-0.13	*-0.15	-0.01

*Significant Coefficient (p<0.05)

Table 2.5: WTP Valuations for Bird Species

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[6] For example, omitting sparrow and tit ($\chi^2_{(2)} = 44.95, p = 0.000$) or robin and woodpigeon ($\chi^2_{(2)} = 42.07, p = 0.000$) variables show evidence of joint significances.

[7] Full tests of WTP differences for Model (1) can be found in Appendix 2.6

[8] Insignificant differences for the full sample: Bullfinch ~ Robin (χ^2 = 1.58, $p(z)$ = 0.21) and Tit (χ^2 = 2.35, $p(z)$ = 0.12).

Nutrition retains a consistently high and positive status across models. Relative to the full sample in Model (1), we see a slight (yet insignificant[9]) elevation among charity givers in Model (2). This result seems fairly surprising as it is plausible that those who express an environmental affiliation through some form of donation could attach greater value to a characteristic which aids the birds. Across models, Model (3) derives a significantly elevated value for bird species against Model 1 (χ^2 = 39.9920, $p(z)$ = 0.000)[10]. However, beyond its ability to produce birds for them to view, these respondents do not seem to value any other aspect of the seed to the same extent. One potential conclusion to be drawn from this is that possessing greater avian knowledge purely yields a heightened private value for birds, without fuelling any allied altruistic or publicly spirited aspects.

On average, increasing the donation associated with an option creates a negative and significant dissuasion from a participant choosing it, *ceteris paribus.* Whilst at first this might appear surprising, this trend was reinforced by anecdotal discussions with respondents, who claimed a distaste to engage in such compulsory philanthropy. Returned to in later discussion, it is worth noting that this effect disappears among charity givers in Model (2) and the 'altruistically-motivated' of Model (4).

Regressor 'nutnum' is negative and significant across all models, suggesting that the importance of nutrition declines when more birds are attracted and fed by a particular option. Further analysis (not presented here) found that the number of birds fed *per se* (i.e. irrespective of species) plays no significant role in people's choice-preference and this enhances the trust we place upon the negative sign for this 'nutnum' variable. Again, the possible importance of this is identified in the following section.

Preference heterogeneity can often be a complicating factor in deriving sound economic valuations (Jacobsen & Hanley, 2009) and subsequent to running the basic conditional logit analysis on this data, further exploration involved regressing the same data using both a mixed logit regression and latent class model. The former is an example of a random parameters model, which affords the researcher greater flexibility by removing the

[9] Confirmed through Mann-Whitney U tests of sample median differences
[10] Confirmed through Mann-Whitney U tests of sample median differences

restriction that all respondents will place the same value upon the attributes and their levels. Econometrically, this involves adjusting the utility specification from Equation (1.2):

$$Prob\ (ni) = \int \left(\frac{exp^{\beta' x_{ni}}}{\sum_j exp^{\beta' x_{nj}}} \right) f(\beta) d\beta \qquad (1.2a)$$

The Latent Class model is a second way to test preference heterogeneity among respondents. These models seek to calculate the optimal number of groups or 'classes' of respondent who hold collectively similar valuations. A more detailed overview of these more sophisticated econometric tests is given by Pacifico (2010).

Full regression results from performing both the mixed logit and Latent Class model simulations can be found in Appendix 2.6. For the latter, the Bayesian Information Criterion (BIC) method was applied to establish the best class size. Again, comparisons are made with respect to Conditional Logit Model (1). Confirmed through Table 2.6 below, this comparison again shows that significant differences occur between the valuations which these three models elicit from our sample[11]. Once again, likelihood ratio tests hold (results not repeated here), and we can confirm that despite its unlabelled alternatives there are significantly lessened concerns regarding IIA ($\chi^2 = 43.86$).

	Conditional Logit (Model 1)	**Mixed Logit**	**Latent Class Model**		
			Class 1 *Share: 0.137*	Class 2 *Share: 0.716*	Class 3 *Share: 0.146*
	All values are expressed in pounds Sterling (£0.00)				
Blackbird^{mult}	0.08	0.07	0.03	0.03	0.05
Bullfinch	0.21	0.14	0.03	0.09	0.32
Bullfinch$^{(e)+}$	0.16	0.10	0.08	0.10	0.00
Robin	0.27	0.25	0.12	0.22	-0.04
Sparrow^{mult}	0.09	0.06	-0.19	0.04	0.62
Tit	0.15	0.07	-0.13	0.04	0.39
Tit^{mult}	0.19	0.14	0.25	-0.47	0.02
Woodpigeon	-0.05	-0.01	0.15	1.11	0.63
Woodpigeon$^{(e)+}$	-0.07	-0.05	0.14	0.72	5.77

Table 2.6: A Comparison of WTP Values across Regression Models

[11] Statistical differences between the conditional logit and mixed logit models can be found in Appendix 2.6

This being said, it does appear that even accounting for preference heterogeneity, a pattern of values the conditional logit, mixed logit and latent Class 1 (around 32%) respondents still emerges, analysis of which will be explored in the next section. Class 2 (roughly 56%) respondents by and large comply with this trend, suggesting that the ranking by which people value local wildlife seems fairly consistent. However, it is also noted at this juncture that our Latent Class model indicates the relevance of understanding that preference differences exist within a population, and acknowledging and embracing these are surely essential for any relevant policy-maker if they are to establish the greatest degree of support for their respective initiatives.

Turning to our behavioural section of the survey, question 4 asked whether a respondent had given some form of donation to an environmental charity within the last 12 months. 110 of the 200 questioned (55%) confirmed they had done so. Whilst this may seem somewhat inflated, no specific restrictions were imposed in people's interpretation of this statement. This means 'donating' could represent the undertaking of a range of activities, be it direct payment, environmental membership or engagement in conservation work. In contemplation of this broader definition, this percentage does not seem so unreasonable.

Given an agreement to participate in the survey, it is perhaps unsurprising that 80% of respondents agreed that they fed birds at least occasionally. 75% did so through some form of purchased sustenance, whilst one third stated they fed leftover food alongside or instead of this. Of the 14 respondents who fed 'Other' foodstuffs, descriptions generally alluded to the use of fresh fruit, lard or domestically harvested corn and maize.

Rank	Description	Score (Average)
1	Enjoyment from looking at them (ENJOY)	877 (4.39)
2	Helps Bird Populations (POP)	835 (4.18)
3	Feel the birds need the food (NEED)	793 (3.97)
4	Good feeling from helping (FEEL)	709 (3.55)
5	Throwing food in the bin is a waste (FOOD)	579 (2.90)

Table 2.7: Motivational Hierarchy for Feeding

Conducive with expectations, summer was the season with the lowest level of bird-feeding - 61.5% fed birds in this period. Feeding prevalence rose during the other seasons to 76% in autumn and spring and 81% over winter months. One might consider that feeding birds in summer reveals a motive which is more anthropocentric in nature. During this season, people spend a greater proportion of time in their garden, affording them a greater opportunity to see birds feeding. Yet, it is unclear whether birds require this food through summer months. The advice from avian charities is ambiguous on this issue; some advocate year-round aid whilst others advise that natural food is abundant in this season.

Question 5 of the survey asked people to rate on a scale of 1 (strong disagreement) to 5 (strong agreement) their attitudes on reasons to feed birds and Table 2.7 provides the aggregated results of these responses, with the associated average score in brackets. Differences between each of these motivations are statistically significant[12]. It shows that people's enjoyment from watching birds is the most potent motive for engaging in the activity. Helping bird populations forms the reason rated second highest, whilst fuelling nutritional need is a tertiary priority. These latter motivations fall under a more altruistic umbrella than the former reason, and Table 2.8 confirms a significantly positive correlation between the two factors. A reluctance to agree with the proposed fifth motive is also enlightening. It illustrates how one well-established environmental concern, namely that of escalating landfill rates in the UK cannot be directly addressed by a raised engagement with the one we focus on here; the protection and conservation of local wildlife.

	ENJOY	**NEED**	**POP**	**FEEL**	**FOOD**
ENJOY	1				
NEED	0.28	1			
POP	0.34*	**0.5***	1		
FEEL	0.08	0.24*	0.14	1	
FOOD	0.11	-0.08	0.04	0.22*	1

**Significant Correlation*

Table 2.8: Correlations across Motivations

[12] **ENJOY** > **POP** (t = 3.36, $p(z)$ = 0.001) > **NEED** (t = 3.53, $p(z)$ = 0.001) > **FEED** (t = 4.57, $p(z)$ = 0.000) > **FOOD** (t = 4.81, $p(z)$ = 0.000)

Table 2.9 provides a full matrix of the bird identification analysis. In congruence with expectation, the robin and blackbird proved easiest for respondents to recognise. By contrast, the house sparrow proved most difficult for people to correctly name. Upon closer inspection, this seemingly relates more to misidentification (37.5%). 65% of these incorrect guesses instead claimed the bird was the great tit, tree sparrow or dunnock. Adjusting for such close mismatching, our sample found it most challenging to correctly name our 'rare' bullfinch species. Whilst nearly 56% did correctly identify this bird, we see a relatively high proportion fail to register any answer.

Nearly two-thirds of respondents could match at least five of the six birds correctly, whilst just one in eight mis-identified three or more birds. Hence, our sample apparently possessed a good level of local avian familiarity. Even those who expressed a low interest in bird-feeding still held a respectable background knowledge, and proclaimed non-feeders achieved a mean score of 4.36.

	Blackbird	House Sparrow	Blue Tit	Woodpigeon	Robin	Bullfinch
Chaffinch	0	17	3	0	0	47
Robin	0	0	0	0	**198**	0
Grey Heron	0	0	0	0	0	0
Lesser-Spotted Woodpecker	0	1	0	0	0	3
Blue Tit	0	2	**179**	0	0	0
Woodpigeon	0	0	0	**169**	0	0
Blackbird	**198**	0	0	0	0	0
Bullfinch	0	6	1	0	0	**111**
Song Thrush	0	0	0	0	0	4
Kestrel	0	0	0	0	0	0
Collared Dove	0	0	0	26	0	0
Dunnock	0	6	0	0	0	0
Mallard	0	0	0	0	0	0
Tree Sparrow	0	24	0	0	0	0
House Sparrow	0	**104**	0	0	0	1
Great Tit	0	19	7	0	0	3
No Answer	2	21	10	5	2	31
	200	**200**	**200**	**200**	**200**	**200**

Table 2.9: Identification Quiz Results

Overall, the majority of our results adhere to *a priori* intuitions. The first aim of this paper was to discover if, and to what extent, people held a value for 'everyday wildlife'. The second wished to explore the underpinnings of any such valuation in the context of

Subjective Well-Being. The values attributed to both the bird species and associated altruistic elements such as nutrition unequivocally confirm a positive answer to the first of these aims. The next section now searches to contextualise this within the field of behavioural economics in order to address the study's second objective.

2.6: DISCUSSION

Given both the study location and non-obligatory conditions for participation, these findings cannot be generalised to the (full) UK population. At the same time, many participants claimed they did not actively pursue bird-feeding as a regular activity. Therefore, whilst the sample may ineffectively represent the *whole* population, it appears reasonable to assume that it can extend to a significant fraction of UK citizens, particularly those who hold interests in outdoor pursuits, horticulture or other assimilated activities. As a consequence, a multitude of meaningful avenues for debate are opened from the results above.

Bird Valuations and 'Nature Connectivity'

From an environmental standpoint, the study's most tangible finding relates to the ranking of species based upon the estimated values given in Table 2.5. This profile predominantly complies with both our *a priori* intuitions and previous researchers who find that more aesthetically pleasing species which possess qualities of colourfulness and vibrancy invite the greatest human value (Jacobsen et al, 2008). Equally, undesirable attributes of pest-species and plumage blandness draw a lower or even negative response (Clucas et al, 2014). Identifying where values differ, and crucially why this seemingly occurs, is no doubt insightful for directing policy. In this case, understanding that species of local wildlife can provide people with varying levels of utility could, for example, help decide how biodiversity action plans and conservation efforts are actioned and marketed to people in order to maximise participation.

In contrast to these intuitive results, the position of our bullfinch on this 'valuation ranking' is interesting. Bullfinches are brightly coloured and reasonably attractive birds, and furthermore they are relatively rare in the Norfolk region. This combination of qualities should, in the eyes of other studies, allow the bullfinch to evoke the greatest valuation of our tested species. However, it consistently fails to achieve this status, meaning that our bird hierarchy only partially complies with previous thoughts surrounding the factors which are perceived to increase one's value for a species.

By instead appealing to the literature on Subjective Well-being and the channels by which humans are presumed by behavioural theorists to derive utility, we find clues which might relate more favourably to our discovered hierarchy and drive the results we obtain. As well as promoting aspects of vibrancy and aestheticism as sources of value, this school would additionally cite utility-enhancing factors that endow humans with repeated interaction and invite the opportunity to exhibit emotions of autonomy, responsibility and interconnectedness (Cameron et al, 2012). Two of our three top ranked species, the robin and blue tit, typify this profile perfectly. Not only are they visually pleasant, but their size, stature and feeding habits serve as classic characteristics to invite human valuation through these other means (Tinbergen, 1953). Humans might interpret such facets as signals that these birds require a greater level of protection in order to increase their chance of survival and ability to reproduce. By being common birds, and thus frequent visitors to gardens, they offer the opportunity for repeated and routinely interaction which then boosts the utility humans develop from feeding them. Fuelling further the plausibility of this approach, other species in our hierarchy are missing some of these enhancing qualities, be it aestheticism (house sparrow), dependency (blackbird), the opportunity for repeated interaction (bullfinch) or a combination of these (woodpigeon).

By transferring this reasoning to identify 'types of respondent' who answered our survey, we can try and uncover what characteristics of a person or their attitudes may give rise to them behaving like a warden. One way to do this is by comparing our alternative models. For example, respondents from Model (4), our 'altruistic feeders', post significantly elevated valuations for the species which seem most vulnerable[13]. Another way would be to use our Latent Class Model to make such inferences. It appears that somebody belonging to Class 3 seems least aligned to possess our definition of a 'warden mentality'. Results in Appendix 2.6 infer that both knowledge (instrumented through the number of birds

[13] Relative to the full sample, significantly higher values for the Robin (χ^2 = 4.62, $p(z)$ = 0.03**), $\text{Sparrow}^{\text{mult}}$ (χ^2 = 3.48, $p(z)$ = 0.06*), Tit (χ^2 = 3.51, $p(z)$ = 0.06*) and Tit^{mult}(χ^2 = 4.00, $p(z)$ = 0.05**) from 'altruistic' feeders.

correctly guessed in the identification quiz) and age (given by a dummy variable for the oldest age group) might act as significant drivers in determining one's value for birds. Both sets of respondent are more likely to align to Class 2 than Class 3 membership and therefore exhibit a greater tendency to adhere to the principles of nature connectivity.

Upon first inspection, the sign and significance of the 'nutnum' variable appears contradictory to previous analysis. Surely individuals should place a constant worth on nutrition, or even increase it, as the volume of birds fed from their seed increases. However, by applying this finding to the individual who derives utility from 'warden' interaction, a negative coefficient may still be consistent. Such people would clearly value the nutrition of a seed which attracted small numbers of dependent species. However, they may gain less utility from the nourishment of food which brought birds in a greater volume and thus where their engagement took a more anonymous and detached stance. Furthermore, as bird numbers increase, the inherent perception would be of a lesser dependency - populations are clearly thriving and are therefore less reliant on human intervention. Subsequently, the sense of responsibility diminishes, and with it the utility gleaned through this form of 'nature connectivity'.

Motivations for Feeding Birds

Another key application of this study pertains to examining people's stated motivations for feeding. The self-rewarding enjoyment from viewing birds constitutes the primary reason for engaging in this act. This is perhaps unsurprising given this is a stimulus which respondents would feel, regardless of if this were complemented by altruistic motivation or not.

The placement of 'help' above 'need' within the stated motives in Table 2.7 is perhaps interesting. This implies that a sizeable component of the utility people gain from nature engagement originates from a sense of responsibility they feel when aiding another species. The word 'need' suggests obligation and that failure to act would otherwise be detrimental. In contrast, 'help' is a slightly weaker phrase. Here, one might wish to contribute to bird welfare, but abstaining from doing so is not necessarily harmful. Under these circumstances, individuals can be more selective regarding when and what they decide to feed. This complies with the aforementioned findings from our species valuations. Birds which glean the greatest worth correlate to those whose characteristics imply a sense of vulnerability and defencelessness and thus where (albeit non-obligatory) aid will reward a feeder with the most satisfaction.

One additional note regarding these motivational rankings is the relative distaste of participants to state they feed birds because it 'made them feel good' to be helping. Whilst happy to concede that they hold personal motives for feeding (namely through visual enjoyment), people were reluctant to agree with this alternative private reason. Described through an altruistic or public goods framework, our sample appear to partition and prioritise a private utility component from watching birds and acknowledge that clear interactions exist between this and the public benefits of this act, namely via increased and/or healthier bird populations. However, the suggestion is that their provision to the public good is to help birds and the produced subsidiary private utility (of feeling good) does not constitute the primary driver of such action. This reasoning complies with the conjecture that people may approach such engagement through a "warden-type" role of responsibility, and acquire utility through channels more likened to that of keeping pets (Johnson, 2011) or gardening (Rappe, 2005).

Donation and the Decomposition of Value

We now turn the focus of our discussions to the experiment's donation variable. This characteristic attempted to relate 'everyday wildlife' to the value people attribute to more general conservation efforts typically explored within the field. This donation coefficient is consistently negative and was significantly so in Models (1) and (3). The most plausible explanation for this arrived from the verbal reasoning of surveyed respondents. They explained their dislike of compulsory donations through the purchase price, which essentially forces them to contribute to a specific cause in pre-defined amounts. Instead, individuals indicated a preference for compartmentalisation. On the one hand they could voluntarily contribute to environmental charities and presumably would yield a form of utility in doing so. On the other they took pleasure from bird-feeding, but as a separate, private act which should be dis-associated from the philanthropy of charity-giving.

The notions behind such anecdotal views invite us to make a number of suggestions. One regards the care which should be taken when interpreting the negative sign: the survey's design and instruction made it very clear that price differences between two alternatives were caused purely from the presence of a donation. This is clearly ill-aligned with the usual nature of such 'bundling', where companies employ far more complex systems such as proportional or corporately-matched donations. Consequently, we retain great caution in the assertions we make over the absolute values people express for regional or national conservation causes. However, this finding could mean that making direct comparisons between values for local and conservation species is somewhat dangerous (Clucas, 2014), and may also question a belief held within the field that engagement with local nature will automatically serve as a catalyst for achieving a wider interest in conservation issues (Miller & Hobbs, 2002; Dunn et al, 2006)

Another insight pertains to the difference this form of existence value takes from that characterised by the "$\mathbf{Bullfinch}^{(\mathbf{e})^+}$" coefficient of Table 2.4. In contrast to the strongly negative donation coefficient, this variable is positive and significant across Models (1) to (3). When contextualised within an impure public goods framework, this disparity seems reasonable. Let us assume that humans value the interactions which occur between their personal engagement with wildlife, which is a private good, and the associated public goods facet. In our example, individuals value seeing birds in their garden (a private aspect) yet realise that this also aids the wider bird population (a public aspect). They could quite plausibly receive contentment from realising the two are linked. This helps explain why, albeit weakened, a value remains for our local existence ("$(\mathbf{e})^+$-bird") variables. By contrast, this value vanishes for the donation variable because the interactive element disappears. Notwithstanding the issues regarding how our particular donation characteristic was constructed, there appears to be a considerable importance in grasping a sound understanding of these non-use interactions within future research and study.

One final conclusion we draw regarding our donation attribute returns to the theme of 'nature connectivity'. The *type* of engagement yielded through a donation mechanism is very distant from that obtained through our 'responsibility-repetitive interactions' conjecture outlined earlier in this section. People are not only unlikely, but are actively discouraged, to try and 'connect' with species like the bittern and "Wildscape" conservation regions are, by definition, designed to resist human intervention or interaction. Therefore, the utility which humans can extract from such expenditure can in no way fuel any feelings of dependency-affiliation or repeated interaction. It may be perceived that charities try to compensate for this by introducing elements like 'animal adoption' schemes into their marketing practices. This attempts to connect donors to an individual creature or species and form some bond between the two. Regardless of whether such action is successful in achieving this aim, the suggestion here is that those values which are derived from engaging with 'backyard wildlife' are more akin to that which might be established through domesticated nature (gardening or pets) than from regional or national wildlife preservation.

2.7: THE USE OF SEED PURCHASE DATA AS AN EXTRENAL VALIDITY CHECK

One of the greatest criticisms of stated preference (SP) studies is the tendency of individuals to respond in ways which belie their true opinions or beliefs. Studies have been conducted which show that aspects such as 'consequentiality' (the belief that responses will directly influence policy) can lessen these tendencies (Carson & Groves, 2007; Vossler et al, 2012). Nevertheless, there are many suggestions as to why 'untrue' responses may still persist. Participants may consciously misreport and are adversely incentivised to provide untrue responses. Such instances include a subject's attempt to impress an interviewer, ethical protests, or a general exaggeration due to a perception that their answers will influence subsequent policy. A second set of reasons surround subconscious error, including a lack of familiarity, insufficient topic comprehension and/or engagement or simple systematic preference miscalculation. Thirdly, there may be design issues with the experiment itself, causing biases from framing effects or internal (within-survey response) inconsistencies. For a full review of these concerns, which together form the 'hypothetical bias' of stated preference studies, see Bateman et al. (2002, p269).

External validity checks are a credible way to show that the findings of stated preference studies replicate or mirror people's revealed preferences (RP). For this study, one such opportunity is to apply the attributes of our choice experiment to bird-food products on the market. This is another big advantage to our payment mechanism, offering a clear chance to compare hypothetical products with those which the public actually choose between.

To conduct a basic external validity check, this study uses a dataset provided by a UK bird-feed wholesaler. They make and distribute sixteen different products and provided monthly sales data for these for the period of October 2012 through to September 2013. Information could be obtained for each product regarding its weight, price and feed composition. Product descriptions also included the types of bird species which might be attracted to the feed. We construct our dataset by assuming that each of the 12,918 purchases made represent a consumer choosing a product from the full range of sixteen.

The purpose of this exercise is to compare this real purchase data and the values they imply people attach to feeding birds with the values obtained through the stated preference responses. Our null hypothesis would be that the two sets of coefficients align, meaning in this case that the types of bird food people pay greater amounts for would correspond to the type of feed which attracts more highly valued birds. If we are unable to reject this null hypothesis, this would constitute our hypothetical study passing its external validity test. As described later in this section, there are key obstacles to providing a perfect comparison between the two sets of values we obtain in this case. These problems arise through a combination of product differences themselves as well as perceptions-based disparities regarding what people's expectations are of a seed product (as in the hedonic data) against what it actually provides (as stated in the choice experiment task).

In the first step, each of the sixteen products are described as 'bundles' of various bird food types. The information on product packaging means that this re-characterisation is based upon factual evidence. Describing each good in this way allows us to measure the worth people apparently place on each of these various bird food components. We then run these choice results in a simple logit model, the findings from of which are given in Table 2.10. Feed coefficients represent the average change in probability that somebody buys a product given that it has contains a raised concentration of that particular type of food. Maize is used as the base case, given that it is the most basic feed-type.

	Coefficient	*P>|z|*
Sunflower Seed	0.029	0.000
Mealworm	0.086	0.000
Berry	0.077	0.000
Nut	0.257	0.000
Fat	0.069	0.000
Price (per gram)	-0.013	0.000
Model Fit (χ^2)	21202.49	0.000
Pseudo R^2	0.2194	

Table 2.10: The Revealed Preference Output

Variables display signs which appear congruent with our previous analyses. Each 'feed' coefficient represents the changing probability of selecting an alternative if that type of food is used instead of maize. For example, by replacing maize with sunflower seeds, the positive coefficient (0.035) illustrates the increased likelihood of a consumer selecting this adjusted product, supposing the feed remains the same in all other respects. Many of our alternative feeds would attract aesthetic birds with vulnerable qualities. This includes fat and sunflower seeds for blue tits or mealworms for robins. These evoke strongly positive responses, suggesting a possible adherence to our assumed "warden model".

The coefficient for 'Nut' delivers a very high valuation in this consumer choice (RP) model. Of the feeds included in this model, 'nuts' pose a very vague and wide-ranging category. It can potentially constitute a major dietary element for many garden bird species. Upon inspection of correlations (not presented here) there are also some strong collinearities between this and other foodstuffs, reducing the confidence we have in its absolute value.

By taking the ratio between each food product and the price (per gram) coefficient, we can establish a 'willingness to pay' in order to replace a certain quantity of maize with each alternative feed. Table 2.11 shows this by estimating the projected additional payment a respondent would offer to replace 100 grams of maize with each of the alternative food types.

Food Type	Replacement Value (100g)
Maize (base feed)	0.00
Sunflower Seed	£2.33
Mealworms	£6.86
Fat	£5.49
Nuts	£20.48
Berries	£6.13

Table 2.11: Estimated Replacement Costs

At this stage, this is as far as we are able to take our hedonic analyses in deriving unambiguous calculations on people's willingness to pay for real market products. However, a final step that one could take would be to transfer the values in Table 2.11 onto a willingness to pay for birds. Undertaking this step will create some degree of inaccuracy, and this is because the 'productivity' of real seed purchased by respondents with regards to the birds it will derive can only be estimated by purchasers at that point when they buy the product. This is in contrast to the hypothetical study where choices relay exactly what birds would be attracted by each given alternative.

Despite this, product descriptions do give information regarding which bird groupings[14] are most likely to be attracted by each type of feed. We can complement this with factual data regarding the composition of each product as described through the feed types above. Of course, this process involves a degree of subjectivity, and mapping bird feeding groups onto market products requires one to both compile the advice from trusted bird-feeding authorities (e.g. web-page and issued guidance from the RSPB, BTO and other reputable sources) and appreciate that estimates rely upon average population statistics for any given location. However, in an exercise to exemplify how this might work in practice, Appendix 2.7 gives a 'best estimate projection' of the type of bird bundles which might be

[14] 'Bird Groupings' must more broadly represent multiple species of bird which have the same dietary preferences. Because we cannot disaggregate these feeding groups of birds, this explains the nature of the comparisons made in Table 2.11. For example, we directly compare 'Woodpigeon and Sparrow' from the SP study with just 'seed-eating birds' in the RP treatment.

attracted by the 16 products in our dataset. From here, we can estimate the corresponding WTP values for different groups of bird species which feed in gardens. These are provided in Table 2.12, with the interpretation of actual values perhaps being of a lesser importance for our purposes than the relativities.

	RP Value (per feed)*	RP Value (per 1kg bag)		SP Value (per visit)	SP Value (bag)**
Tit	£0.11	£2.24	***Blue Tit***	0.17	£3.40
Thrush	£0.11	£2.18	***Robin***	0.27	£5.40
			Blackbird	0.08	£1.60
Finch	£0.08	£1.55	***Bullfinch***	0.16	£3.20
Seed-Eater	£0.09	£1.79	***Woodpigeon***	0	£0.00
			Sparrow	0.09	£1.80

Table 2.12: A Comparison of Revealed and Stated Preference Values

** RP Value (per feed) is not directly comparable to SP Value (per visit) as we do not know people's perception or factual evidence of how many birds will visit per feed for RP data.*
*** The price estimations in the SP study were based upon retail prices of 1kg bags of seed (see P.29)*

Hierarchies are similar between the two if we appreciate that the 'thrushes' are a combination of the value people hold for the robin and blackbird, alongside others like song thrushes and wrens. The 'finches' feed group provide a lower ranking than that of the bullfinch in the stated preference study, but the former would of course combine values for bullfinches with more common finch species like greenfinches and chaffinches.

This brief inspection of the bird-feed market by no means constitutes a comprehensive external validity check for our choice experiment. However, it is noteworthy to see how such a robustness analysis could be designed and performed so as to test many of the key attributes within this type of choice experiment. At this juncture it is important to highlight where the use of a hypothetical study holds great advantage over this type of hedonic approach. The latter contains issues of inter-attribute correlations which cannot be overcome through a neat orthogonal design which a choice experiment permits. Furthermore, we have no way of testing our hypotheses regarding the existence or impure public goods values by using purely consumer choice models, and the flexible manipulations which a stated preference study allows enables a far deeper and comprehensive inspection of people's preferences to be explored.

Despite these advantages to stated preference studies, we believe this type of hedonic inspection is highly useful when trying to validate such hypothetical responses. Given the unique nature of this work, and in particular its transferable payment vehicle, designing a stated preference study which held a high degree of transference to existing seed products would seem both logical and beneficial for any replicative research in this area. Not only could this strengthen the specific conjectures presented here, but having a relatively easy external validity check potentially has wider benefits for combatting stated preference biases and their associated criticisms.

2.8: CONCLUSION

This study's major motivation was to explore the extent to which people gain from their engagement with 'everyday wildlife'. Its findings suggest that humans hold a value for creatures in their local area, such as garden birds, in a distinct and separate manner from that of conservation or aid to rare and endangered species. The types of utility which each evoke also appear different, and local interactions encroach into an area of our subjective wellbeing which raises our contentment through a sense of responsibility and/or repeated interaction with other entities. Such attainment is not overly distant from the advocated practices of religion, culture and social-networking in raising one's life satisfaction. By contrast, the utility we derive from contributing to endangered species protection seems more aligned to the type of 'warmth' we receive from those charitable or philanthropic acts which consist of an 'impersonal' or detached form of giving. Whilst some research has recognised the stand-alone benefits of local wildlife (Miller & Hobbs, 2002), there is a need to appreciate and distinguish between the values attained through everyday interactions against those yielded from wider environmental or conservation causes. We cannot automatically assume that each act as the other's substitute and, more generally, this work suggests the important need to understand how people derive utility from the different components of the natural world around them.

Seeking to manage the natural environment so as to enhance people's well-being to the greatest extent is vital, and if the findings of this paper are to be replicated, this would certainly open new channels of discussion for a range of policy arenas. Indeed, if 'preferences can be quantified in economics terms', the relative advantages and drawbacks of associated empirical proposals can be more effectively analysed (Hanley et al, 2003 p.123). If we take the example of local conservation initiatives or public park management, recognising that some bird species hold a greater worth to the local population than others could provide direction upon the sort of habitat creation and restoration priorities which should be invested in so as to afford these communities the best chance of interacting with the wildlife which deliver them the greatest amount of nature-connected utility. A similar interpretation could be applied to the redesigning of urban planning laws. Furthermore, this type of investigation provides a first insight regarding how the bird seed manufacturing industry can deliver products which its customer base value most highly.

To the authors' best knowledge, this is the first paper which seeks to extract exactly why people gain value from 'backyard wildlife' and so its conjectures can only be strengthened or verified by the undertaking of assimilated work to either corroborate or refute the assertions made here. In particular, this work is yet to fully derive the conditions under which humans receive contentment from wildlife within an impure public goods framework and the corresponding role of non-use values in this context. Subsequently, this paper has suggested that advantages may exist from investigating far more deeply the underpinnings of these values within the field of environmental economics.

SECTION 3

'PLEASE IN MY BACK GARDEN':

WHEN NEIGHBOURS COMPETE IN THE PROVISION OF LOCAL ENVIRONMENTAL PUBLIC GOODS

3.1 : INTRODUCTION

This paper models the effort exerted by neighbouring individuals as they compete for an environmental commodity which exhibits the properties of a mixed public good. Our motivating example is the levels of seed that neighbours dispense when trying to attract birds to their individual gardens for private enjoyment.

Relying upon private contributions will typically result in an under-provision of a public good. This sub-optimality will be exacerbated the stronger the good exhibits aspects of non-excludability or non-rivalry in consumption, each of which create higher incentives to free-ride (Olson; 1971). The literature regarding the free-rider problem is vast, both in theoretical (Arnott & Small, 1994), empirical (Olson, 1971) and experimental (Andreoni, 1988; Weimann, 1994) fields. These papers typically describe a *pure* public good, yet there are many instances when an individual is able to derive a private utility stream through their act of contribution. These *impure* public goods, first coined by Samuelson (1954), may begin to partially offset the free-rider problem, as now individuals have a greater incentive to contribute. Although incentives may be monetary, payoffs could be intrinsic or psychological in nature, with examples including the social or reputation value one attributes to their action (Cameron et al, 2012; Sexton & Sexton, 2014)

The Impure Public Goods model is algebraically explored by Cornes & Sandler (1994). They illustrate that the extent to which the private element of an impure public good can tackle the free-rider problem largely hinges upon the degree of complementarity between its private and public aspects.

A detailed overview of early environmental valuation studies is provided by Carson et al (1996), assessing not only valuation but also methodological differences in this area. Previous empirical work by Brock, Perino & Sugden (2014) provides an interesting environmental example which exhibits the attributes of an impure public good, namely the feeding of garden birds in local neighbourhoods. Survey responses suggest that individuals understand the public-goods benefits of feeding. These arise in the form of positive externalities from an increase in the bird population to the local neighbourhood and, one could argue, to the birds themselves. However, people state that the primary incentive for feeding is to view birds within the confines of their garden. The private and public benefits which arise in tandem from bird-feeding give a very nice instance of how a public good's impurity can begin to alleviate free-rider tendencies.

While impure public good characteristics can reduce the degree of under-provision, they usually do not achieve the good at its socially optimal level when relying upon private contributions alone. This is because in many cases a public goods element will persist and will therefore not be internalised fully by private parties.

However, in the case of bird feeding there are additional mechanisms that may fundamentally change the nature of the game. In order to successfully construct a model which most accurately resembles our motivating example, we must introduce two further theories to operate in conjunction with Impure Public Goods Theory.

Birds can move freely and usually forage in territories greater than an individual's garden, yet a bird can only feed in one person's private garden at any given time. Ecology provides us with a neat way to model the way birds allocate time within their foraging territory based on the spatial distribution of food within this area. Ideal Free Distribution theory is an ecological modelling technique which illustrates how animals employ Nash-equilibrium strategies in response to changes in food density so as to maximise their survival and/or reproductive success. Whilst one of the earliest and most comprehensive applications of this theory is given by Fretwell & Lucas (1970) when assessing territorial behaviour, studies have furthered these notions to include the impacts of species mobility

(Cressman et al, 2004), relative species competitiveness (Parker & Sutherland, 1986) and spatial segregation (Corazzini & Gianazza, 2008).

These foraging strategies create a direct (strategic) link between the numbers of birds attracted by the food present in a given individual's private garden against that available in neighbouring areas. Contest Theory illustrates situations where individuals 'expend effort to increase their probability of winning a given prize' (Dixit, 1987). This theory nicely fits our bird-feeding model, with 'effort' characterised by the volume of seed an individual allots and birds constituting a 'prize' which can be distributed in proportion to effort. In order to procure the private utility that is derived from viewing birds in their own garden, neighbours therefore face a strategic situation similar to a Tullock-type contest. Contests typically create incentives for an overprovision of effort relative to the level which is deemed socially optimal. Such 'over-dissipation' (Konrad, 2009 p.55) is accentuated in applied settings and evidence shows the extent to which respondents engage in real contests consistently exceed the thresholds predicted by theory (Davis & Reilly, 1998).

Our model now fuses theories which offer contrasting predictions regarding the direction of inefficiency that Nash-playing individuals create relative to a first-best solution. The combination of a public goods aspect inducing too little and a contest aspect inducing excessive incentives for private provision of this good is the key point of this paper. The benefit of these theories' contrasting predictions is that we are able to construct versions of our model where each effect is greater or lesser in magnitude. We can then assess how the gap between privately and socially optimal levels of provision changes. By doing so, we can explore the extent to which we find ourselves disparate from the socially efficient solution.

Whilst modelling this motivating example is in itself interesting, it also generates first insights into a much more general setting where aspects of public good provision and contests interact. Examples of these include eco-tourism and environmental volunteering. In this paper, we shall not only study bird feeding as an interesting environmental economic phenomenon in its own right, but also its ability to represent these alternative cases. In particular, it is the contest between neighbours that drive their feeding decisions and thus provide the stimulus for the role of a mixed public good in delivering voluntary contributions which would otherwise not materialise. The competitive mechanism through which this occurs is pivotal here, and requires great scrutiny when assessing the transferability of this case to other situations both within and outside of the environmental economics arena.

In the UK, bird feeding is a common and well-practiced act. Studies (Davies et al, 2009; Saggese et al, 2011) estimate that as many as 48% of the population at least occasionally feed birds. Furthermore, 87% of people in the UK have private access to a garden, with a significant proportion engaging in a range of 'wildlife gardening' techniques to enhance biodiversity within their local environment. The manufacture of seed for supplementary feeding also constitutes a noteworthy industry, with UK residents estimated to purchase around 60,000 tonnes of seed, creating a bird-food market valued at around £200 million in 2009. This illustrates an economic importance to an industry which is not only substantial in its current state, but is expanding at an estimated 4% annually (Fuller et al, 2008).

It is at this stage necessary to consider the extent to which bird-feeding holds economic, ecological and social importance. We initially consider the human benefits that accrue from this association with local wildlife. Engagement with the natural world exhibits many of the qualities which have been identified as beneficial to lasting life satisfaction by the literature on Subjective Wellbeing (SWB). 'Interconnectedness' is a good example of this, and is an emotion common to many of the SWB enhancing actions such as involvement with religion (Frey & Stutzer, 2010), community (Dutcher et al, 2007) and wider society. Furthermore, the repetition associated with 'everyday wildlife' interactions can induce positive feelings of responsibility (Jacobssen et al, 2008), routine (Diener & Biswas-Diener, 2008) and achievement of success under uncertainty (Dolan et al, 2008). Given the many of these attributes which bird-feeding adhere to (see Fuller et al, 2008 for an overview), it appears highly relevant to explore the main factors determining if and to what extent individuals' decide to feed birds in their own garden. Given that such activities can induce positive feelings of social responsibility and connectivity, this may suggest that there are wider social benefits to understanding the factors which drive people to engage with their local environment. Socially beneficial examples could relate to improving the quality of life for elderly members of society (Rappe, 2005), providing children with an extended level of education (Louv, 2008) or allowing people to recover more quickly from serious health issues (De Vries et al, 2003).

Even if feeding birds is beneficial to humans, it may be deemed unjustifiable if substantial evidence exists to suggest it is detrimental to the birds themselves. Arguments against the act surround notions of species over-dependency (Sagesse et al, 2011), improper nutrition for juvenile birds (www.rspca.org.uk) and the ecosystem-related consequences of artificially elevated populations (Cannon et al, 2005). Current attempts to combat many of these objections take the form of providing more detailed advice of when supplementary feeding is and is not conducive with the welfare of birds (see www.rspb.org.uk for one such source).

There is growing evidence that an ecological importance exists to supplementary feeding, yet the nature of this aid is quite complex. This is because the help offered from artificial food would seemingly take two differing roles simultaneously. Firstly, Fuller and co-authors (2008) explain that feeding birds in UK cities enables avian populations to viably thrive within the urban environment. Whilst not explicitly defined in their paper, we assume that 'urban-adapted species' describe those which can settle permanently within the confines of non-rural landscapes. Secondly, bird-feeding may prove ecologically necessary through the benefits it yields as an 'emergency stock of food'. Longitudinal studies consistently show a greater tendency of birds to visit urban bird tables in times of harsh weather conditions (Glue, 2006). Such species would normally reside in woodland or farmland habitats and one potential explanation for this ever more prevalent encroachment may relate to habitat loss and/or changes in agricultural practices which have occurred within the UK and other developed nations.

The role of bird feeding to either sustain resident species, or as an emergency fund for migratory or transient birds to 'dip into' illustrate the potential importance of supplementary feeding to sustain or even enhance biodiversity. This may also explain the urge of environmental organisations to issue their more detailed guidance.

It is also highly relevant and insightful that these avian benefits align so neatly with those which accrue to humans from bird-feeding. Firstly, the two streams of benefit complement one another in the aspects of human utility enhancement they appear to fulfil. The sustaining of 'urban adapted species' ensures an interaction and engagement with local wildlife which is repeated and interconnected, whilst the emergency stocks facet of bird feeding enhances human welfare from a dependency and uncertainty of outcomes standpoint. Furthermore, the latter of these sources ensures that this pro-social activity is self-supporting. Humans will increase their instances of feeding in winter time, when feeding is most productive in attracting different types of birds to their gardens, thus enabling them to feel a greater sense of responsibility. Simultaneously, this is the exact time of year when the emergency stocks are most necessary, and so the greatest variety of species will profit accordingly.

So far, we have introduced the act of bird feeding among local neighbourhoods as a motivating example to understand why the private contributions to a public natural resource can exceed the level predicted by pure public goods theory. This occurs through a combination of the impurity surrounding the contribution action, the contest which ensues between neighbours and the freedom of the 'consumer good' to arrange themselves in proportion of food densities. Whilst this is interesting theoretically, it appears that there may be important ecological and socio-economic reasons to explore this topic more thoroughly, with increasing evidence that both humans and birds benefit from the act of supplementary feeding in local urban environments. Furthermore, grasping a more rigorous understanding of the role of private motivations in determining contributions to public goods may prove insightful for a range of other policy arenas. This applies to the field of environmental economics and toward wider social and economic situations where extracting private funds currently fails to fully exploit the true willingness of its beneficiaries to support and supply a good.

Section 3.2 proceeds by identifying the Model. This begins by introducing a special (simplifying) case, before advancing to include algebraic and implicit analysis with an exogenous and then endogenous population. Section 3.3 makes some further extensions to the model to consider some empirically plausible situations. Section 3.4 applies our model to other possible empirical scenarios both within environmental resource management and more broadly to the field of economics. Section 3.5 provides some concluding remarks.

3.2: THE MODEL

3.2.1: THE SPECIAL CASE

To introduce the world we are modelling, we shall begin by outlining a special case of our neighbourhood. Here we make a number of simplifying assumptions, some of which shall later be relaxed. Firstly, we assume our neighbourhood population to be homogenous, and thus impose identical incomes, tastes and preferences across individuals. We also restrict ourselves to a single bird species, whose members arrange themselves between gardens in accordance with Ideal Free Distribution theory. This implies that birds are highly mobile within our neighbourhood and adjust their location so as to maximise their feeding opportunities under the IFD assumption that each plays a Nash strategy. Furthermore, the number of birds (N) is fixed, meaning the bird population is independent of the aggregated food stocks. Introducing this variable as an exogenous parameter is not only useful for model simplification purposes, but also allows us to assess the Nash equilibrium against the first best when the contest but not the public good effect is present. Under such circumstances, we can confidently predict that instances of over-provision should occur.

In this special version of the model, no one neighbour is influential enough to impact upon the cost of attracting a bird, which means that this cost then remains constant for feeding decisions of our neighbours. We shall see later that this accentuates the contest element and shares intuition with the price-taking behaviour of agents in perfectly competitive markets. Such a scenario would be realisable where we have a 'large neighbourhood'. The interpretation of this which most naturally resonates is a settlement with a large or concentrated number of human residents (M). However, an equally feasible notion of a large neighbourhood is one where the bird species is far ranging in its feeding habits. For example, 'flock birds' such as starlings will travel great distances in search of food. Hence, a far larger number of neighbours actually compete when attempting to attract this type of bird. By contrast, a less nomadic bird, such as a blue tit or robin, will concentrate their feeding in a small geographical area, constituting a 'small neighbourhood'.

The Nash Equilibrium

Once we have defined its structure, we shall initially derive the Nash equilibrium of this simple model. We will then compute the level of effort which is optimal socially, thus enabling us to see if these two levels differ, and, if so, whether this is in an over-dissipating direction. We use a Cobb-Douglas function to represent the utility of a given neighbour. Equation (3.1) shows that neighbours can derive utility (U_i) either from birds which visit their garden (n_i) or through the consumption of other goods (x_i):

$$U_i = {x_i}^{(1-\alpha)} n_i^{\alpha} \qquad (3.1)$$

Only a small element of one's budget is empirically assigned to bird feeding, leading to an assumption that α is positive yet fairly close to zero. Any individual is of course constrained by a budget (Y), denoted through (3.2). The term s_i is the quantity of bird seed bought and dispensed in a neighbour's garden. Each neighbour purchases this at price (p) in order to attract birds to their garden.

$$Y = x_i + ps_i \qquad (3.2)$$

Note that we normalise the price of other goods (x_i) to unity. In order to ensure that our utility function and budget constraint are expressed as functions of the same variables, we will have to appreciate the way in which n is derived from s. Expression (3.3) relays this mechanism, with s here denoting the seed dispensed by one representative neighbour:

$$n_i = \frac{s_i}{\sum_{j=1\ldots M}^{j} s_j + Q} . N \quad (3.3)$$

The above formula supposes that the number of birds coming to any one neighbour's garden will depend upon the seed allotted by that neighbour in relation to the total food stocks contained within the neighbourhood. These stocks include both the aggregated seed of all neighbours ($\sum s_j$ in (3.3)) and exogenous natural food stocks which occur within the neighbourhood (Q). This fraction is multiplied by the number of birds which are present in the neighbourhood (N). Expression (3.3) describes a Tullock-style contest (Tullock, 1980), and resembles the behaviour of foraging birds as dictated by the Ideal Free Distribution theory.

A crucial simplifying assumption within this first version of our model is that the stocks of feed dispensed by all other households ($[M-1]s_j$) or the natural food stock (Q) is sufficiently large that an individual's feeding efforts have a negligible effect on the total amount of food provided. Hence, each neighbour takes n as a linear function of s. Under these conditions, we are permitted to use Equation (3.3) to amend our expression in (3.1). We construct our associated Lagrangian Function (L) via Equation (3.4):

$$L = x_i{}^{(1-\alpha)} s_i \left[\frac{N}{\sum_{j=1\ldots M}^{j} s_j + Q}\right]^{\alpha} + \lambda(Y_i - x_i - ps_i) \qquad (3.4)$$

Taking the first order conditions and imposing symmetry ($\bar{s} = s$), we can then solve for these expressions:

$$\frac{dL}{dx_i}: \quad (1-\alpha)\, x_i{}^{-\alpha} s_i \left[\frac{N}{\sum s + Q}\right]^{\alpha} = \lambda \qquad (3.5(\text{i}))$$

$$\frac{dL}{ds_i}: \quad \alpha \left[\frac{N}{\sum s + Q}\right] x_i^{(1-\alpha)} s_i{}^{(\alpha-1)} = p\,\lambda \qquad (3.5(\text{ii}))$$

Substituting 3.5(i) into 3.5(ii) and cancelling yields:

$$\alpha x_i + \alpha p s_i = ps_i \qquad (3.6)$$

It is noteworthy that the above expression is independent of N, meaning that the exact threshold of the bird population is not crucial for the individual when they form their equilibrium effort. We make one small adjustment in that we express (3.6) in the form of income (Y) denoted by (3.2) and rearrange to find the Nash equilibrium level of seed purchased:

$$s^* = \frac{\alpha Y}{p} \qquad (3.7)$$

Equation (3.7) gives the standard Cobb-Douglas result. The individual maximises their utility at a seed dispensation level (s^*) which is a product of their taste for birds (α) and their income (Y), divided by the price of the good (p) itself. Simple comparative statics are intuitive; seed purchase increases with a rise in income or taste and decreases with a rise in the commodity's price. Note that this equilibrium is independent both of the number (M) and feeding thresholds (s_j) of other neighbours. This confirms that we can impose symmetry in this model and then make the distinction between s_i and s_j if need be. However, this is not crucial to our analyses in this limiting case.

The Socially Optimal Level

The first-best allocation can be found by equating the Marginal Social Cost (MSC) to the Marginal Social Value (MSV) of bird feeding. We consider an appropriate definition for the MSC as the monetary cost to society of attracting one more bird to gardens. Again we impose symmetry (meaning s_i = s_j) and now capture aggregated artificial feeding through the expression Ms. To discover the MSC, we use this updated version and describe the Tullock Contest via Equation (3.3(i))

$$n = \frac{s}{Ms+Q}.N \qquad (3.3(i))$$

By differentiating this term with respect to s, we establish how the number of birds alter with a unit change in seed dispensed:

$$\frac{dn}{ds} = \frac{QN}{(Ms+Q)^2} \qquad (3.8)$$

We now wish to find the reciprocal of (3.8), as this will illustrate the change in seed required to entice one extra bird to gardens:

$$\frac{ds}{dn} = \frac{(Ms+Q)^2}{QN} \qquad (3.9)$$

We now multiply (3.9) by the price of seed (p) to obtain the MSC. This gives a monetary measure of the cost involved in attracting one extra bird into the gardens of neighbours:

$$\text{MSC} = \frac{p(Ms+Q)^2}{QN} \qquad (3.10)$$

Having derived an expression for the Marginal Social Cost, we must now define and then produce a term to represent the Marginal Social Value (MSV) of birds. The MSV should indicate the monetary value which an individual associates with the benefit of enticing one extra bird to their garden. Using our model, this can be expressed as the Marginal Rate of Substitution between our two consumption goods, x and n:

$$MSV = -\frac{\partial x}{\partial n}\Big|_{U\ Constant} \qquad (3.11)$$

A relatively simple way of calculating (3.11) is to use a version of the Chain Rule below:

$$\frac{\partial x}{\partial n}\Big|_{U\ Constant} = \frac{\partial x}{\partial U} \times \frac{\partial U}{\partial n}$$

These two constituent parts of this equation can be established directly from our utility function (3.1):

$$u = x^{(1-\alpha)} n^{\alpha}$$

$$\frac{dU}{dn} = \quad \alpha\, x^{(1-\alpha)} n^{(\alpha-1)} \qquad (3.12(i))$$

$$\frac{dU}{dx}: \quad (1-\alpha)\, x^{-\alpha} n^{\alpha}$$

$$\frac{dx}{dU} = \quad \frac{1}{(1-\alpha)}\, x^{\alpha} n^{-\alpha} \qquad (3.12(ii))$$

Using 3.12(i) and 3.12(ii), we can now derive $\frac{dx}{dn}$:

$$\frac{dx}{dn} = \frac{\alpha}{(1-\alpha)}\left(\frac{x}{n}\right) \qquad (3.13)$$

We can then use (3.3) to remove n from Equation (3.13), and express this in terms of s. The notation s^F conveys the fact that this is the effort level of a representative neighbour seen as optimal from a first-best perspective:

$$\frac{dx}{dn} = \frac{\alpha}{(1-\alpha)}\left(\frac{x\,(Ms+Q)}{sN}\right) \qquad (3.14)$$

We equate the Marginal Social Cost from (3.10) the Marginal Social Value in (3.14). We then substitute this into (3.2) and rearrange in order to make the expression comparable to (3.7):

$$s^F = \frac{\alpha Y}{p}\left(\frac{Q}{(1-\alpha)s^F + Q}\right) \qquad (3.15)$$

Equation 3.15 can be rearranged to show our social equilibrium equation has two unique roots. This is demonstrated by Equation 3.15(i) below. We previously assumed α to be relatively small, as bird seed will only constitute a small fraction of overall expenditure. This ensures that the expression within the square root of Equation 3.15(i) will be positive, in turn confirming that Equation 3.15 has two real solutions. The presence of the second component within the square root term means that one of these solutions will be negative. However, the 'credible' solution which is of greater interest for the purposes of this analysis would be the positive solution of Equation 3.15(i).

$$s^F = \frac{-PQ \pm \sqrt{(PQ)^2 + 4PQ\alpha Y(1-\alpha)}}{2P(1-\alpha)} \qquad (3.15(i))$$

Comparing (3.7) with (3.15), we conclude that the first-best level of seed an individual should allot (s^F) lies below that which the individual would choose (s^*). Thus, we confirm that there is an over-exertion of effort when neighbours after left to select their optimal feeding level. Recall that this model currently lacks a public goods aspect as the bird population (N) is exogenous and so our only 'distortion' is that of the contest effect. Consequently, the elevated Nash equilibrium represents the superfluous individual action driven through competitive motivations.

This initial model contains many simplifying assumptions which may cause a disassociation with the empirics of bird feeding at this point. However, it serves as a helpful starting point from which to begin our analyses. Furthermore, it establishes a useful reference point that helps to identify the key drivers behind the results which follow.

3.2.2: *THE EXOGENOUS POPULATION MODEL*

In reality the number of individuals interacting across a neighbourhood through a bird-feeding contest will be finite, sometimes even quite small. We therefore proceed by relaxing the assumption of a large neighbourhood used in the special case, appreciating that neighbourhoods vary in size and that such institutional differences may have a bearing upon the effort decisions of individuals (Evans & Weninger, 2014). Studies have assessed the role of effort exertions both within (Baik, 2008) and between (Nitzan & Ueda, 2009) groups of varying sizes, and have discovered that the implications of varying such a parameter are often complex and context-dependent (see Konrad, 2009 for an overview). Our model does holds the potential to reinforce or refute these ideas, although our greater focus is to assess what additional role an offsetting public goods effect may hold.

As previously described, neighbourhood size can be characterised through avian behaviour, and by analysing size through this method, our model hopes to build upon the findings of Cressman et al (2004). This study assesses how relative mobility influences the feeding distribution of birds, and we complement this work by showing how *human* decisions may change for birds whose biology or habit lead them to more localised foraging tendencies. We retain the assumptions of species and neighbour homogeneity, and also that of an exogenous bird population, supressing a public goods aspect.

Nash Equilibrium

We adjust Equation (3.3) to account for the fact that any given neighbour will have to respond to the exogenous decisions of other residents. Expression (3.3a) helps with this, decomposing the denominator in (3.3) to separate out s_i, the seed allotment decision of the individual, from s_j, the seed investments of other neighbours, which can be aggregated across all other feeders ($[M-1]s_j$). This decomposition allows us to disentangle the various feeding locations and show those which the individual can perceive as exogenous.

$$n_i = \frac{s_i}{s_i+[M-1]s_j+Q} . N \qquad (3.3a)$$

With a finite neighbourhood size we can no longer assume that the individual perceives n as a constant linear function of s. The easiest way to achieve expressing our utility function and budget constraint through the same variables is to replace n_i in the utility function with the right hand side of (3.3a). This creates 3.16(i). We can then re-write our Lagrangian function (3.16(ii)) expressed purely in terms of s_i and x_i:

$$U_i = x_i^{(1-\alpha)} \left(\frac{s_i N}{s_i+[M-1]s_j+Q}\right)^{\alpha} \qquad (3.16(i))$$

$$L = x_i^{(1-\alpha)} \left(\frac{s_i N}{s_i+[M-1]s_j+Q}\right)^{\alpha} + \lambda(Y_i - x_i - ps_i) \qquad (3.16(ii))$$

We again calculate First Order Conditions and then impose symmetry to find s:

$$\frac{dL}{dx_i}: \quad (1-\alpha)\, x_i^{-\alpha} \left[\frac{s_i N}{s_i+[M-1]s_j+Q}\right]^{\alpha} = \lambda \qquad (3.17(i))$$

$$\frac{dL}{ds_i}: \quad \alpha \left[\frac{([M-1]s_j+Q)N}{(s_i+[M-1]s_j+Q)^2}\right] x_i^{(1-\alpha)} \left[\frac{s_i N}{s_i+[M-1]s_j+Q}\right]^{(\alpha-1)} = p\,\lambda \qquad (3.17(ii))$$

We use the methodology of the proceeding section to then derive the new Nash Equilibrium:

$$s^* = \frac{\alpha Y}{p} \left[\frac{[M-1]s+Q}{(1-\alpha)s^* + [M-1]s+Q}\right] \qquad (3.18)$$

The term contained in the square brackets of (3.18) is strictly less than one. Therefore, when comparing this new Nash equilibrium to that of the special case (3.7), the result is a fall in the individual's optimal effort decision under the new conditions of a finite neighbourhood. By imposing symmetry within our neighbourhood, s^* is in fact equal to s in this expression. However, these two terms are kept as separate entities in order to simplify the analyses which are conducted in the following sections.

Equation (3.18) does not give a closed-form solution. However, using the Implicit Function Theorem, we are able to derive comparative static results to show how effort levels adjust with each of our parameters. Table 3.1 gives an overview of these comparative statics, with full results posted contained within Appendix 3.2.

Comparative Static	Sign	Explanation
$\frac{ds}{dP}$	Negative	As seed price rises, the amount of seed purchased should fall. This is logical if bird seed exhibits standard demand properties.
$\frac{ds}{dY}$	Positive	As Income rises, the level of seed purchased also rises. If we assume seed (and therefore birds) are normal good, then this is sensible.
$\frac{ds}{d\alpha}$	Positive	As a person's taste for birds rises, they will expend more effort on seed allotment. Again this complies with intuition.
$\frac{ds}{dM}$	Positive	If there is a greater intensity of feeding from other neighbours, a given neighbour will raise their effort levels. This is discussed in the section below using the graphical representation.
$\frac{ds}{dQ}$	Positive	If a greater abundance of natural food exists, a given neighbour will raise their effort levels. This is again discussed in the section below using the graphical representation.

Table 3.1: An Overview of Nash Equilibrium Comparative Statics with an Exogenous Bird Population

For the purposes of this study, another appealing method for exploring the impact of neighbourhood size is to graphically demonstrate the drivers at work within this model. To achieve this, we rearrange Equation (3.18) so that all elements outside of the square brackets move to the left-hand side of the expression, denoted through (3.18a) below:

$$\frac{ps^*}{\alpha Y} = \frac{[M-1]s+Q}{(1-\alpha)s^* + [M-1]s+Q} \qquad (3.18a)$$

By making this adjustment, we are able to now present both the left-hand side and right-hand side of the above equation on the same graph (Figure 3.1a). We now want to consider how this Nash Equilibrium, signified by the intersection of the left (line) and right (curve) hand sides, adjusts as the neighbourhood size rises. In this case, a 'Larger' neighbourhood refers to one where more neighbours exist in the model, meaning that the amount of food which is dispensed aside from that of a given individual $[M-1]s$ is relatively large compared to their contribution s. Given the nature of the right-hand side term, this curve will pivot upwards as we move towards a larger neighbourhood. Figure 3.1b describes this movement, illustrating that s^* rises as the neighbourhood gets larger. A further note is that, due to the curvature of the line, these incremental increases in s^* slow for a given rise in $[M-1]s$. As we move toward an infinitely large neighbourhood, we converge towards point E. This is the value of s^* which we discovered in our special case, and holds a value of $\frac{\alpha Y}{p}$.

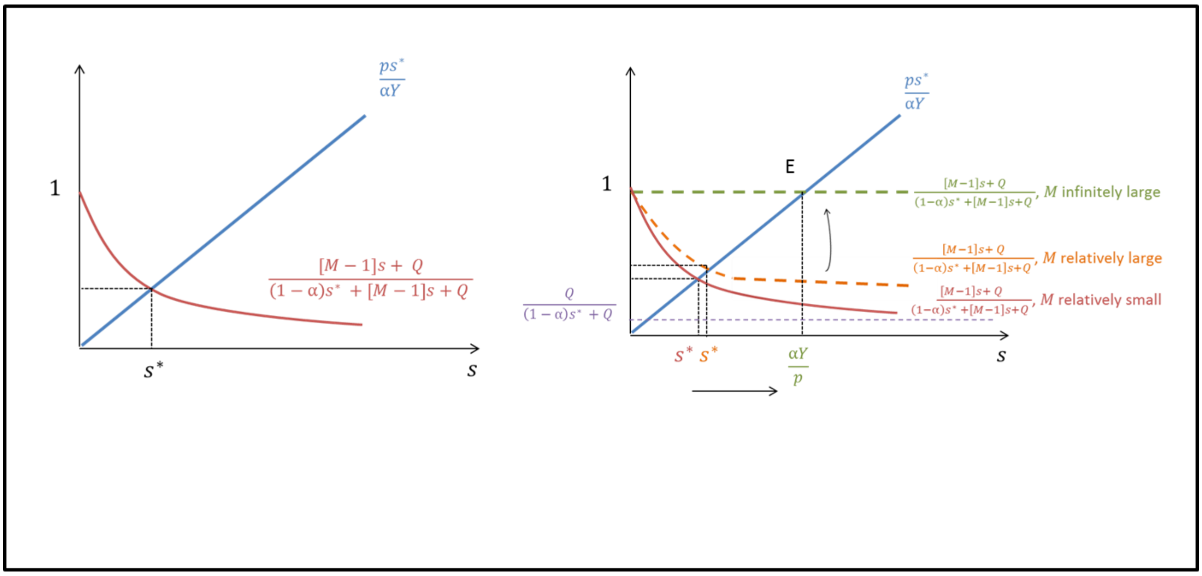
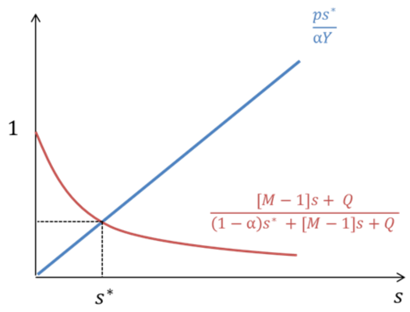


Figure 3.1a: An Implicit Analysis of the Static Nash Equilibrium

Figure 3.1b: The Impact of a Rising Neighbourhood Size

It is possible to interpret this adjustment intuitively. As a neighbourhood contains fewer and fewer rival residents the contest is dampened. Thus, there is a smaller impetus for those remaining neighbours to fight so fiercely in their attempts to draw birds to their private garden and away from those nearby. We could assess this in the limit by imagining a 'one person neighbourhood'. Here, the contest element collapses, with the now monopolistic individual knowing that any level of seed put out will result in a strong redistribution of birds toward their garden. This effect is exacerbated further in a case where the monopolistic feeder lives in a neighbourhood devoid of natural food (Q). We can check for consistency with (3.7) by assessing how (3.18) adjusts if our neighbourhood returns to its infinitely large level. In this case, the additional expression in the denominator of our bracketed term ($(1-\alpha)s^*$) becomes less and less influential, meaning s^* tends to the special case.



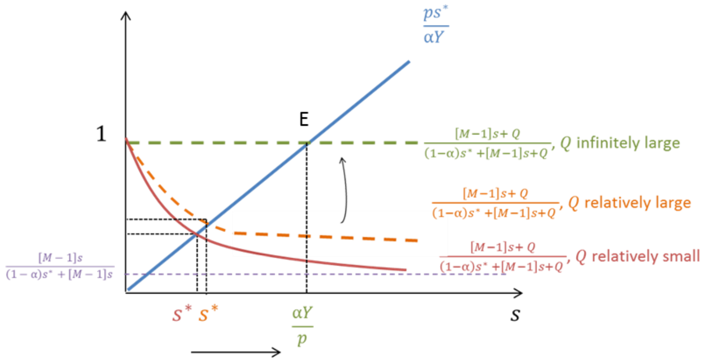


Figure 3.1c: An Implicit Analysis of the Static Nash Equilibrium

Figure 3.1d: The Impact of Rising Natural Food on the Nash Equilibrium

This implicit analysis could also be used to demonstrate the impact upon the Nash Equilibrium of a neighbourhood having varying levels of natural food (Q). Figures 3.1c and 3.1d confirm that the effects are very similar, with the only difference being the threshold of convergence upon which the individual tends toward as Q falls. As before, when natural food stocks become very large, the right-hand side tends to one for all values of s and we return to the Nash Equilibrium of the Special Case where the individual is non-influential and dispenses at a value of $\frac{\alpha Y}{p}$. As Q falls, the competitive influences decrease in our neighbourhood and the individual holds a lowered incentive to dispense seed so intensely in order to procure birds to their garden. This effect is captured by the downward swivelling of the right-hand side and a fall in the intersection which derives s^*.

There is an empirical ecological importance in discussing a change in Q separately from $[M-1]s$. This is that we can assess how the effort decision of our individuals adjusts across potential habitats. For example, in remote rural settings, we are likely to have a low level of $[M-1]s$, as there are relatively few competing residents, but this might be offset by a high level of natural food which a neighbour must compete against in order to attract birds to their garden. By contrast, Q is likely to be fairly low, even non-existent, in densely-populated urban areas, but here the concentration of other human feeders will be higher, meaning $[M-1]s$ is the main source of competition for a given neighbour. It is also credible to envisage habitats where both Q and $[M-1]s$ are either low or high, and so it is prudent to investigate how our equilibrium changes when each of these variables are adjusted in isolation.

Returning to the basic comparative static results, s^* retains a positive and negative inversely linear relationship with income and price respectively. With its additional (yet relatively minor) inclusion in the denominator of (3.19), there is a slight adjustment in the way s^* alters with changes in tastes (α). However, simulations of a closed-form solution confirm that a positive and broadly linear relationship is maintained between these two variables. When assessing the way in which s^* changes with alterations in other food sources, the association is confirmed as positive yet concave, aligned to the graphs in Figures 3.1a to 3.1d. Proofs of this relationship, which show that both $\frac{\partial s}{\partial M}$ and $\frac{\partial s}{\partial Q}$ are positive but that $\frac{\partial^2 s}{\partial M^2}$ and $\frac{\partial^2 s}{\partial Q^2}$ are negative can be found in Appendix 3.1 The positive relationship is derived from the contest element of our model, forcing any neighbour to compete more intensively in the presence of a greater number of alternative feeding sources. The concavity, played out as a function of Cobb-Douglas Model, relates to the increasing futility of such effort as the number of rival sources tends to infinity. Of course, the threshold upon which this concave expression converges is that of the Special Case (3.7).

The Social Equilibrium

It is not possible to say whether the lower Nash investment decision of 'small neighbourhoods' is better or worse than in the special case until we have determined if the first-best feeding rate is affected by this change in conditions. The original social optimum, defined by (3.15), is re-written below:

$$s^F = \frac{\alpha Y}{p}\left(\frac{Q}{(1-\alpha)Ms^F + Q}\right) \quad (3.15)$$

Recall that we did not rely upon an infinite neighbourhood size when deriving this and therefore the expression for the social equilibrium is then applicable to all neighbourhood sizes and remains unchanged for this version of our model. With algebraic calculations given in Appendix 3.2, Table 3.2 gain summarises the algebraic comparative statics which can be derived through using The Implicit Function Theorem:

Comparative Static	Sign	Explanation
$\frac{ds}{dP}$	Negative	As seed price rises, the amount of seed purchased should fall. This is logical if bird seed exhibits standard demand properties.
$\frac{ds}{dY}$	Positive	As Income rises, the level of seed purchased also rises. If we assume seed (and therefore birds) are normal good, then this is sensible.
$\frac{ds}{d\alpha}$	Positive	As a person's taste for birds rises, they will expend more effort on seed allotment. Again this complies with intuition.
$\frac{ds}{dM}$	Negative	If there is a greater intensity of feeding from other neighbours, a given neighbour should lessen their effort levels. This is discussed in the section below using the graphical representation.
$\frac{ds}{dQ}$	Positive	If a greater abundance of natural food exists, a given neighbour will raise their effort levels. This is again discussed in the section below using the graphical representation.

Table 3.2: An Overview of First-Best Comparative Statics with an Exogenous Bird Population

Again we can use graphical analyses to see how the social equilibrium adjusts with neighbourhood size. We again begin by rearranging the expression to give a linear left-hand side and curved right-hand side:

$$\frac{ps^F}{\alpha Y} = \frac{Q}{(1-\alpha)Ms^F + Q} \qquad (3.15a)$$

Replicating the steps then taken for the Nash solution, we can describe a relationship through Figure 3.2b, which symbolises how the two sides adjust as the value of $[M-1]s$ rises. This creates a downward swivel in the curve and thus from the perspective of a first-best solution, it would be better if each individual fed less intensely in a larger neighbourhood *ceteris paribus*.

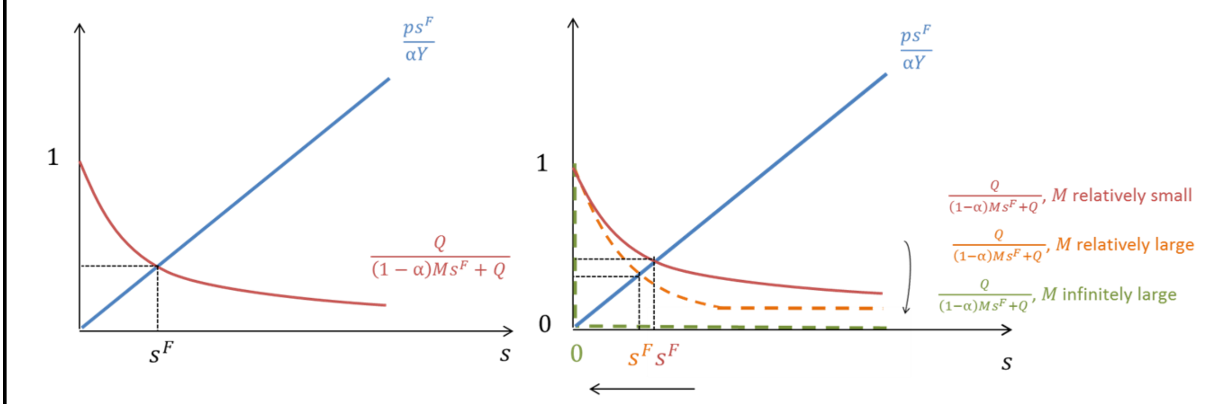


Figure 3.2a: An Implicit Analysis of the Static Social Equilibrium

Figure 3.2b: The Impact of a Rising Neighbourhood Size

The beauty of such an analysis is that we can present the two above equilibrium results (3.1b and 3.2b) on the same diagram. Figure 3.3 captures this, illustrating the divergence of the Nash and first- best solutions as the number of rival neighbours rise.

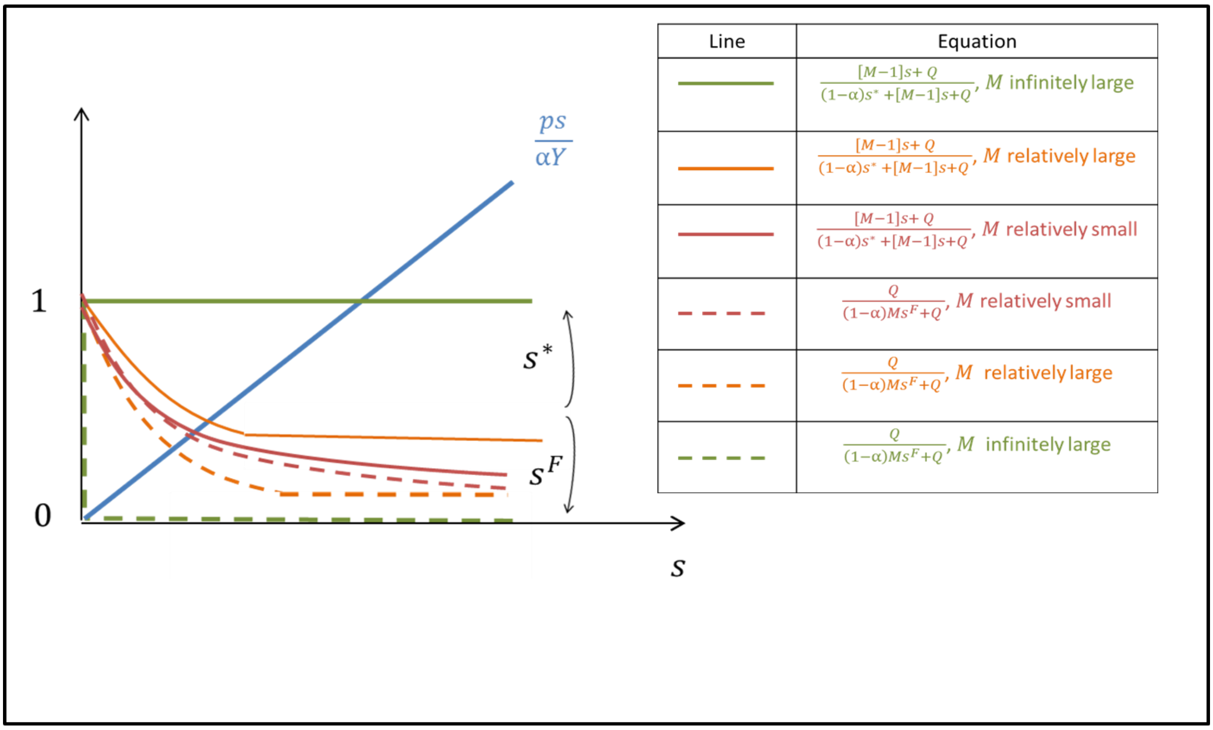


Figure 3.3: An Implicit Analysis of the Divergence from Social Efficiency as the Neighbourhood Size Rises

Our conclusion for the special case was that we witnessed an over-exertion of feeding effort by neighbours. With no alterations in the expression for first-best optimum and yet seeing our new individual equilibrium (3.18) fall, our model predicts a convergence toward social efficiency as we reduce neighbourhood size. From an inspection of the alterations in the bracketed terms of expressions (3.15) and (3.18), it becomes clear that when $0 < \propto < 1$ over-provision persists within the model and that this over-dissipation of effort rises as $[M-1]s$ increases. This is reinforced by Figure 3.3, where the Nash equilibrium always appears above that of the first-best solution, and we witness a greater gap between dashed and filled lines as the neighbourhood size rises.

If we instead explore the impact of increasing the stock of natural food on the first-best solution, this direction of efficiency is not so clear. Using the same analysis as above, we see that the social optimum also shifts upwards towards our special case (seen in Figure 3.4). Thus, the analysis of Figure 3.3 no longer holds, as now s^* and s^F both move in the same direction. In the limiting case of an exceptionally large level of Q, the Nash and first-best solutions converge to a value of $\frac{\alpha Y}{p}$:

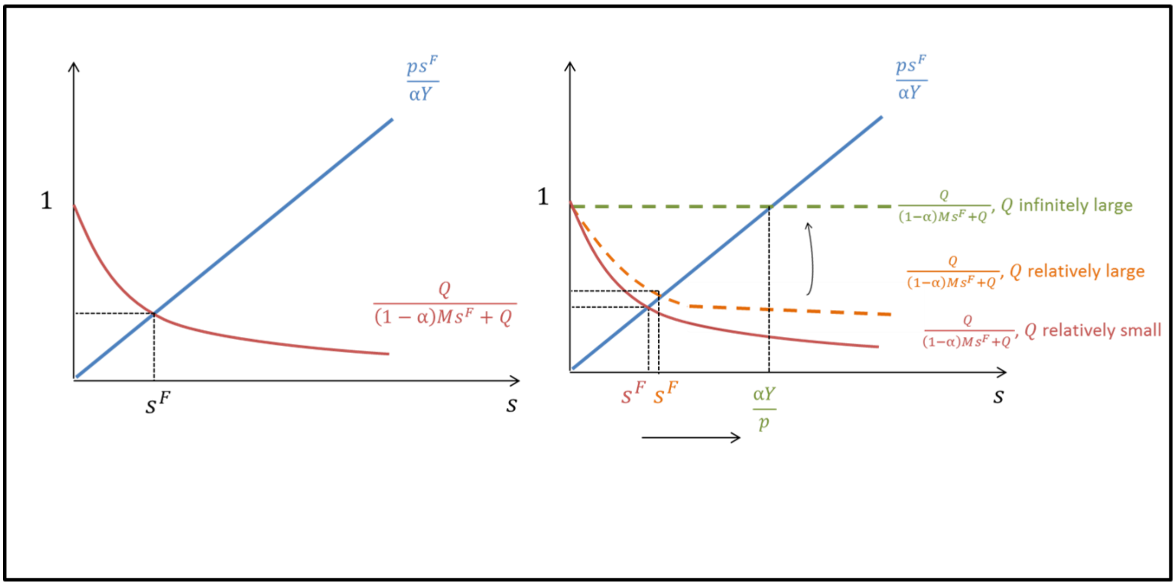


Figure 3.2a: An Implicit Analysis of the Static Social Equilibrium

Figure 3.4: The Impact of Rising Natural Food on the First-Best Solution

How can we associate this difference with the Contest elements within our model? In the former case, where we increase the number of other supplementary feeders, our individual feeds more intensively, but a social planner would prefer them to relent from feeding. In this scenario, the reason for the divergence is that whilst the individual feeds in order to try and attract more birds to their garden, they disregard the negative implications that this has on the neighbours who they 'steal' birds from. However, from the first-best standpoint this disutility of stolen birds has to be accounted for. In essence, this reallocation of birds from one neighbours' garden to another constitutes wasteful duplication of effort as a social planner is indifferent as to which neighbour receives the birds so long as they appear in somebody's garden.

In the latter case, we are adjusting the natural food holding all other variables constant. Here, the individual is feeding in greater quantities for the same purposes, only this time their 'rival' is that of the natural sustenance as opposed to other artificial feeders. However, this explains why the first-best solution also advocates an intensification of feeding. Now, a greater effort from a neighbour will predominantly result in a relocation of birds from natural sources, where society yields no utility, to neighbours' gardens where they do. Because the contest is not occurring between two neighbours, there is no wasteful repeated effort and the motives of the individual and the social planner align.

From a policy perspective, our analysis concludes that a 'small neighbourhood' leads to a lower but more socially optimal level of effort when decisions are purely driven by an inter-neighbour contest. The rationale behind this is clear: in smaller neighbourhoods the negative spillovers are lessened as they affect fewer people and hence the wedge between the private and the social optima is smaller. This resonates with the empirical notion that close-knit or localised communities expend effort in a more efficient manner (Frank, 2003). If we instead use our avian interpretation of neighbourhood size, our results indicate that regions which contain a greater proportion of bird species who forage locally create a more economically and ecologically efficient neighbourhood than ones which contain a higher percentage of birds with nomadic feeding tendencies. This is because in the latter case, the birds are essentially living in a 'neighbourhood' with a greater number of competing neighbours ($[M-1]s$).

3.2.3: <u>THE ENDOGEOUS POPULATION MODEL</u>

The over-provision which exists in the models discussed until now is unsurprising given that we still only include one of our two contrasting effects. Neither model representing an exogenous bird population gives an individual the opportunity to contribute to a public good and therefore no incentive to refrain from exerting effort in behaviour akin to free-riding. With just contest-induced motives active thus far, a situation describing autonomous over-investment is a natural product of our world in its current form. The next challenge is to remove the assumption that bird populations are independent of feeding intensity and repeat our analyses when both the public good and contest effects exist within our model. Assuming neighbourhoods with greater disposition to put down seed will hold a greater concentration of local sustenance compared with adjacent regions, Ideal Free Distribution Theory implies that these will then profit from elevated local bird populations. This could occur in one of two ways; either through the migration of new birds into this food-rich location and away from other neighbourhoods, or through the additional reproductive success which will be afforded from birds living in a now more nutritious environment. The motivations for this amendment are obvious as we finally allow our model to assess the impact of including a public good aspect, identifying the role that avian population adjustment has on human decision-making.

In order to capture the notion of an endogenous bird population, we replace N in our model with an expression where bird numbers react positively to food levels. How public goods are introduced into a model can have profound implications for the level of ensuing contributions (Isaac & Walker, 1988; Chan et al, 1996; Chan et al, 1999) and so it is important to use a mechanism which is credible and realistic. Our chosen method is defined through (3.19) below, which replaces (3.3a) and gives a new expression to resemble our contest:

$$n_i = \frac{s_i(s_i+[M-1]s_j+Q)^{\beta}}{s_i+[M-1]s_j+Q}, \quad \beta \geq 0 \qquad (3.19)$$

As well as allowing us to incorporate a public goods aspect into our model, transforming (3.3a) into (3.19) affords us the opportunity to evaluate how different values of β influence our equilibrium solutions. This parameter can be thought of as the degree to which higher food stocks provide more birds, analogous to returns to scale. Through the following calculations, we use this new endogenous population expression whilst also retaining a relaxation of the assumption that there exists a finite population of neighbours.

Nash Equilibrium

In order to calculate the new Nash solution, we apply the same method from the 'exogenous population' model, simply amending the initial utility function to appreciate the new public goods opportunity:

$$U_i = x_i^{(1-\alpha)} \left(\frac{s_i(s_i+[M-1]s_j+Q)^{\beta}}{s_i+[M-1]s_j+Q}\right)^{\alpha} \qquad (3.20(i))$$

$$L = x_i^{(1-\alpha)} \left(\frac{s_i(s_i+[M-1]s_j+Q)^{\beta}}{s_i+[M-1]s_j+Q}\right)^{\alpha} + \lambda(Y - x_i - ps_i) \qquad (3.20(ii))$$

$\frac{dL}{dx_i}$: $\quad (1-\alpha)\, {x_i}^{-\alpha} \left[\frac{s_i(s_i+[M-1]s_j+Q)^{\beta}}{s_i+[M-1]s_j+Q}\right]^{\alpha} = \lambda$ (3.21(i))

$\frac{dL}{ds_i}$: $\quad \alpha \left[\frac{(s_i+[M-1]s_j+Q)^{\beta}[\beta s_i+ [M-1]s_j+Q]}{\left(s_i+[M-1]s_j+Q\right)^2}\right] {x_i}^{(1-\alpha)} \left[\frac{s(s+[M-1]\bar{s}+Q)^{\beta}}{s+[M-1]\bar{s}+Q}\right]^{(\alpha-1)} = p\,\lambda$ (3.21(ii))

Imposing symmetry and rearranging the above expression yields our associated Nash equilibrium effort level:

$$s^* = \frac{\alpha Y}{p}\left[\frac{\beta s+ [M-1]s+Q}{(1-\alpha(1-\beta)s^* +[M-1]s+Q}\right] \quad (3.22)$$

As with the exogenous population model, the comparative static results can be found in Appendix 3.2, with calculations derived using partial differentiation of The Implicit Function Theorem. The introduction of this public good element leads to some interesting changes within the individually-optimal feeding decision. Crucially, we realise that the extent to which the level of exertion coincides with previous counterparts (3.7 and 3.18) hinges upon the value of β.

When β is equal to zero, we return to a world whereby bird populations are unaffected by feeding concentrations. Algebraically, we can confirm that the consequence of this is a partial collapse in the bracketed expression of (3.22) which leads to a reversion to the expression for s^* denoted by (3.18). Conversely, consider the impact of when β is equal to unity. This represents an environment exhibiting 'constant avian returns to scale' from a given change in the level of food made available within a neighbourhood. Here, the bracketed term in (3.22) collapses completely (to one) and we return to the equilibrium level of the special case (3.7). Figure 3.5 relays these insights diagrammatically.

This result illustrates that the absolute level of feeding in the presence of a public good element is completely dictated through the degree of productivity associated with pro-social activity. This analysis suggests that the greater the value of β, and thus the more easily attainable the public good, the greater the absolute level of effort exerted by the individual. We must realise that witnessing a higher value of β simply represents the enablement of a greater level of birds (n_i) to be achieved by an individual at *any* given food level. As we assume birds to be a normal good, this increased effort can then be taken to represent an outward swinging of the budget constraint as aggregate food stocks $(Ms + Q)$ increase.

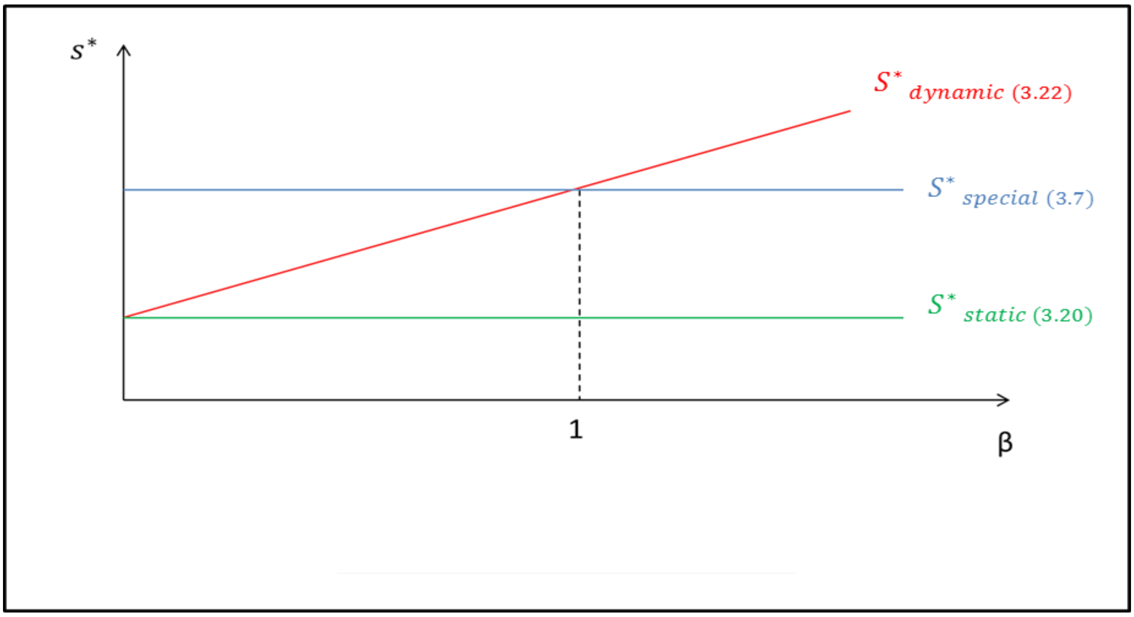


Figure 3.5: The Relationships between the Various Nash Equilibrium Effort Levels as the Productivity of Feeding (β) Rises.

To see whether the inclusion of this public good has driven any real change in the level of social efficiency requires a re-calculation of s^F. This should also allow us to ascertain whether, and if so to what extent, free-riding tendencies emerge.

Creating a new expression for both the Marginal Social Cost and Marginal Social Value is necessary given that both elements adjust under these new conditions. However, the mechanism by which these are derived does not alter, meaning we simply repeat the earlier methodology:

$$\frac{dn}{ds} = \frac{(s+[M-1]s+Q)^{\beta}[\beta Ms+Q]}{(s+[M-1]s+Q)^2}$$

$$\frac{ds}{dn} = \frac{(s+[M-1]s+Q)^2}{(s+[M-1]s+Q)^{\beta}[\beta Ms+Q]}$$

Again, we multiply the above expression by seed price in order to formulate the MSC:

$$\text{MSC} = \frac{p(s+[M-1]s+Q)^2}{(s+[M-1]s+Q)^{\beta}[\beta s+Q]} \tag{3.23}$$

$$MSV = -\frac{\partial x}{\partial n}\Big|_{U\ Constant}$$

$$\frac{\partial x}{\partial n} = \alpha\, x^{(1-\alpha)} n^{(\alpha-1)}\ x\ \frac{1}{(1-\alpha)}\ x^{\alpha}\ n^{-\alpha}$$

$$\text{MSV} = \frac{\partial x}{\partial n} = \frac{\alpha}{(1-\alpha)}\left(\frac{x}{n}\right) \tag{3.24}$$

This time, we use our adjusted contest expression (3.19) to define the Marginal Social Value in terms of s:

$$\text{MSV} = \frac{\partial x}{\partial n} = \frac{\alpha}{(1-\alpha)}\left(\frac{x\ (s+[M-1]s+Q)}{s(s+[M-1]s+Q)^{\beta}}\right) \tag{3.25}$$

Finally, we equate MSC = MSV by setting (3.23) equal to (3.25):

$$\frac{p(s+[M-1]s+Q)^2}{(s+[M-1]s+Q)^{\beta}[\beta Ms+Q]} = \frac{\alpha}{(1-\alpha)}\left(\frac{x\ (s+[M-1]s+Q)}{s(s+[M-1]s+Q)^{\beta}}\right)$$

$$s^F = \frac{\alpha Y}{p}\left(\frac{\beta Ms^F+Q}{(1-\alpha(1-\beta))Ms^F+Q}\right) \tag{3.26}$$

Having found a new first-best equilibrium, we initially compare this with the original optimum (3.15), before considering whether these adjustments create any differences between the private effort exertion and that deemed communally best.

When moving from s^F of the exogenous (3.15) to the endogenous (3.29) population model, it is apparent that the socially optimal level of bird feeding is larger in the latter. To confirm this, consider the alterations that occur in the bracketed terms. Both the numerator and denominator contain an additional term (βMs), although the latter is multiplied by alpha. Given the nature of this fraction, we observe an increase in the social equilibrium whenever 0 < ∝ < 1. If both s^* and s^F are now increasing, this reinforces the earlier statement that a rising individual optimum does not necessarily signal a violation of the free-rider problem.

When assessing how this new first-best optimum (3.26) relates to that of the Nash effort level (3.22), we use a similar analysis as above. This time we compare the alterations which occur in the numerator and denominator as we move from the social to private equilibrium. The numerator rises by a factor of $(1-\beta)[M-1]s$, and again the corresponding adjustment to the denominator is this expression multiplied by α. Our assumptions on the magnitude of alpha and beta are now critical in determining whether the individual over, under or exactly provides food relative to the level advocated in a first-best situation. If we assume β < 1, meaning the public good exhibits decreasing returns to scale, then $s^F < s^*$ and thus over-provision persists within our model. However, the degree of over-provision is reduced compared to the exogenous population model.

The diminishing potency of over-exertion continues as β approaches 1, or as the public good gains in its productivity. Algebraically, we can confirm that over-dissipation is completely eradicated when β equals unity. This means that if bird (re-)production exhibits constant returns to scale there will be no difference between (3.26) and (3.22), meaning that the Nash equilibrium coincides with the social optimum . Moreover, this situation where β = 1 results in a complete collapse of the bracketed fraction (to unity). In this case, both the private and social equilibrium will exist at a magnitude of $\frac{\alpha Y}{p}$.

We can take the analysis one step further and imagine a world where the public good offers increasing returns to scale, or where β > 1. We see that now the social optimum (3.26) will be at a level higher than the privately optimal amount of bird feeding (3.22) and individuals under-provide seed relative to the first-best level.

Let us explicitly assess these differing scenarios from the perspective of our two effects. For either 'exogenous population model', we see an unequivocal over-provision of bird seed relative to the social optimum. In these cases, this occurred because only the contest facet was present within the model. By adapting our world to then include the public goods effect, we see our results change. When nature exhibits decreasing returns to scale in providing birds, meaning values of β which are positive but less than one, the contest effect continues to dominate, albeit to a lesser degree. However as beta rises, the over-dissipation of effort from the contest finds itself being substantially eroded by the public goods effect. This reaches a threshold, where β = 1, when the two forces perfectly offset one another and s^* represents a level of feeding which exactly corresponds to s^F . When β is allowed to surpass unity, neighbours fail to exert effort in the volumes advocated by the social optimal. Under-provision now ensues within the neighbourhood, signifying a domination by the free-rider tendencies of individuals over content effects. These neighbours can now draw private benefits from the relative productivity of others' contributions in delivering birds to the neighbourhood. Put another way, when the model contains increasing avian returns to scale from raising aggregate food levels, people can satisfy their taste for birds by dispensing a socially sub-optimal quantity of seed.

It is worth noting at this stage that adjustments in the Nash and first-best solutions are more exaggerated within smaller neighbourhoods. In the limiting case where neighbourhoods become infinitely large, some of the comparative static results displayed here and in subsequent analyses will only cause relatively insignificant changes in the behaviour of each individual neighbour. Despite this, the analyses contained here nicely demonstrate how our two offsetting effects operate, and describe how their relative potencies determine whether the aggregated private contributions of individuals within a local area will be below, at or above that which is efficient from a communal perspective.

3.3: FURTHER EXTENSIONS

Within both our 'exogenous' and 'endogenous' population models there are still a number of assumptions which we may wish to question and adjust in order to exhort additional realism. The next two sub-sections relax two such facets.

I. Private Natural Food (q)

Natural food (Q) is a sensible variable to contain within our model. It gives us the chance to construct a hypothetical scenario whereby no neighbours feed and yet birds can still thrive within the neighbourhood. Additionally, it enables the modeller to assess the impact of these natural food stocks being relatively abundant or scarce in relation to aggregate (Ms) or individual (s) supplementary seed.

Despite its relevance for the model, the current notion that natural and privately provided stocks of food are located in spatially separate areas is not always realistic. Whilst natural food does exist outside of private gardens, for example in urban parks or waste grounds, it is equally feasible that natural sustenance can be found within the borders of people's private gardens. This is perhaps even more likely across urban landscapes, where gardens constitute a high proportion of total foraging space. Furthermore, even when they feed upon natural sources of food, the very presence of birds in people's gardens still offer an opportunity to engage with nature and establish inter-connectedness, forming a channel from which residents could derive utility. Subsequently, we briefly consider how neighbours' dispensing efforts are influenced by converting Q to a disaggregated $'q'$ that represents garden-specific natural food. Of course, from a subjective wellbeing standpoint, we cannot necessarily assume q and s as perfect substitutes because the utility-enhancing attributes of dependency and responsibility are reduced (if not eradicated) when birds forage 'naturally'. For the purposes of our analysis, we shall ignore this technical disparity.

We would imagine that this conversion should reduce the incentive to actively engage in supplementary feeding. Essentially, q provides neighbours with a pre-existing threshold of food and consequently the marginal productivity of dispensing seed falls. Assessing this effect allows us to consider how people adjust their behaviour when a substitutable product not only exists, but also how their decisions may vary as the degree of exclusion or ownership alters.

Whilst calculations are not explicitly included here, we re-ran our analyses to test our conjectures regarding the adjustments in the Nash equilibrium when converting natural food stocks from an externally to privately-located variable. For both the exogenous population models and the endogenous population model with $\beta \leq 1$, the equilibrium effort level of our individuals falls. This relates to a form of 'crowding out' akin to that described by other studies (see Bergstrom et al, 1986 for an example). Given these models were previously susceptible to qualities of over-provision, the effort dissuasion which is facilitated through this redistribution mechanism resembles a convergence towards the associated level of supplementary feeding deemed socially optimal. It is also worth mentioning that, for a sufficiently high level of q, we may find the individual completely unwilling to supply supplementary feed. We excluded our analyses of these corner solutions by imposing the restriction that q cannot be so high that the optimal seed dispensing level is at a threshold below zero.

Regarding the endogenous population model, this effect becomes smaller as β rises. Why would the inclusion of a public goods effect decrease a neighbour's disinclination to feed in the presence of q? When β is strictly positive, aggregate bird numbers rise from an increase in food stocks. Holding all other things constant, neighbours are now rewarded more greatly from feeding relative to a case where bird numbers are fixed (the exogenous population model). This, at least partially, re-incentivises them to feed. Further to this point, where β > 1, the conversion to q actually causes a *rise* in contributions relative to the case containing Q, lessening the extent to which this neighbourhood would under-provide.

These findings, depicted through Figure 3.6, suggest that amending the characterisation of natural food stocks from a location independent to an individually allotted system creates a 'regulating' mechanism. This means that neighbours reduce their feeding levels in an over-exerting world but will increase their efforts when private contributions are falling short of the threshold which is seen as socially optimal.

Reiterating our earlier reasoning, the disinclination to feed in over-providing scenarios usually stem from dampened contest effects. This is essentially what occurs when neighbours are endowed with an initial natural food stock (q). However, delivering an empirical distinction between 'natural' and 'manual' food sources is not straight-forward. For example, humans who invest in wildlife gardening indirectly expend money on substances which then constitute 'quasi-natural' sources of sustenance although not being manually dispensed in the traditional bird-feeding manner. This is not unusual in the UK, and 29% of those sampled in the 2013/14 'Monitor of Engagement with the Natural

Environment (MENE) survey' indicate that they invest in some form of wildlife gardening to encourage local creatures to visit and thrive (www.gov.uk, p.2). Despite this confounding practical facet, it is interesting and important to realise the impact that digressions such as these may have upon the private actions of an individual. This gives further reason to emphasise the importance of understanding the context-specific considerations associated with the provision of environmental public goods. Indeed, it is only by appreciating these types of factor that environmental economists will be able to advocate insightful and useful policy recommendations.

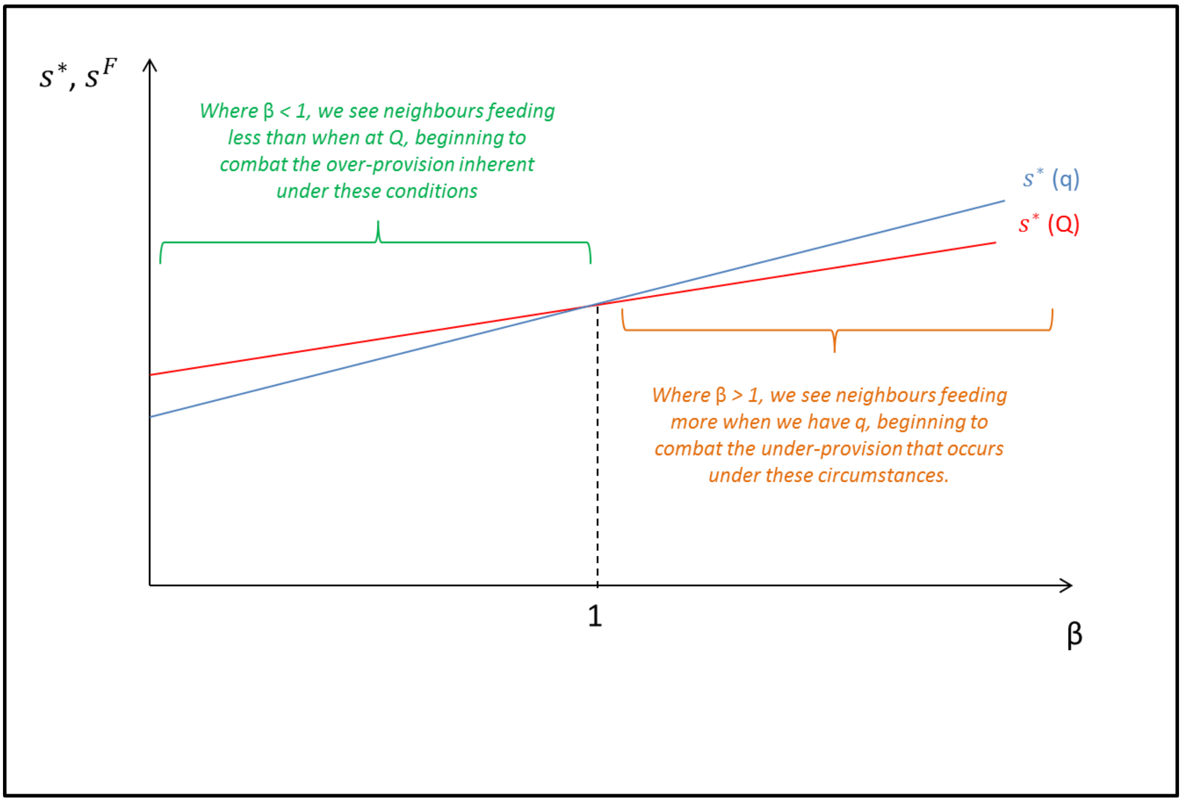


Figure 3.6: An Illustrative Explanation of Moving from External to Locally-Specific Natural Food

II. *Introducing Heterogeneity in Income (Y)*

The final assumption we relax in these analyses is that which imposes symmetry across neighbours. Some degree of homogeneity is clearly realistic when examining a neighbourhood. People who live within the same residential area are likely to reside in houses of similar size, have comparable incomes and hold some overlap in their tastes.

However, strict homogeneity is unrealistic. We briefly discuss the implication of introducing a dispersion in particular personal attributes upon the aggregated seed investment within a neighbourhood. The standard theoretical prediction is that 'asymmetry between contestants who participate actively in the contest reduces total expenditure' (Konrad; 2009, p.63-64). Here, we consider just one attribute, income (Y). In our opinion, this constitutes one of the most empirically intuitive aspects to model heterogeneously.

The existing literature casts a varied picture regarding the impact of disparate incomes and contributions to public goods. Some studies show the aggregate impact as unaffected (Sugden, 1984; Buckley & Croson, 2006; Bartling & von Siemens, 2011), whilst others suggest that wealth or power differences can lead to greater (Chan et al, 1996; Bewley, 1999; Olszewski & Rosenthal, 2002; Frank, 2003) or lesser (Isaac & Walker, 1988; Doraszelski & Markovic, 2007) levels of contribution. These authors have assessed the impact of heterogeneity in both experimental and empirical settings. They have also applied them to a range of topics including employee effort, taxation, group co-operation and advertising.

In order to assess the impact of income heterogeneity without the complex comparative static analysis of a closed form solution, we explain our results implicitly through the graphical model of Figure 3.1a:

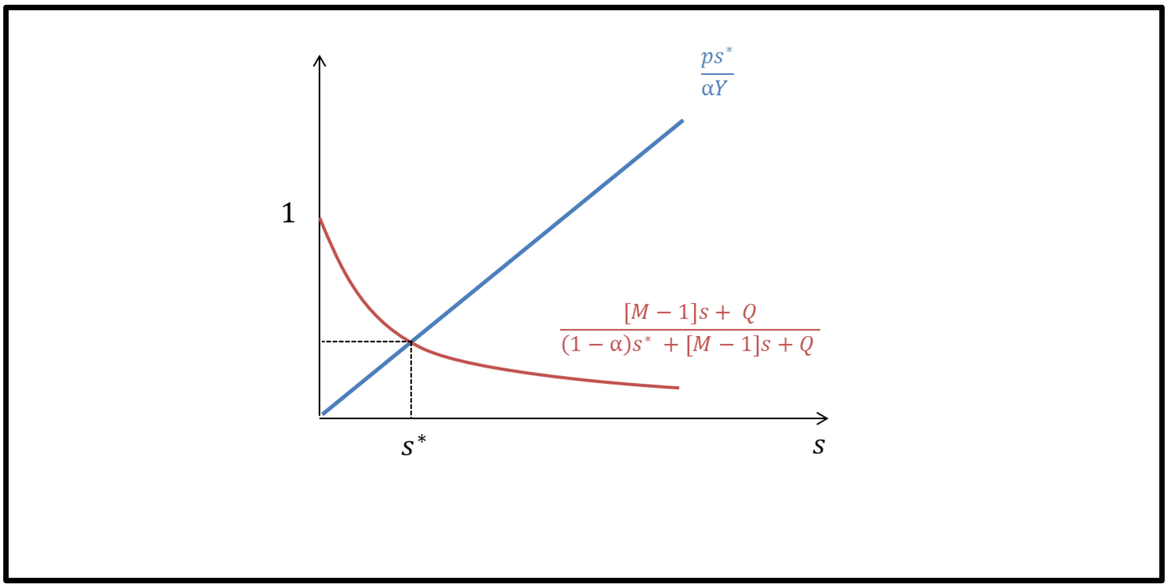


Figure 3.1a: An Implicit Analysis of the Static Nash Equilibrium

This graph confirms that income (Y) appears as a linear interaction with seed effort decisions. Those with higher incomes would expend an above-average level of effort whilst those on lower incomes would allot seed and levels below the mean. Using a set of reasonable parameters (runs of which are not shown here) confirm that by introducing heterogeneity of income, aggregate investment efforts fall relative to when income homogeneity exists. This effect, constituting a convergence towards social efficiency, rises as we increase neighbourhood size. This result adheres with the theoretical prediction of Konrad described above, and can be attributed to the contest element of our neighbours' utility functions. Under conditions of homogeneity, all neighbours have an equal endowment with which to compete. However, as incomes are transferred to create an unequal society, the feasibility for less endowed neighbours to actively engage in the contest is lessened. In the limiting case whereby all income is transferred to one individual, the Nash Equilibrium would converge to the first-best solution because the contest is effectively eradicated from the neighbourhood. An equally pertinent finding realises that even when the average income of a group is held constant, there is a significant *redistribution* of effort expenditures when income heterogeneity is introduced.

Our model began as one of simplicity, containing a number of convenient assumptions. However, the above analyses have enabled us to explore the impact of relaxing many of these restrictions. These investigations have enabled us to derive a set of sound conjectures of when and by what extent competing neighbours would feed their local garden birds with greater or lesser social efficiency. By doing so, we have discovered different instances where our 'autonomous neighbourhood' finds itself feeding above, below or at the threshold advocated by the social optimum. This is widely dictated by two competing effects; contest-driven competition and public goods-fuelled free-riding. Neighbourhood size (M), natural food substitution (q) and socio-demographic heterogeneities (Y) can all impact upon the extent of neighbourhood inefficiency and thus are all important factors to consider before advocating a policy recommendation. In the final section we discuss some empirical applications and implications of this model and draw some conclusive remarks which we hope will hold some poignancy for the field of environmental economics.

3.4: <u>APPLICATIONS</u>

Whilst our analyses applied this model to bird-feeding, there is no reason to believe that our theory cannot be extended to situations beyond this example. Indeed, there are a variety of relevant problems within the field of environmental economics where the competing impacts of public goods and contests could be modelled in a way similar to that which we presented here. In each case, society can use the competitive nature of private individuals to establish a greater level of effort or expenditure. This would simultaneously secure a greater level of the associated public good (Cameron et al, 2012; Croson & Treich, 2014). Potential instances include the motivating of energy efficiency (Allcott, 2011; Delmas & Lessem, 2014) or examining the desire for humans to undertake eco-tourism, grouse-shooting and wildlife volunteering (e.g. toad rescues www.bbc.co.uk).

The studies by Allcott and Delmas & Lessem provided individuals with information on their peer-related energy efficiency. This is an example of where relatively cost effective behavioural mechanisms can be implemented so as to drive competitive individuals toward socially advantageous outcomes. Allcott's study found that by raising a resident's awareness regarding their approximate energy efficiency created a private adjustment in action equivalent to a 1-2% drop in energy usage. Furthermore, many of the behavioural changes were simple and already known by the residents. This suggests that imposing competitive stimuli can create fairly cost-free and self-beneficial impacts for the private individual, whilst at the same time generating desirable public advantages.

Another example which illustrates the potency of competition in enabling the private provision of public goods relates to litter rebate mechanisms established in developed societies such as Germany. This Government introduced legislature which entitled people to a refund when they return the packaging of products such as plastic and glass bottles. One unforeseen implication of this policy has been that, in many public places, a social norm has arisen whereby people discard the packaging of these goods as an act of charity. Their rationale is that the litter will be collected by those most in need who will then receive a form of payment for their action. Let us apply this example to our model. The 'contest' is akin to the efforts of competing litter-pickers. The environmental public good relates to the removal of unsightly litter from public areas. Let us assume that litter levels are fixed in a given area (like the exogenous population model). If no payment existed, we would expect an under-provision of effort by citizens relative to the social optimum. Litter is left unpicked and the public good is insufficiently provided. If instead a very small rebate is paid, then we should expect a reaction to this. Those with very low marginal value for time invest their efforts collecting the packaging to receive the associated payments. However, we would not expect this to completely eradicate litter. By contrast, at a very high rebate rate, there is now a sizeable private incentive to retrieve litter. Individuals are driven by these payments but are also in direct competition with each other. The consequence of this will surely be an over-exertion of effort, demonstrated through agents spending time searching for litter in areas absent of packaging, or through wastefully duplicated search efforts (Evans & Weninger, 2014). Whilst this will mean the public good objective is met (i.e. all litter is removed), this will have been achieved in an effort-inefficient manner relative to that which the social optimum would dictate. Overall, our analyses would lead us to assume that an equilibrium rebate rate would be one whereby the level of effort employed by citizens exactly matches that required to eradicate all litter from public places efficiently. However, the contest and associated private monetary incentive to retrieve litter will cause this equilibrium rate to be lower than if no such dynamic existed. We assume the level of litter to be exogenous, yet it is plausible to adapt this example so that the volume of litter is endogenous. This would resonate with our charitable German population who discard more rubbish in public places through seeing a higher concentration of people dependant on litter picking in their society. Such action is in fact promoted in Germany (see http://www.pfand-gehoert-daneben.de/ for an instance of this). This example of course has a natural policy implication. Although employed in Germany, many similar societies have not introduced such a scheme. Our analyses therefore nicely show one way in which an institution might manipulate the private incentives of individuals in order to derive social constructs which simultaneously solve classic public goods dilemmas.

Our model of offsetting effects may also be of interest to other areas in economics. One natural application would be to the advertising decisions of rival firms. An area already explored by competition economists (Grossman & Sharipo, 1984; Simbanegavi, 2009), this industry has a similar public goods dilemma. The difficulty lies in establishing whether the total private advertising efforts of firms are excessive or inadequate relative to the socially advisable level. Excessive advertising primarily arises when strong competitive tendencies exist between substitutable products, whilst inadequate advertising will occur when the promotional efforts of one firm provide strong public spill-overs to those of allied products, facilitating extensive inter-firm benefits. Understanding just how these two aspects interact within a given industry will allow competition authorities to decide when the intensity of advertising is too great or is insufficient. Furthermore, it may potentially suggest how to adjust the market's structure so as so remedy against these imperfections.

Whilst the cases above show likenesses to our motivating example of bird-feeding, one should always be wary of the ease with which the findings from one example can be transferred to another (Evans & Weninger, 2014). In this case, this may hinge of a number of factors. One of the most important of these is the mechanism by which a contest is formed. In the bird-feeding case, the competitive drive of neighbours is borne from their self-motivated desire to attract birds to their own garden. In the three examples we examine above, the derivation of a contest instead occurs through status relativities, institutional structure and product substitutability respectively. Despite this technical issue, the purpose of this section was to illustrate more broadly how the role of competition could be instrumental in combatting free-rider tendencies synonymous with traditional public goods theory. Nevertheless, one important research recommendation of this paper is to establish whether, and if so to what extent, the contest structure itself influences people's decisions. This should help ascertain the degree to which our bird-feeding model is capable of representing these assimilated cases.

3.5: <u>CONCLUSION</u>

The under-provision of public goods when dependent upon private voluntary contributions is a well understood phenomenon and discovering a solution to this issue poses a sizeable social, economic and political obstacle. Environmental goods are no exception, and attempts to make private organisations or individuals invest adequate time and/or finances in the procurement or conservation of natural public resources typically falls short of the required standard. Previous studies have already shown that one mechanism which may partially alleviate this disinclination to contribute involves manipulating the 'impurity' of a good. When executed correctly, an individual should hold a greater incentive to contribute because they can simultaneously derive some form of private utility through this action. This notion has been used to explain how instances of charitable donations (Sieg, 2012), environmental offsets (Kotchen, 2009) and lottery fundraising (Morgan & Sefton, 2000) can procure higher thresholds of revenue than traditional economics would predict.

The theoretical model in our paper employs contests as a way to boost private incentives for contributing to public goods. Using bird-feeding as a motivating example, we have illustrated how an individual's contribution efforts will depend upon two opposing mechanisms. We define these as 'the contest effect' and 'the public goods effect'. When compared against a first-best solution, these forces should create over-provision and under-provision respectively when analysed as individual actions. However, our analyses have shown that it is possible to combine these two effects within one model in such a way that their influences can partially or completely counteract one another. An instance of perfect offsetting occurs when nature exhibits constant avian returns to scale from food stock alterations. If instead we have decreasing or null returns to scale, our model illustrates a domination of the public goods effect by the contest, leading to a level of provision (or effort) deemed excessive to that which society warrants. This ecologically plausible scenario is a far cry from the usual dilemma of insufficiently procuring environmental resources.

This is also of great importance from a policy perspective. As an environmental social planner, realising how to achieve collectively desirable objectives could hinge upon many context-specific facets. The necessary advisory action may be altered or even reversed when applied to a location where neighbours are more or less heterogeneous, where the endowment structure is endogenously influenced (for example by garden size), and where the bird species are of a different level of scarcity, diversity or ornithological habit.

Section 3.4 attempted to provide a number of alternative examples which our model looks to represent. A similarly important aspect of this paper was to highlight the necessity in developing a sound understanding of how humans interact with the environment. This involves grasping *why* people do or do not engage in environmental activities and the underlying causes for their motivation or disinclination. Only upon achieving this will it be feasible to deliver or conserve our natural resources at economically and socially efficient levels. By way of example, it would have been hard to explain our findings without realising how neighbours yield utility through the 'nature connectivity' (Dutcher et al, 2007) they establish when engaging with local wildlife. It is only once we appreciate that individuals primarily gain satisfaction from birds coming to *their* garden that we are able to describe and defend the notion of a contest effect and see instances of optimal or even over-provision for this impure public good. Therefore, a leading recommendation of this paper is to urge conservationists, politicians and other policy directors to appreciate our need to capture the underpinnings of people's interconnectivity with nature. Until we are able to confidently understand this aspect, it will not be feasible for accurate and insightful environmental proposals to be devised.

The paper also illustrates the opportunities which environmental economists must take regarding the 'manipulation' of private motivations. Natural resources are fast decreasing, and the retention of those which still exist will not be possible unless we use all the available tools at our disposal. Where a human population exists who are prepared to pay and there is a mechanism whereby payment is possible, this chance must surely be taken by the field.

SECTION 4

PUTTING BAMBI IN THE FIRING LINE:

APPLYING MORAL PHILOSOPHY TO ENVIRONMENTAL AND ECONOMIC ATTITUDES TO DEER CULLING

4.1 : INTRODUCTION

This study elicits the values associated with deer population control and forest management in the UK. In particular, it seeks to explore the key determinants of one's choices over ethically contentious environmental decisions. We use discrete choice experiments to test whether two alternative theories can outperform the rational choice model in this regard and, if so, identify the extent to which either can better represent the stated preferences of individuals.

Effective deer management has both an environmental and economic importance, with the various types of destruction caused by these animals estimated to cost £4.3m in the UK each year (Haw, 2013). Culling is one of the leading methods to combat this type of problem and such human interference is typically seen as 'necessary' when a species' population is sufficiently high to negatively impact upon the wider ecosystem, local economy or other social aspects. The justification is seen as particularly strong if, as with deer, humans are at least partially responsible for the population explosion via historical predator removal or species introduction (Melstrom & Horan, 2014). Despite this, there often exists a considerable resistance to culling and other forms of animal population control. Attitudes and perspectives regarding this type of environmental issue are often "associated with strong moral feelings" (Croson & Treich, 2014 p.336) and, under these conditions, an agent is unlikely to base their decisions purely by event outcomes (Boyce et al, 1992; Falk et al, 2003) or through strategic motivation (Vossler et al, 2012). To this end, it is highly plausible to believe one's perception of whether a process by which deer numbers are reduced is well intended, or indeed necessary, will largely depend upon their level of knowledge and style of interaction they hold with their local environment.

Sometimes people deviate from rational choice (or outcomes-based) models through sub-optimal or erroneous decisions. However, it is also true that on other occasions these choices represent a genuine preference construction that is beyond at least the more narrow of frameworks that standard economics have used to describe utility maximisation. We offer an example of where, contrary to classic economic thought, people's strength of agreement with a forest management scheme will focus less heavily on the outcome of an act *per se.* Instead, they will contemplate whether the procedure by which a result was achieved can be judged as just or ethical. In this study, we present two alternative procedural theories, namely intentions-based reasoning taken from behavioural economics and the Doctrine of Double Effect, a principle which attempts to explain our moral and philosophical perspectives towards harm. Our findings give evidence that intention does play an important role in delivering choice, but neither economic theory nor the Doctrine of Double Effect appear to truly capture people's preferences when considered in isolation. Instead, our results suggest that the roles of intention, action and outcome interact when shaping the moral decisions of an individual. Only by appreciating the nature of this fusion are we able to better understand the underlying determinants of an individual's choice and use this to produce more robust predictions on their true preferences.

A second reason to explore our attitudes to culling pertains to how humans derive Subjective Well-Being (SWB). The associated literature promotes activities where people can obtain a sense of responsibility, dependence and/or repeated interaction (see Diener & Biswas-Diener, 2008 for an overview). Practices advocated to enhance life satisfaction include strong interactions with one's community, religion and family. These stimulate feelings of interconnectivity whilst simultaneously providing stability and routine to our lives. Engagement with our local environment, which can be termed as 'Nature Connectivity' (Dutcher et al, 2007), seems another channel from which one could plausibly attain the same type of life satisfaction. In such instances, humans could derive pleasure from performing a 'warden' role, inducing valued qualities of repetitiveness and protective care. Furthermore, this type of benefit seems more applicable to local nature. Not only might these welfare benefits reverse trends of environmental detachment (Cameron et al, 2012), but via its interactive nature could constitute a distinct and disparate worth from that of conservation or preservation which people establish through classic donation mechanisms.

Studying intention in this setting also allows us to assess how engaging with local wildlife might conflict with long-term sustainability. Generally, a warden mentality should complement wider environmental objectives. Take the example of feeding birds; this not only endows the human feeder with a 'warden-style' utility, but simultaneously raises the survival chances of fed birds, benefitting long-term conservation efforts. Such complementarity disappears when nature connectivity is applied to culling. Our warden desire is to protect individual creatures and so the action to cull, even if 'well-intended' for long term sustainability, may be highly objectionable to those who place a strong value upon nature connectivity.

Our results indicate that 'warden ethics' may deliver the crucial missing determinant in shaping our sample's alternative preferences. Therefore, this study not only seeks to identify how people exhibit warden-style preferences, but also acknowledges the views of Scholtz (2005) by considering how society should organise population control so that is then deemed morally permissible. Regarding policy, this work nicely exemplifies the need for woodland managers to exercise caution as they attempt to create schemes designed to maximise societal welfare. This requires inventing sustainable habitat management strategies which strike a balance between nature connectivity and the need to protect wider biodiversity.

The remainder of the paper is set out accordingly. Section 4.2 outlines our two alternative theories and their associated literatures; Section 4.3 gives a comprehensive overview of the survey design, methodology and implementation; Section 4.4 presents the results whilst Section 4.5 then proceeds with a discussion of the main findings. Section 4.6 provides some secondary insights from the study. Section 4.7 concludes, and proposes some next steps in light of these findings.

4.2: INTENTIONS, THE DOCTRINE OF DOUBLE EFFECT AND TROLLEY PROBLEMS

Whilst both of our alternative theories are similar in their belief that choice is not driven solely by outcomes, they differ in *how* they imagine procedure to impact upon decision-making. 'Good' intentions, as defined by behavioural economics, attach weight to how an agent justifies their choice and the morality of their underlying motivations to select a particular option. The Doctrine of Double Effect has a slightly different focus, and supposes that ethical permissibility is dictated by perceptions on whether a harmful impact is created as a direct consequence of a given action, or whether it is a foreseen but unintended secondary effect. The 'double effect' arises from the fact that although the final outcome from two events can be the same, these events may not be judged as ethically equitable. More specifically, morally 'just' events are those where bad effects are foreseen but were not the intended purpose of the perpetrator's initial action, whilst 'unjust' events are those which require or necessitate the bad action in order for a 'good outcome' to be achieved[15]. Whilst the remainder of this section looks to provide a greater degree of clarity over this distinction, we characterise this difference through the two statements below:

Intentions-Based Reasoning: "Why did you undertake that (harmful) act?"
Doctrine of Double Effect: "Did you mean to cause that (harmful) outcome?"

Intentions-Based Reasoning

Many situations in the real world exemplify where humans fail to adhere to the self-interested agent which traditional economic theories have portrayed as rational. As such, there now exists significant evidence within the literatures of experimental and behavioural economics which illustrate scenarios where we exhibit 'bounded rationality'. These studies and their potential explanations are presented in both classic and modern reviews (Kahnemann & Tversky, 1984; Marwala 2014).

Whilst it is instructive to identify systematic deviations from the standard behavioural assumptions of the *homo oeconomicus*, it is equally vital to understand the underlying causes of these departures in order to gauge the transferability of choice

[15] For a further discussion of this with real-world examples, please see Audi R. (1999), p.737-38

practices. The initial line of enquiry sought to explain our non-self-interested behaviour through consequentialist means. One such example involves our perceptions regarding outcome-based egalitarianism. Rabin's 1993 paper is cited as one of the first to approach the incorporation of payoff fairness into economics, with subsequent work by Fehr & Schmidt (1999) and Bolton & Ockenfels (2000) demonstrating how adjusting a standard utility function so as to incorporate measures of outcome inequity aversion readily improves the predictive nature of a model.

More recently, the literature has shifted its focus to appreciate that aspects of procedural or intentions-based action may be of equal importance in explaining choices which defy the rational choice theory. In these studies, the concern is not necessarily whether resulting outcomes are equal *per se*, but instead consider whether the actions taken by an agent can be judged as appropriate or fair given the choices which were available to them. We exemplify the impact of procedural intention through the two scenarios below.

Game 1: *Person A ("The Proposer") is initially given £10 and is presented with the task of offering an amount £X to Person B ("The Respondent"). If Person B accepts the proposal, then they will receive the offered amount and Person A will keep what remains of the £10. If they reject the proposal, each will receive nothing. The amount Person A could offer to Person B can be any integer value between £0 and £10. Both players know that this is the range of choices open to Person A. After careful consideration, Person A decides to offer £2 which, should Person B accept, will leave them with £8. Imagine now that you are Person B.* ***Do you accept the offer of £2?***

Game 2: *Person A ("The Proposer") is initially given £10 and is presented with the task of offering an amount £X to Person B ("The Respondent"). If Person B accepts the proposal, then they will receive the offered amount and Person A will keep what remains of the £10. If they reject the proposal, each will receive nothing. The proposal choices open to Person A is restricted, and they can only offer Person B either £1 or £2. Both players know that this is the range of choices open to Person A. After careful consideration, Person A decides to offer £2 which, should Person B accept, will leave them with £8. Imagine now that you are Person B.* ***Do you accept the offer of £2?***

For each of the above ‘ultimatum games’, “The Respondent’s” decision regarding the £2 offer will result in the same monetary payoff for each player. In either situation an acceptance creates a Proposer-Respondent split of £8/£2, and each will receive nothing in the case of rejection. Thus, from a consequentialist standpoint, these games should be perceived equivalently. However, behavioural economists have shown that a typical respondent will reject the offer of £2 in Game 1, whilst accepting it in Game 2. A strong explanation for this stems from Person B’s perceptions regarding Player A’s intentions. In Game 1, “The Proposer” is unrestricted in their offer choices and therefore could have proposed a more egalitarian sum to Player B. However in Game 2 the imposed constraints mean that by offering £2, Player A seemingly signals an intent to reach the most equal split of the endowment they are allowed to make. Thus, we assume that it is this disparity in procedural opportunity which fuels the switch in Player B’s decision.

Many studies have acknowledged the range of determinants which cause the type of decision-making shown by Person B. These include an individual’s ability to plan or control their choices (Ajzen, 1991), their opportunity to signal why they made a particular decision (Falk et al., 2003) and other factors which allude to the intent of one’s action (Terry et al., 1999; Bolton et al., 2005). In all cases, a similarity exists in that subsequent choices depend upon one person’s judgment regarding another person’s intention of their action.

The Doctrine of Double Effect

The Doctrine of Double Effect (hereafter DDE) is a longstanding philosophical theory which illustrates how our moral attitudes my hinge upon the perceptions we hold of a perpetrator’s intention from their action. This ethical exploration was resurrected by Philippa Foot in 1935, who describes these adjustments in moral permissibility through a combination of theoretical examples. Perhaps the most famous of these (and certainly most intensely scrutinised) is the ‘Trolley Problem’. Whilst various strains of this ethical dilemma have emerged since Foot’s initial proposal, its basic principles are outlined through Stories 1 and 2.

Foot's conjecture is that people on average believe flicking the switch to be ethically permissible, yet pushing the large man is not. However, from an outcomes-perspective we see no distinction between the two stories - the consequence of either is to sacrifice one to prevent the death of five. This creates the 'Doctrine of Double Effect'.

Story 1: *When standing next to a rail track you see an out-of-control trolley hurtling down a hill. In its path are five individuals. The sides of the track are steep and the five have no way of escaping. You cannot stop the trolley and if you do nothing it will hit and kill all five with certainty. There is a switch next to you that you can flick. By doing so, you would divert the trolley onto an alternative track, preventing the death of the five. However, on this other line is one individual with no means of escape. If the trolley is switched to the other line, this individual will be killed with certainty.* ***Should you flick the switch?***

Story 2: *When standing on a bridge overlooking a rail track, you see an out-of-control trolley hurtling down a hill. In its path are five individuals. The sides of the track are steep and the five have no way of escaping. You cannot stop the trolley and if you do nothing it will hit and kill all five with certainty. There is a large man stood next to you on the bridge. You realise that, given his size, if you pushed this man into the path of the trolley then it would de-rail, preventing the death of the five. However, the force of the trolley hitting the man will kill him with certainty.* ***Should you push the large man?***

Foot proposes that the opposing moral stances are caused through differences in the intentions of one's action. In Story 1, flicking the switch saves the five individuals through a means which, under different circumstances, could have achieved the same result without any death (i.e. had no individual been on the other line). Here, the one's death is a foreseen and unavoidable yet unintended side-effect of the initial action. By contrast, the death of the large man in Story 2 is a necessary and integral component to achieve saving the five. Foot believes it is this aspect which creates the ethical objection, and immorality is expressed despite its final outcome appearing justifiable.

Many philosophers and theorists have since revisited and extended this dilemma. Notable contributors include Thompson, 1976; 1985, Ungur, 1992 and Kamm, 1996. These authors explore this ethical conundrum by adjusting aspects like anonymity, rail-track set-up and other social dynamics. More recently, the theoretical literature has been complemented by hypothetical experiments such as those by Lanteri et al, 2008 and Liao et al, 2012, the results of which generally reinforce the conjectures of Foot and others. Further experimental studies have extended their analytical focus by exploring the effects of the type of harm endured (Greene et al, 2009; Gold et al, 2013) or have introduced 'trilemmas' to assess the impact of similarity effects (Shallow et al, 2011), self-sacrifice (Di Nucci, 2013) and the role of reputation (Gold et al, 2014).

It is true that many economic theories are reluctant to move away from consequence-based analyses (Iliev et al, 2009) and, as such, our two alternative theories and their related conjectures are potentially troublesome for such pragmatic theories. Just as with Game 1 and Game 2 in the previous section, the resulting outcomes of Story 1 and Story 2 are identical. Because a utility-maximising agent should only ever consider the final pay-offs, traditional economic theories of consequentialism, such as Rational Choice Theory, have no way to explain the switches in preference which occur in either case.

Regarding the focus of our study, the moral quandary which we wish to test assesses whether individuals express an ethical objection to the killing of deer in order to protect and sustain the wider woodland habitat. If so, how are these ethics influenced by procedural differences regarding the way in which forest management is undertaken and how directly or intentionally a woodland manager causes harm to deer through their choice of protection scheme. To the best of our knowledge, this is the first study to apply discrete choice modelling to Trolley Problems and certainly is the first to do so in order to explore animal death, which may certainly challenge people's willingness to make attribute trade-offs (Colombo et al, 2013). Thus, this paper will build upon others in the field (Needham & Lehman, 1991; Boyce et al, 1992, Hanley et al, 2003) to try and gauge how moral perceptions for non-human harm may correspond to those for our own species. Ethically this may be particularly poignant: our study, through its emphasis upon 'warden tendencies', presents one possible reason why people can hold seemingly inconsistent perspectives between different types of animal welfare. For example, one's ethics toward the protection of local wildlife may differ to that for meat-producing livestock. Of course, people display general differences in preferences which are unrelated to ethics, and we acknowledge that this form of heterogeneity may complicate and hinder us deriving any concrete solutions from conducting just one study. However, we believe that this experiment can illustrate the possible role ethical perspectives may play and stimulate a wider interest in exploring the impact of morality within the field.

Furthermore, this study may provide an example of where local and wider environmental objectives conflict with one another (Glaeser, 2014). As a research area experimental philosophy is relatively young, yet the ever-sharpening experimental skills of behavioural economists could considerably help in revealing answers to the ethical quandaries which theoretical philosophers throw into the academic sphere. By applying economic experimentation to long-standing philosophical dilemmas, our work seeks to maximise the research synergies which exist between the two disciplines and thus provide another potential contribution to the field.

4.3: SURVEY DESCRIPTION AND METHODOLOGY

Designing the Survey

The survey comprised a 16-case discrete choice exercise and a questionnaire. The latter sought to establish each individual's topic-related attitudes and socio-demographic status.

When addressing the former, an 'efficient' choice model seeks to "maximise the amount of information… to identify the estimates of vector β" (Scarpa & Rose, 2008, p.257), where "β" measures and weights the characteristics which a person values in their utility function. For us, this will involve the various woodland-related attributes which are described below. When designing a choice experiment of this nature, consideration must be given to ensure that a survey holds both 'statistical' and 'behavioural' efficiency (Scarpa & Rose, 2008). For the former, achieving pure statistical efficiency had to be partially compromised in our model because of the constraints which we wished to impose in order to ensure credibility and realism. An example of this would be to ensure that no choice case suggested the sale of meat when no culling was taking place. Despite taking these complicating factors into consideration, we were able to derive designs which achieved an orthogonal and fully balanced choice exercise.

Once produced, each design was tested in Microsoft Excel. Here, we follow recommendations from the literature (see Scarpa & Rose, 2008 p.265-266) and apply a utility function which estimated attribute values of "β" under *a priori* beliefs on their relative worth. We included 'noise' within our simulated utility functions which sought to reflect possible preference and/or moral heterogeneity within the sample. These 'simulated responses' were then run through a conditional logit model, the purpose of which was to test and compare how well each design could replicate the assumed utility function by providing robust coefficients and valuations.

The two strongest of these designs were then presented to independent focus groups, providing a pilot test that could examine the second element of successful design – behavioural efficiency. Here, all aspects of the survey were combined in order to assess the duration and ease with which respondents could complete the task. Assessing efficiency also required an assessment of how often clarity was sought and whether any cases arose which confused or perplexed members of the focus group. A recurrent theme from both studies showed an inability for these groups to appreciate alternative options relative to the Status Quo. As a consequence, the wording and detailing of the tutorial was adjusted to emphasise this factor and the piloting re-run on a further two groups. This second wave of focus group testing delivered no repeat of this confusion, instilling a confidence that the chosen design and length were both statistically and intuitively suitable for the main study.

a) The Choice Experiment

Based on Lancaster's Characteristics Approach (Lancaster, 1966), discrete choice experiments assume that a good's value can be established through its constituting attributes. Not only do the characteristics carry value, but these are formed independently from the way in which they are bundled. This section describes each of the attributes used, explaining not only how each were defined to respondents, but also how their presence could help answer the study's objectives. To provide a visual interpretation of how characteristics were displayed, an example choice set is given in Appendix 4.1. Explanations of all attributes were provided through tutorial-style instructions. All respondents received this prior to undertaking the choice task, and abbreviated versions are provided in both Appendix 4.2 and throughout this section.

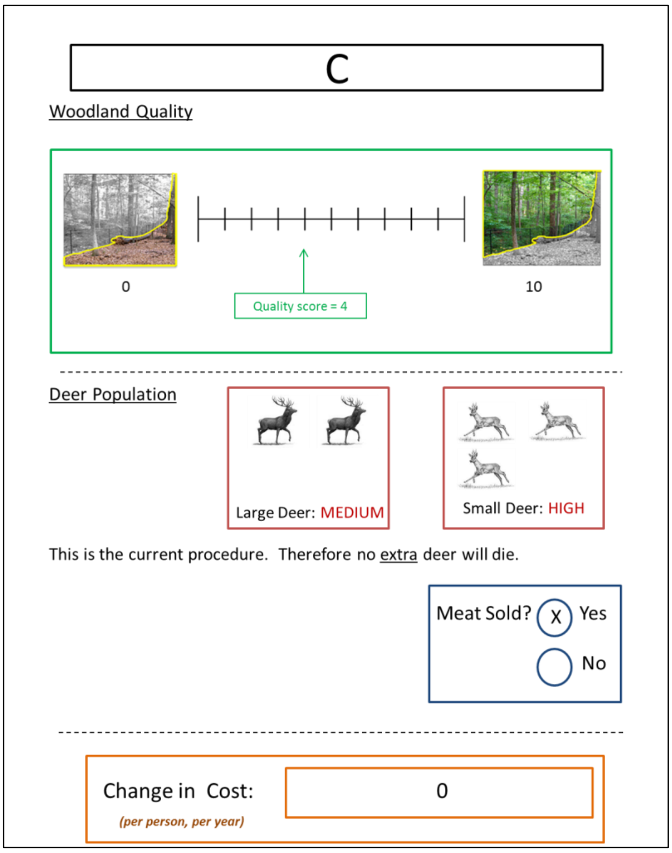


Figure 4.1: The Baseline (Option C)

Constituting the main part of the survey, the choice experiment offered each respondent 16 forest management 'cases'. Focus group discussions and pilot testing indicated that the way in which this number of cases had been presented struck a balance between enabling a participant to see a variety of possible scenarios without creating a survey whose length proved cognitively burdensome or led to disinterest or disengagement with the task (Colombo et al, 2013). Each case presented two alternative schemes and a constant 'current plan' baseline. Presenting three-alternative sets in this way is believed to improve model robustness (Bennett & Rolfe, 2009) and because people were asked to express both their first and second preferences, a complete ranking was established for every choice set. A description of the baseline (shown in Figure 4.1) was given at the instructions stage, and a copy was available on each respondent's desk for them to review if necessary. This choice ("Option C") was based upon current practices and plans and was developed following consultations with East Anglia's Forestry Commission.

Whilst answer sheets were paper-based, the instructions and survey were presented on computer screens. A researcher read the tutorial-style instructions aloud to subjects in order to overcome any issues of illiteracy or ambiguity. A laminated copy of the abbreviated tutorial displayed in Appendix 4.2 was also made available for a participant to refer to.

Woodland Quality

Exemplified in Figure 4.2, all alternatives held a corresponding woodland quality, with scores ranging from 0 to 10. The integer scale was deemed the simplest way to present this grading system. This was confirmed in our pilot studies, where a range of alternative mechanisms were tested and discussed at the focus group stage. The yellow-bordering on the images within Figure 4.2 illustrated this scales' extremes, and related to a photograph shown at the start of the tutorial instructions which had depicted the impact of deer-proof fencing on woodland vegetation.

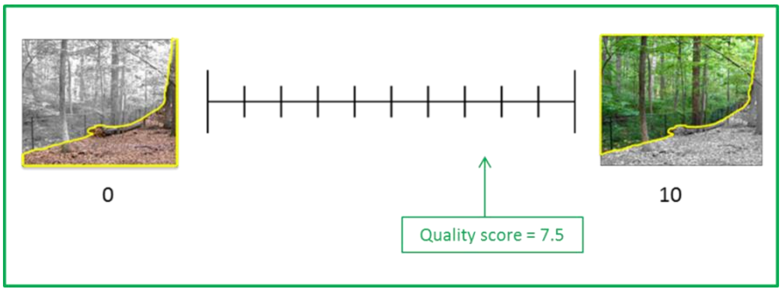


Figure 4.2: The 'Woodland Quality' Attribute

Respondents were informed that 'high quality' woodland related to an ecosystem which enjoyed a superior and sustainable health. Whilst focus groups seemed to grasp the grading concept fairly well, the tutorial text was complemented by a reiteration that scores further to the left-hand side of the scale represented more greatly degraded forests. Those who participated in the survey were also told that a woodland quality could be achieved through either an exclusive or mixed use of policies. This could involve deer management through fencing or culling, or via other methods unrelated to deer population control. This 'vagueness' held two purposes. From a respondent perspective, this should prevent over-speculation regarding how quality changes might occur between cases, and also confirmed to them that although a major contributor, deer populations were not the only determinant of a woodland's quality. For us, this enabled orthogonal choice sets to be achieved with both greater ease and credibility.

Deer Populations

A description of East Anglia's deer populations were presented in the form shown through Figure 4.3. Regarding 'Large' and 'Small' deer, each characteristic could exist at Low, Medium or High thresholds, and a key gave visual and written representations of these levels. In relation to the latter, it was described how each level resonated with the likelihood of seeing a deer, indicating a form of use value. Respondents were given a brief description of the types of destruction that each size of deer might cause, alongside simple background information such as species names.

Deer population changes were relative to Option C and would occur over a two-year period. Instilling that changes were comparable to the constant Option C was important given that this was the area of pilot testing where respondents had struggled the most. In this baseline, 'Large' deer appeared at a medium population level and 'Small' deer at a high one. Whilst this could potentially influence the results we received regarding deer valuation, it seemed important to try and accurately convey the nature of the Forestry Commission's intended plan through Option C. Consultations with the Commission in East

Anglia revealed that under the current system, the management's biggest concern related to the spiralling populations of small deer and the associated damage this would bring. With their current resources and finding, they felt unable to control these small deer populations sufficiently, and thus believed that Option C should try and indicate this to respondents by having the population at its highest attribute level.

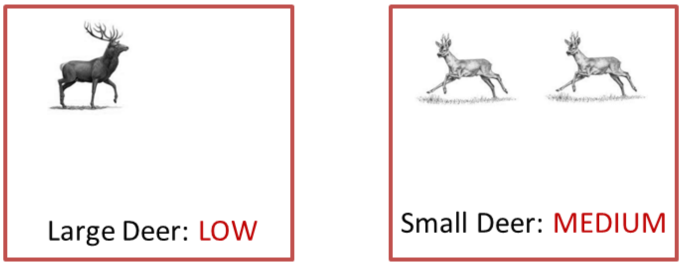


Figure 4.3: The Deer Populations Attribute

Although many species of deer reside in East Anglia, we defined deer through just two 'types'. The first reason for this related to simplicity; with no prior information on a respondent's knowledge of deer (i.e. whether species were native, common, destructive etc.) a broad categorisation prevented a need to relay such detail, which could have caused survey disengagement and/or unnecessary cognitive burden. Nevertheless, some level of species disaggregation was necessary to test the role of nature connectivity. We told respondents that large and small deer were equally destructive, meaning any elevated values expressed for small deer could represent warden-type preferences. Small deer such as Roe and Muntjac certainly appear more vulnerable and dependant on human aid than the more physically robust large species of Fallow or Red. These two groups also vary behaviourally, with Roe and Muntjac deer typically visiting suburban areas more frequently (Austin et al, 2013), affording greater opportunities for repeated interaction. Of course, a respondent could hold species-related historical experiences which interfere with this valuation story and, as such, we approach this interpretation cautiously.

Deer Population Change

The third characteristic the tutorial introduced were deer population reduction mechanisms. Table 4.1 gives an overview of how each method relates to both DDE and intentions-based reasoning:

		Trolley/DDE Equivalent	Intentions Perception
1	Licenced Hunter Culling	Story 2 (Unethical)	Bad Intention
2	Forestry Commission Culling	Story 2 (Unethical)	Good Intention
3	Fencing	Story 1 (Ethical)	Good Intention

Table 4.1: How Deer Population Reduction Methods relate to DDE and Intentions

Licenced hunting most closely resembles the bridge version (Story 2) of the Trolley Problem. By indicating that these hunters undertake culling for leisure, we imply that the deer's death is both a necessary and intended component of their action to shoot. Furthermore, the hunters cull for 'bad' reasons in that they do not shoot deer for environmental sustainability and its affiliated benefits for woodland management. Instead, their motivation is to fulfil their private utility from killing. It is this second (intentions-based) component which distinguishes licenced hunters from Forestry Commission culling. Because Commission culling still involves the shooting of deer, this form of population control would still conform to Story 2 if we were to follow Foot's description of DDE when applied to human harm in a Trolley Problem context. However, a Forestry Commission huntsperson is employed to ensure long-term woodland preservation and society might perceive this as a 'better intended' and therefore more ethically permissible reason for culling to be undertaken. Prior to implementing the survey, we wanted to ensure that this perceived difference between the intentions of hunters and Commission workers was believable. Whilst discussions with members of East Anglia's Forestry Commission suggested this was so, our strongest affirmation of this came through the focus groups, where participants regularly expressed a vehement dislike of hunters controlling deer populations, whilst seeming far more favourable to the exact type of cull being undertaken from a body like the Commission, whom they felt would be doing so as part of their work obligations. Whilst purely anecdotal, it was pleasing to hear similar verbal comments being expressed by respondents through the real choice survey, relating both to a confidence in the Forestry Commission's good intentions and a disdain for the hunters conducting a cull.

Fencing coincides with Story 1 of the Trolley Problem because the associated action (erecting a fence) is done to ensure long-term woodland sustainability. A foreseen but secondary consequence of this action is that deer starve, yet their death was not a necessary condition for the fencing to have achieved its primary aim. Through DDE reasoning, this action would be seen as ethically permissible.

Of every additional 100 deer which die:

90	are culled by the Forestry Commission
10	are culled by Licenced Hunters
0	starve from fenced woodland

Figure 4.4a: Method with Deer Populations Falling

Of every 100 deer which no longer die:

100	are not culled by the Forestry Commission
0	are not culled by Licenced Hunters
0	do not starve from fenced woodland

Figure 4.4b: Method with Deer Populations Rising

Figures 4.4a and 4.4b illustrate how these population changes were portrayed and again it was explained that these adjustments were relative to Option C. In order to show that the intended plan did involve a population reduction, some alternatives allowed populations to actually rise. In these cases the wording was altered to that in Figure 4.4b. Because the word adjustment was so slight, an identical verbal prompt was issued to every respondent by the experimenter when the first case of rising populations appeared in the choice task. Alongside this, each alternative included a box which explicitly indicated whether populations were projected to "Rise" or "Fall" (see Appendix 4.1). This combination of prompts seemed sufficient to ensure respondents recognised when each scenario was being presented.

A detailed slide within the tutorial explained each method. Agreement with a system of licencing often heavily depends upon public perceptions surrounding the degree of hunter regulation (Holzer et al, 2012). Therefore, it was explicitly stated that hunters would be trained to a sufficient standard. Whilst maintaining ethical impartiality was crucial to this experiment, the tutorial had to draw attention to the private enjoyment which licenced hunters yielded from culling and to the deer starvation that would occur should an intense level of fencing be pursued by the woodland management organisation. Although this may seem emotively influential, a failure to explicitly state these aspects could have meant respondents failed to view each scenario within their intended ethical context. One strategy employed to try and dilute these potential biases was to intersperse the statements with more factual ones, such as the aforementioned training standards and the cost implications to each system.

Meat Sales

A simple attribute to describe, it was explained that venison meat could be sold from deer when they were culled. The beneficiary from these revenues would be whichever party had undertaken the cull.

Once again, financial advantages were explicitly relayed to subjects. Should the Forestry Commission be the group receiving these revenues, it was highlighted that this could reduce the costs to managing the woodland. We provided this information in part to retain consistency with previous cost-related cues. However, from an intentions-based standpoint, this also sought to test attitudes toward licenced hunters selling venison. A rise in the support for this form of culling could represent an ethical judgement that hunters now held an alternative (and more permissible) justification to shoot deer. Alternatively, one could argue that hunters profiteering from their ill-intended deed may actually decrease instances of agreement with this method.

The Cost Attribute

Vital to any choice modelling exercise is the construction of a payment vehicle. One of the greatest difficulties is to ensure that this attribute instils both credibility and realism in both its magnitudes and format of delivery. Given that the Forestry Commission is funded by the government, the use of taxation was an obvious instrument of cost to use. In the UK there has been a relatively intense and well documented debate on how public forestry is financed[16] . Advantageous from our perspective, this has meant that people are now better informed on how woodlands are funded and raise their beliefs that their responses could be 'consequentialist', or truly impact upon public policy. Put another way, if subjects felt that taxation alterations may actually be enforced through ongoing public funding pressures, they are more likely to provide honest answers through the greater degrees of control and realism they assume regarding this topic (Boyce et al, 1992; Iliev et al, 2009, Vossler et al, 2012) as well as improving the degree of attention which they pay to attributes (Colombo et al, 2013). Whilst ethical or cognitive disadvantages can accompany the use of taxation in some settings, it was felt that such impacts may be considerably lessened given the nature of the topic and associated magnitudes of change involved.

Once again, cost changes were expressed relative to Option C. The tutorial described that cost adjustments would involve a flat annual levy placed upon each and every resident in East Anglia in an attempt to ensure that all respondents felt changes could impact upon them personally. Effective survey design usually requires "input from policy staff" (Hanley et al, 2003, p.125) and in deriving our scales, we undertook consultations with East Anglia's Forestry Commission regarding associated training, staffing and monitoring costs to deer culling. These discussions also proved useful insofar as the Forestry Commission confirmed that woodland users understand the substantial element of forest management costs which must be dedicated to controlling deer populations. The consequence of this is that we were able to feel more comfortable using this parameter as a

[16] See http://www.independent.co.uk/news/uk/politics/government-plans-huge-selloff-of-britains-forests-2115631.html for this article

basis for our WTP calculations. Our taxation changes took four possible tiers, namely to cost £5.00 less, yield no change or impose an additional £5.00 or £10.00 payment.

b) The Socio-demographic Survey

This questionnaire covered a range of topics regarding one's environmental attitudes, associated behaviour and demographic status. Respondents were informed that all questionnaires were anonymous and that disclosed information would be used solely for data analyses. A sample questionnaire is provided in Appendix 4.3.

Attitudinal and Behavioural Questions

Six questions within the survey looked to gauge a mix of actions and opinions that respondents held regarding forests. Each were asked their woodland visit frequency (question 1) and range of activities they undertook there (question 2). Questions 4 and 5 respectively asked if they had contributed to animal welfare and/or environmental charities within the last 12 months, or whether they regularly fed birds in their garden. Whilst question 5 was of particular interest given previous work in the field (see Brock, Sugden & Perino; 2014), we perceived that those who engaged in bird feeding may place value upon local nature connectivity which formed one of the study's main focuses.

Questions 3 and 6 invited more subjective answers from participants. The former asked whether a subject agreed in principle with culling and fencing as schemes for population control. For culling, this was asked in relation to both deer and badgers. Badger culling is a highly topical and contentious UK initiative, and there exists conflicting scientific evidence as to whether killing these animals would actually achieve its intended aim of preventing the spread of tuberculosis in cattle. Providing robust and verifiable scientific evidence is deemed crucial for topics such as culling (Waber et al, 2013). Whilst public perspectives to deer management can vary considerably, an example being those surrounding red deer in Scotland (Nilsen et al; 2007, MacMillan & Leitch; 2008) it still seemed reasonable to compare the culling of badgers to that of deer where the reasoning is widely seen as more defensible for the latter. In all cases, respondents could select a 'Don't Know' option, deliberately designed to make no distinction between those possessing a lack of knowledge and those who, in view of the current evidence, felt unable to actively express an opinion. Question 6 offered a (1 – 5) Likert Scale which asked for one's strength of agreement with whether they believed (a) effective forest management was important, (b) culling deer was preferable to starvation as a means of reducing deer numbers and (c) that educating children in environmental studies was important. We expected a general agreement with these statements, but they gave some measure for people's notions of nature connectivity and of sustainably managing resources for future generations.

Socio-demographic Questions

Forming the final five questions of our survey, these requested standard demographic information on one's gender (question 7), age (question 8) and income (question 9). The two final questions asked whether those surveyed had participated in shooting or fishing (question 10) or were vegetarian or vegan (question 11), both of which correspond to attributes of the choice task itself. Confirmed by the response distributions contained in Appendix 4.4, the small number responding positively to question 10 meant only question 11 was fit for analysis.

Conduct and Execution of the Survey

All 200 surveys took place through February 2014, with half being conducted at a Norwich garden centre and the remainder held at a country park in Thetford Forest, Suffolk. Inclusive of the ten to fifteen minute tutorial, the average completion time was between twenty and thirty minutes. In both locations we assume that, on average, a participant would hold an accentuated interest in outdoor and/or environmental issues. Given the focus of this paper was to explore the moral preferences surrounding animal harm, it was imperative that our sample held an existing interest and level of engagement in this area. On this note, we were not concerned that subsequent valuations may not reflect those of the general UK population. It was also judged that the choice experiment itself may be seen as quite tasking to completely uninformed audiences, and so by selecting from this sample we felt confident that instances of topic miscomprehension would be lessened.

Despite this, the two locations were also chosen in order to offer a meaningful contrast. Based near Norwich city centre and therefore away from woodland of any substantial magnitude, the former site constitutes one in East Anglia where deer populations are typically low. Conversely, the Thetford site should provide a greater fraction of respondents who live within close proximity to dense forest, although it should be noted that no question explicitly asked how far a respondent lived from forests. These two samples therefore may hold preference structures which convey different practical understandings of woodland management or on average possess disparate use values for forestry. Furthermore, it is quite plausible that because each location holds a different focus (i.e. garden centre versus forest park) this could impact upon the stance or approach that a respondent possessed at the point at which they completed the survey. These elements constitute cultural aspects that can be highly influential in shaping decisions in such ethically driven contexts (Machery et al. 2004). On a practical note, both sites formed non-obligatory environments in which to conduct a survey. This ensured that when approached, any potential respondent felt confident to decline to partake in the survey if they so wished.

Surveys were collected through face-to-face interviews. Whilst answer sheets were paper-based, the instructions and survey were presented on computer screens. This format enabled participants to engage orally with the researcher over the topic, and provided complementary qualitative statements to accompany quantitative data. This also did not restrict our sample only to those confident in the use of information technology. The response rate was very good, averaging 50% and 80% at the Norwich and Thetford sites respectively. Reasons for decline typically consisted of time constraints as opposed to subject disengagement or disinclination. Whilst uptake was roughly consistent across genders, 110 (55%) respondents were female.

The optimal number of cases to present participants with is widely debated and different stances exist within the field (Swait & Adamowicz, 1997; Adamowicz et al, 1998; Scheufele & Bennett, 2012). By issuing 16 choices, this study sits at the upper bound of this recommended range. However, it was felt that the familiarity respondents held with this particular topic would prevent a damagingly excessive degree of fatigue or cognitive burden occurring.

As reward for participation, each respondent was issued with a voucher for a hot drink and snack at the respective on-site cafes. This incentive scheme seemed highly suitable for the study. Firstly, it made no financial promise which could influence participant responses through a form of 'interviewer effect' (Bowling, 2005). Secondly, the average redemption value came to approximately £4.00, which is judged as adequate compensation given the survey duration. We were pleased with this system of reward and would advocate such a monetary-alternative compensation method if both the topic's nature and survey's duration permits.

The Empirical Model

Attribute	Description
Quality Level	With all other attributes remaining constant, this is the probability change in choosing an option because the woodland score increases by one integer value.
Large Deer	With all other attributes unchanged, this is the change in the probability that a respondent chooses an option because 'large deer' are of one frequency level higher.
Small Deer	With all other attributes remaining constant, this is the probability change in a respondent choosing an option because 'small deer' are of one frequency level higher.
Commission Culling	With all other attributes unchanged, this is the probability change in a respondent selecting an option because one percentage point of fencing has been replaced with that of Forestry Commission-led culling.
Licenced Hunter Culling	Holding all other attributes constant, this is the probability change in a respondent choosing an option because one percentage point of fencing has been replaced with that of hunter-led culling.
Meat Sales	With all other attributes remaining constant, this is the probability change in a respondent choosing an option because the meat is now being sold.
Cost	With all other attributes remaining constant, this is the probability change in a respondent choosing an option because the taxation-based price to deliver that management scheme has risen by one penny (£0.01).

Table 4.2: A Description of the Coefficients

With regression coefficients described in Table 4.2, characteristics were presented across alternatives in a way which ensured choice-set orthogonality. The coefficient for 'Quality Level' represents the probability change for increasing one integer score on the 1-10 scale denoted by Figure 4.2. The same interpretation can be made for our two size-differentiated deer variables with respect to changes in population level. Culling variables compare people's preference for these methods relative to that of fencing, which acts as the base case.

The data is analysed using a conditional logit model[17]. Algebraically, this means that the utility person n derives from alternative j is assumed to take the form characterised by (4.1).

$$U_{nj} = \beta_n' x_{nj} + \varepsilon_{nj} \qquad (4.1)$$

Here, x_{nj} constitutes the variables which are observed by a participant for any given choice option and which are pre-determined by the researcher through the survey's design. β_n then relates this to the person n's personal preferences over the attributes at these particular levels. These models apply a Gumbel distribution to the random element of people's utility (ε_{nj}), which is deemed appropriate when included, as above, as an additive element to the utility function (McFadden, 1974; Louviere et al, 2000; Hoyos, 2010). Consequently, it is possible to establish the projected probability change for a participant's selection of a given alternative i based upon the rule that person n will only select option i if that derives them the greatest utility relative to any other option (j) available to them in a given and fixed choice set. A formula to demonstrate this is given by (4.2):

$$Prob\ (ni) = \int \left(\frac{exp^{\beta' x_{ni}}}{\sum_j exp^{\beta' x_{nj}}} \right) \qquad (4.2)$$

Attribute coefficients thus represent the respondent's change in probability for choosing an option if, *ceteris paribus*, there is a unit change in that attribute's level when described as a discrete variable, or through its presence relative to a base case for dummy (0-1) coded attributes (Bennett & Blamey, 2001). The coefficient on price (β_{price})

[17] Our econometric specification does not deviate from that which is used widely in the literature, yet much of the notation and descriptions are adapted from Train (2009).

represents the marginal utility of income, which for such environmental commodities is assumed to remain constant and negative (Hanley et al, 1998a). Presuming that product characteristics act as normal goods, determining any attribute's marginal valuation then involves taking a ratio of its coefficient against that of price (Hoyos, 2010).

$$WTP_x = \frac{-\beta_x}{\beta_{price}} \quad (4.3)$$

Participants were asked to state both their first and second preferences, essentially creating a ranking of the three alternatives for each choice set. Our regression groups responses by choice set whilst clustering these over individuals. By doing so, this specification is able to incorporate the fact that each individual is making multiple choices and therefore can identify any participant-specific patterns and error variations which may occur with and between respondents in their in decision-making.

4.4: RESULTS

Sample Representation

Given its taxation-based payment vehicle, the study hoped to predominately survey people who were knowledgeable on household budgeting and responsible for their financial management. Table 4.3 decomposes the sample's age profile and compares this to the 2011 Census data for Norfolk's population (www.norfolkinsight.org.uk). Wilcoxon Mann-Whitney U tests confirm no significant differences exist between these (z = -0.85, $p(z)$ = 0.3955).

Age Bracket	Sample Population (%)	Norfolk Representation (%)
18-25 years	23/200 (11.5%)	52/681 (7.6%)
26-35 years	25/200 (12.5%)	96/681 (14.1%)
36-45 years	26/200 (13%)	105/681 (15.4%)
46-55 years	35/200 (17.5%)	118/681 (17.3%)
56-65 years	44/200 (22%)	114/681 (16.7%)
Over 65 years	47/200 (23.5%)	196/681 (28.7%)

Table 4.3: Age Profile Comparison

Table 4.4 provides similar summary statistics for income, acknowledging that 15% of respondents opted not to provide this information. The remaining distribution seems to adequately represent that of the Norfolk region (z = 1.295, $p(z)$ = 0.1952). The slight under-representation of lower income households potentially relates to our below-average proportion of pension-age respondents. Anecdotally, this group typically show a reluctance to view pensions as 'income' which often lead to greater tendencies to select the non-disclosure option.

Income Bracket	Sample Population (%)	Norfolk Representation (%)*
Under £20,000	54/200 (27%)	39%
£20,000 - £29,999	37/200 (18.5%)	21%
£30,000 - £39,999	21/200 (10.5%)	24%
£40,000 - £49,999	23/200 (11.5%)	
£50,000 - £59,999	10/200 (5%)	
£60,000 - £69,999	9/200 (4.5%)	
£70,000 - £79,999	5/200 (2.5%)	16%
£80,000 - £89,999	6/200 (3%)	
Above £90,000	5/200 (2.5%)	
Preferred not to disclose	30/200 (15%)	N/A

Table 4.4: Income Profile Comparison

**Data approximations from Norfolk Insight (CACI), 2010*

Regression Results: Parameter Estimations

Using our Conditional Logit model, Table 4.5 estimates the results from our complete sample of 200 participants. The dataset benefits from the fact that fully ranked preferences were derived for every choice set. Table 4.6 displays Models (2) and (3), which analyses the same explanatory variables from particular subgroups. The former extracts those from both the lowest age bracket and the highest age bracket, each of which can then be contrasted against the full sample estimates in Table 4.5. Model (3) does likewise for income groups.

Valuation sensitivity with respect to income can often be a concern with choice experiments (Jacobsen & Hanley, 2009) and it should be noted that for our study the lower cost parameter for 'Low Income' respondents is mildly significant (χ^2 = 3.93, $p(z)$ = 0.0476) when compared against the full sample. The impact of this would of course be slightly inflated WTP valuations. However, in an exercise not displayed here, we substitute the cost parameter for the full sample and re-calculate the WTP values for this sub-group. This revealed that elevated values still persisted even with a less responsive cost coefficient. No significant differences exist between the full sample and the 'High Income' subgroup (χ^2 = 0.93, $p(z)$ = 0.336). Interestingly, adding an interaction term between income and quality produces a variable which has no statistical significance. These regression results can be found in Table 1 of Appendix 4.6.

Whilst not presented here, many similar analyses were conducted by isolating a certain subset of respondents who held particular characteristics. These are referred to in later discussion and Appendix 4.5 contains a matrix displaying these valuations.

		Full Sample *(n=200)*		**Associated Valuation** *(£)*
	Coef.	*St. Error*	*P>|z|*	**£**
Quality Level	0.249*	0.016	0.000	**3.85**
Large Deer	0.227*	0.036	0.000	**3.51**
Small Deer	0.612*	0.057	0.000	**9.46**
Commission Culling	0.007*	0.001	0.000	**0.12**
Licenced Hunter Culling	0.000	0.001	0.780	**0.01**
Meat Sales	0.789*	0.050	0.000	**12.19**
Cost	-0.065*	0.005	0.000	
Model Fit (χ^2)	643.80		0.000	
Pseudo R^2	0.1591			

** Significant Coefficient (p<0.05)*

Table 4.5: Conditional Logit Regression Results from the Choice Experiment

In both Tables 4.4 and 4.5, columns in bold give the average marginal valuation associated with each attribute. Attribute non-attendance or partial attendance can be problematic for choice models. Whilst attribute ranking can be unaffected by this problem (Colombo et al, 2013 p.26), systematically ignoring or disregarding characteristics can impact upon WTP magnitudes. Regrettably, we did not test for this by explicitly asking respondents whether they had considered all aspects subsequent to their undertaking of the choice task. However, we perceive that most participants would have attended to all variables contained on the choice card. The foundations for this are based upon the pilot testing and focus discussions, alongside the verbal reasoning which occurred whilst respondents partook in the survey.

Reiterating the descriptions given in Table 4.1, in most cases this implies the willingness to pay for a one-step improvement in a characteristic (for example increasing the woodland grade score by one for 'Quality Level'). However, for our culling attributes the interpretation adjusts slightly, and these values represent the willingness to pay for a one percentage point shift away from fencing and instead towards the particular culling type[18].

Before analysing and interpreting these parameters, we conduct a number of specification tests, applying these to Model (1) only. As shown by Table 2 in Appendix 4.6, there is significant evidence that respondents are persuaded by the status quo ($\chi^2 = 8.34, p = 0.000$). This reinforces some of the anecdotal comments from respondents who felt confident in the Forestry Commission's judgment and so would then opt for the 'intended plan' of Option C. Table 2 of Appendix 4.6 does confirm that the impact of these Status Quo effects apply only to the quality and deer attribute WTP values and regarding the former, this disparity disappears if we compensate for cost parameter differences between models. Importantly, this means that tending towards Option C bears no impact upon the ranking or magnitudes the sample attribute to the population reduction methods that link choice to ethical value. Regarding the effect for deer valuation, these changes may occur through the way Option C was presented, as it displays 'Small Deer' numbers at their highest frequency level. This is something which we perhaps should have addressed in the survey's design. Regardless of this possible explanation, a Status Quo inclination will impact upon the emphasis we are able to place upon Nature Connectivity as an explanation for wildlife WTP differences. The model does not pass the Independence of Irrelevant Alternatives (IIA) test ($\chi^2 = 58.98, p = 0.000$), yet we add two caveats to this result. The

[18] For example, if 'Commission Culling' holds a value of 0.12, this suggests respondents would be willing to pay £0.12 to see one percentage point of fencing replaced with culling of this type. In the cases where deer numbers rise, they would pay £0.12 to see one percentage of fencing retracted instead of reducing Commission culling by that proportion.

first is that alternatives are unlabelled and so our interpretation of omitting an 'alternative' does not hold the usual meaning which is applied to the IIA test. Furthermore, this test is widely seen as inappropriate for clustered models like the conditional logit (see McFadden, 1973, p.243). This is a further reason why the alternative Latent Class Model was pursued. Likelihood ratio tests do confirm the joint significance when multiple attributes are omitted from the regression[19],

	Youngest (Aged 18-25) Respondents *(n= 23)*			**Oldest (Aged 65 +) Respondents** *(n=47)*			**Low Income (<£20,000) Respondents** *(n= 54)*			**High Income (>£40,000) Respondents** *(n=58)*		
	Coef.	*P>|z|*	*£*	*Coef.*	*P>|z|*	*£*	*Coef.*	*P>|z|*	*£*	*Coef.*	*P>|z|*	*£*
Quality Level	0.365	0.000	**5.69***	0.235	0.000	**3.82***	0.242	0.000	**5.17***	0.257	0.000	**3.44***
Large Deer	0.634	0.000	**9.89***	0.203	0.006	**3.29^**	0.345	0.000	**7.36***	0.237	0.001	**3.17***
Small Deer	0.727	0.001	**11.34***	0.437	0.000	**7.09***	0.543	0.000	**11.61***	0.651	0.000	**8.71***
Commission Culling	0.002	0.375	**0.03**	0.009	0.000	**0.14***	0.006	0.002	**0.12***	0.008	0.000	**0.11***
Licenced Hunter Culling	-0.005	0.232	**-0.08**	0.000	0.937	**0.00**	-0.003	0.231	**-0.07**	0.001	0.757	**0.01**
Meat Sales	0.579	0.000	**9.04***	0.993	0.000	**16.10***	1.055	0.000	**22.55***	0.729	0.000	**9.76***
Cost	-0.064*	0.001		-0.062*	0.000		-0.047*	0.000		-0.075*	0.000	
Model Fit (χ^2)	89.57	0.000		140.31	0.000		203.55	0.000		171.44	0.000	
Pseudo R^2	0.2045			0.1588			0.1847			0.1640		

** Significant Coefficient (p<0.05); ^ Significant Coefficient (p<0.10)*

Table 4.6: Comparison of Results by Age Group *(Model 2)* **Comparison of Results by Income Group** *(Model 3)*

Across all samples, the 'Quality Level' characteristic remains positive and significant, showing that participants prefer a management policy which, *ceteris paribus*, raises woodland quality. Reviewing Table 4.6, these quality valuations increase with mild significance for both the youngest participants (χ^2 = 3.69, $p(z)$ = 0.0547) and low income respondents (χ^2 = 3.93, $p(z)$ = 0.0475). A range of possible explanations exist for these findings. One is that those on low incomes are more greatly restricted by the set of activities which they can engage in. They may therefore place extra emphasis on public forestry being of high quality. We would imagine that younger respondents, on average, could utilise woodlands for a wider variety of physical and aesthetic uses, raising their desire

[19] For example, omitting deer ($\chi^2_{(2)} = 687.14, p = 0.000$) or method ($\chi^2_{(2)} = 84.73, p = 0.000$) variables shows evidence of joint significances.

to have a good quality forest within close proximity to them. From a broader perspective, young people also have longer personal time-span in which to interact with the woodland resource. This may lead to them adopting a less myopic stance regarding sustainable forest management compared with older users.

The coefficients on both deer attributes are positive and significant, with absolute values again elevated among young[20] and low-income[21] respondents on large but not small deer. The relative difference between these two size-differentiated variables is important given our conjecture that one possible explanation for these valuation differences may correspond to nature connectivity and a desire to engage with local wildlife. As described earlier, this would arise because small deer possess greater 'warden-inducing' qualities and habits compared with larger deer. Relative to the full sample, the disparity is most pronounced for older respondents and those who gave to animal welfare charities and is of a lesser prevalence among younger participants and men.

Our culling attributes reveal an interesting story. Econometrically, their coefficients describe the projected probability change for selecting an option whereby a fencing policy is partially replaced by the respective culling alternative. For example, Table 4.5 suggests that on average our sample would pay £0.12 for a one percentage point swing away from fencing and towards Forestry Commission culling. A fairly consistent pattern forms across both the main sample and many of our analysed sub-groups. This suggests a small yet significant preference for moving from fencing to Commission-based culling, with no statistically significant difference placed upon a similar swing from fencing towards the use of licensed hunters. Exceptions to this rule include those who agreed with badger culling and respondents of the lowest age bracket. The former express a positive and significant preference for either version of culling relative to fencing, whilst the latter state indifference between any policy. In analyses not given here, we included interactions between deer population thresholds and method of population change, testing if participants responded to the magnitudes of adjustment over alternatives. Including these attributes added very little explanatory power to our model, and we attribute this to the fact that deer populations were described through levels as opposed to numbers. This creates a hugely

[20] Large Deer: χ^2 = 8.64, $p(z)$ = 0.003; Small Deer: χ^2 = 0.33, $p(z)$ = 0.5644

[21] Large Deer: χ^2 = 5.62, $p(z)$ = 0.0178; Small Deer: χ^2 = 0.84, $p(z)$ = 0.3602

burdensome cognitive challenge for a respondent who wishes to consider how many deer might be affected by each method of population change.

Finally, ‘Meat’ and ‘Cost’ variables hold intuitive signs. Respondents strongly value the efficiency of selling the meat from culled deer. Later discussed in Section 4.6, this relationship is quite complex, and meat valuation appears highly sensitive to who participants are informed the beneficiary will be from the venison revenues. Our negative cost parameter stays fairly consistent in magnitude across sub-samples.

Subsequent to running the basic conditional logit analysis on this data, further exploration involved regressing the same data using a latent class model. This alternative model affords researchers greater flexibility by removing the restriction that all respondents will place the same value upon the attributes and their levels. Econometrically, this involves adjusting the utility specification from Equation (1.2):

$$Prob\ (ni) = \int \left(\frac{exp^{\beta' x_{ni}}}{\sum_j exp^{\beta' x_{nj}}} \right) f(\beta) d\beta \qquad (1.2a)$$

The Latent Class model seeks to group ‘classes’ of respondent who hold collectively similar valuations. A more detailed overview of this econometric test is given by Pacifico (2010).

	Conditional Logit (Model 1)	**Latent Class Model**		
		Class 1 *Share: 0.375*	Class 2 *Share: 0.387*	Class 3 *Share: 0.238*
	Values are expressed in Pounds Sterling (£0.00)			
Quality Level	3.85	5.07	2.56	4.24
Large Deer	3.51	6.44	-0.96	4.63
Small Deer	9.46	16.59	6.08	-2.48
Commission Culling	0.12	0.02	0.16	0.09
Licenced Hunter Culling	0.01	-0.17	0.11	0.04
Meat Sales	12.19	8.00	10.24	10.61
Cost Coefficient	-0.065	-0.096	-0.127	-0.046

Table 4.7: A Comparison of WTP Values across Regression Models

A three class model seems to perform particular well for this choice data (the Bayesian Information Criterion (BIC) method was used to identify this) and full regression results from this specification can be found in Table 3 of Appendix 4.6. Again comparisons with the original conditional to model only extend to that with Model (1). Table 4.6 shows that WTP differences which occur between the valuations between these models. As will be discussed in the next section, it appears that segregating our sample in this way may lead us to disentangle participant 'types' and distinguish between ethical or warden-affiliated patterns of valuation.

4.5: <u>MAIN FINDINGS</u>

Decision Making for Deer Population Reduction

This paper used choice experiments in order to provide evidence that would either support or refute the conjectures contained within Rational Choice Theory, behavioural economics and philosophical theories such as the Doctrine of Double Effect regarding how people make ethically challenging decisions. Assuming that a deer death is considered comparable no matter which method of population control is used, we would assume a pure consequentialist to be indifferent to whichever management tool is applied. Instead, their decisions would simply rest upon which scheme derived the woodland quality or deer numbers most favourable to them.

Let us instead imagine that a respondent solely bases their decisions upon the principles of DDE. If we assume, as with Trolley Problems, that one ought to avoid the causation of deer death where possible, then these preferences should adhere to the following preference structure:

Culling by Licenced Hunters ~ Culling by the Forestry Commission < Fencing (1)

To briefly recap, 'Fencing' constitutes an action which does not require deer death as a necessary means to achieve the desired outcome of long-term woodland preservation. Instead, their death through starvation is just a foreseen and regrettable side effect. Thus, this branch of moral philosophy would assume individuals to find this method ethically permissible. This is in contrast to the 'morally wrong component' attached to the act of culling. Here, the deer's death must be incurred in order to achieve the sustainable woodland. To this end, it is irrelevant whether a Commission worker or licenced hunter conducts the cull as it is the action (of firing the gun) which is unethical.

Let us now consider the preferences of a respondent driven purely by perceived *intention*, which behavioural economics regularly demonstrate play a vital determining role in the way people make decisions. For this group, it would be possible to segregate the culling methods and issue an adjusted preference profile:

Culling by Licenced Hunters < Culling by the Forestry Commission ~ Fencing (2)

Participants would now be able to state a clear preference for a Commission employee to conduct a cull over a licensed hunter. Because 'hired' by society to maintain and preserve public forestry, the former's intention for pulling the trigger is to enable long-term woodland sustainability. Put another way, they are not assumed to derive any private pleasure from the culling action itself, but undertake this procedure as a means to achieve their target of providing well-managed forests. Conversely, because licenced hunters pay for a permit to hunt deer for pleasure, they cannot be assumed to cull for these same 'good intentions'. For one making intentions-fuelled choices in this way there would be no obvious preference between the culling of deer by a Commission worker and the erecting of a fence. In both cases the action is undertaken under the well-intended circumstances of sustaining the woodland.

In light of these theoretical assertions, we now apply our empirical findings to this preference-construction methodology. As confirmed by of Latent Class Model, it is perfectly possible that a range of preference structures can exist among our population regarding environmental action and behaviour. Czajkowski and co-authors show this with regards to recycling, which can not only be influenced by financial or cost-based aspects, but also through social or psychological aspects such as self-image (Czajkowski et al; 2014). Appreciating this heterogeneity is highly necessary given the moral nature of our study yet even if we account for the fact that our aggregated sample could consist of a mixture of preference type (1) and type (2) candidates, this elicited profile in (3) - which the Conditional Logit model discovers - fails to fully adhere to either aforementioned hierarchy:

Culling by Licenced Hunters ~ Fencing < Culling by the Forestry Commission (3)

This ranking structure represents the pattern of responses stated from both our full sample and the majority of our 'extracted' sub-samples. It suggests that Commission culling is preferable to fencing, yet no difference exists between the support for a policy of fencing and of licensed hunting.

As our theories seem unable to explain the data collected here, we must now consider whether there are in fact other factors which, when combined with these procedural or intentions-based aspects, can explain preference structure (3). A major difference between the procedural theories we assess here and our study is that examples of the former often suggest that an identical form of death occurs from each eventuality. Use the example of the Trolley Problem: whoever dies does so through the collision with a truck and this *type* of death is the same regardless of which choice the individual makes. This may allow respondents to more easily construct preferences over these situations because they are devoid of any empathetic or emotive differences which may arise from changes in the *way* that death occurs.

It is in this respect that our study potentially produces a complication, and the starvation of deer through a policy of fencing may be emotively received very differently to that of shooting, as occurs when deer are culled. Whilst one might argue to the contrary, starvation suggests a suffering that is more drawn out and thus less appealing when compared to the almost instantaneous death when deer are shot. This is particularly true given the tutorial's insistence that both sets of hunter would be sufficiently trained. Such insistence would lessen concerns that a deer could be shot inaccurately, consequently preventing their immediate death. In order to impose DDE onto the study in question, the instructions explicitly informed subjects that deer would die through starvation as a result of widespread fencing, increasing the salience of this factor from what might otherwise have been an unconsidered aspect in the minds of our respondents.

To try and uncover how an individual constructs moral preferences, Table 4.8 adds this extra factor, *method of death,* to those which currently existed to test our two procedural theories.

	Good Action *(As seen by pure DDE)*		Good Intention *(as seen by behavioural economics)*		Good Consequence *(shown by method of deer death)*	
Fencing	Yes	L	Yes	M	No	0
Commission Culling	No	0	Yes	M	Yes	N
Hunter Culling	No	0	No	0	Yes	N

Table 4.8: A Matrix to Illustrate how Perceptions appear over Deer Reduction Methods

Included in Table 4.8, we allow letters L, M and N to represent the 'positive characteristics' associated with each deer reduction situation for the relevant school of thought. For example, the letter M signifies a numerical 'score' which people have for the characteristic of an action being well-intended. In this way, letter L symbolises 'Goodness of Action', letter M the 'Goodness of Intention' and letter N the 'Goodness of Consequence'.

We can normalise those processes devoid of such merits to zero. By then assuming that letters L, M and N hold some positive weight in determining choice, each deer control mechanism can be expressed as a vector of moral attributes in the form shown below:

Fencing : (L, M, 0)
Commission Culling : (0, M, N)
Licenced hunter Culling: (0, 0, N)

From these moral attributes, we are able to describe how the utility one derives due to these factors exist through a simple characteristics approach in expression (4.4) below (Lancaster; 1966).

$$U_i = v_L L + v_M M + v_N N \qquad (4.4)$$

The subscripted 'v' symbols represent the relative values people place upon each of the moral attributes. We can now explore the preference structure (3) elicited from our sample using this notation:

Culling by Licenced Hunters ~ Fencing < Culling by the Forestry Commission (3)

Our first insight confirms that no one policy dominates another with respect to its moral attributes. Despite this, we are able to make some inferences regarding the weight which our sample attach to these. For example, the preference for Commission culling over licensed hunting implies $v_M > 0$. Thus, the role of intentions is important in determining choice, and a woodland manager's more genuine mandate for culling makes it more morally just for them to shoot deer. As assumed in other studies, intentions must be considered 'in conjunction with other factors' (Greene et al, 2009 p.369) and a second thing we can decipher is that $v_N > v_L$. This is because Commission culling is stated as preferable to fencing and M (the importance of intention) is common to both methods. This implies that, on aggregate, our sample attach a greater value to *how* deer are killed, and find starvation distasteful, than whether a method adheres to the ethical permissibility advocated by DDE reasoning.

This style of analysis can be insightful for a number of reasons. It illustrates very clearly why context-specific details matter for ethically contentious topics. People often have emotively-charged reasons which dissuade them from selecting certain policies and whilst this study has found evidence to support intentions-based reasoning, subtle factors such as method of death can also determine choice. This echoes the scepticism which surrounds 'pure economic' theories which believe that the rational agent should not look beyond the basic outcomes which accrue from any given option. Thus, great caution must exist regarding the ability to transfer ethical reasoning from one case to another, or in the delegation of such decision-making to an expert analyst (Liao et al, 2012).

Specific to this research topic, these findings give additional evidence of how our relationships with wildlife may hold weight in determining human utility. Valuation profile (3) suggests that people carrarte about how an animals' death occurs and the type of suffering the creature may endure. This could naturally extend to the human interactions with agriculture, including our views regarding free-range meat and dairy products (Croney

& Millman, 2007), organic livestock farming (Alrøe et al, 2001) or sustainably sourced fish (Needham & Lehman, 1991; Verbeke et al, 2007). This alludes again to the role which 'nature connectivity' might perform and its potency for influencing optimal collective choice policy.

Deer Valuation and Nature Connectivity

Aside from its influence in shaping our moral preferences over deer death, the role of 'nature connectivity' is cautiously assumed as the source of valuation disparities between Large and Small deer, with the latter enjoying more favourable appearances and habits to instil a 'warden-style' satisfaction. These valuation differences exist among of general Conditional Logit model, but also appear to persist for both Class 1 and Class 2 members (who between them account for around 75% of our sample) when preference heterogeneity is considered within the Latent Class Model (as illustrated through Table 4.7).

When considering absolute deer species valuations, it is perhaps unsurprising that these are greatest for groups such as vegetarians and animal welfare charity donors. In contrast, men and those who agreed with badger culling express some of the lowest absolute values for deer.

We extend our analyses by combining absolute and relative values in order to speculatively review the possible role of nature connectivity. Let us exemplify this by contrasting the deer valuations of animal welfare donors against those who feed birds regularly. It seems reasonable to assume that an average member from either group would hold a stronger connection to nature when compared against the population as a whole. Appendix 4.5 confirms that both sub-samples hold an elevated worth for small deer over larger ones. However, whilst absolute deer values expressed by 'bird-feeders' adhere quite closely to those of the full sample, the values elicited from animal charity donors rise by 28% and 43% for large and small deer respectively. Such increments are even more pronounced for vegetarians. One way to interpret this would consider the 'environmental mind-set' of each group. Whilst attaching a 'warden-style' worth for deer, those who feed birds may acknowledge the potentially detrimental impact that artificially high deer numbers can have for long-term woodland biodiversity. If this is so, the average bird feeding individual would then prioritise wider environmental processes when forming their valuation. This more pragmatic stance to culling (Scholtz, 2005) would explain the alignment of absolute deer values with those of the full sample. By contrast, your average vegetarian or donor to an animal charity could be assumed to prioritise the welfare of an individual beast over that for the collective ecosystem, creating warden-style inflationary values upon the deer attributes.

This reasoning could be extended to other sub-group valuations, potentially resonating with slightly deflated deer values from arguably more informed woodland users, including those who visit more frequently or live in closer proximity to forestry.

Age is the final parameter which we explore regarding the deer valuation and nature connectivity relationship. The disparities between our two sized deer attributes appear to diminish as the age of a respondent falls, and our youngest band of participants (aged between 18 and 25) do not seem to differentiate between the two. To confirm this, we introduce an interaction term between age and each deer variable. With full regression results contained within Table 4 of Appendix 4.6, the impact of adding these interactions, named "largeage" and "smallage", is given in Table 4.9:

	Model 1	Model 4	
	Absolute Value	*Absolute Value*	*Average change as Age Group rises by 1*
Large Deer	£3.51*	£8.70*	-£1.30*
Small Deer	£9.46*	£7.58*	+£0.46

** Significant Coefficient (p<0.05)*

Table 4.9: The Impact of Age in Determining Deer Values

The impact of these interaction terms are that as somebody ages they will reduce their value for large deer whilst retaining a high worth upon smaller ones.

This finding implies that ‘nature connectivity’ may be driven by age, with the oldest members of society gleaning most value from local engagement with nature. This assertion corresponds to those made within the existing literature who suggest that older people can derive particular utility by engaging in activities such as keeping pets (Johnson, 2011), bird-feeding (Brock, Perino & Sugden, 2014) or gardening (Rappe, 2005), and that they may hold particularly strong moral attitudes to harm (Gold et al, 2014). Assessing this through the rationale of SWB, older members of society are on average endowed with fewer channels from which to obtain warden-style interconnectivity. One example of a removed avenue is that their children have grown up and so are no longer dependent upon their parents. Many older people also do not work and thus have no employment-related responsibilities. Finally, those in the higher age brackets may suffer from a decrease in their mobility. This limits the range of actions they can undertake to otherwise engage and interact with the wider community.

An alternative yet equally relevant theory is that older people have the greatest amount of leisure time in which to engage with their local environment, and subsequently appreciate more fully the wildlife which resides close to them. This combination of factors builds a strong case to suggest the importance of local wildlife as a tool for improving the wellbeing of otherwise isolated and vulnerable groups in society and surely testing the scope and robustness of this conjecture in future research could prove highly informative to a range of agents.

4.6: <u>FURTHER FINDINGS AND DISCUSSION</u>

This section delves deeper into some of the other results of our study, and issues some conjectures regarding what drives our preferences for environmental engagement and economic efficiency.

Exploration of the Latent Classes

Here, we investigate how our three latent classes from our sample may resonate with the ethical stances and environmental preferences which have so far been discussed.

The corresponding valuations of the Latent Class Model were presented in Table 4.7, which is copied below here for reader reference:

	Conditional Logit (Model 1)	Latent Class Model		
		Class 1 *Share: 0.375*	Class 2 *Share: 0.387*	Class 3 *Share: 0.238*
	Values are expressed in Pounds Sterling (£0.00)			
Quality Level	3.85	5.07	2.56	4.24
Large Deer	3.51	6.44	-0.96	4.63
Small Deer	9.46	16.59	6.08	-2.48
Commission Culling	0.12	0.02	0.16	0.09
Licenced Hunter Culling	0.01	-0.17	0.11	0.04
Meat Sales	12.19	8.00	10.24	10.61
Cost Coefficient	-0.065	-0.096	-0.127	-0.046

Table 4.7: A Comparison of WTP Values across Regression Models

Let us firstly consider those members which fall into 'Class 1'. These form just under 40% of participants, who collectively have a more elastic (χ^2 = 35.95, $p(z)$ = 0.000) cost sensitivity than the pooled sample of our conditional logit model. This sensitivity is even greater among those of 'Class 2'[22], who represent a similar proportion of respondents. The remaining subjects, here defined as 'Class 3', are less price elastic than the main sample (χ^2 = 12.84, $p(z)$ = 0.000) yet form just under one quarter of those surveyed.

Assessing the preference rankings of these three groups with respect to deer reduction method, we see that Class 1 respondents display a hierarchy which, of the three, concentrate most heavily upon intentions:

Culling by Licenced Hunters < Fencing < Culling by the Forestry Commission (4.1)

The suggestion here is that they are dissuaded from the ill-intentions of the licenced hunter, who as you will recall can least justify their actions through the pretence of ensuring environmental sustainability. However, there is not a complete agreement from this class with DDE because they do not exhibit a clear preference for fencing, where starvation is a side effect, over direct Forestry Commission Culling. Nevertheless, this group would

[22] χ^2 = 142.42, $p(z)$ = 0.000)

seemingly be those who place the greatest emphasis upon ‘Good Intention’ as described by Table 4.8.

By contrast, Classes 2 and 3 members hold this hierarchy of methodological preference:

Fencing < Culling by Licenced Hunters < Culling by the Forestry Commission (4.2)

This pattern of responses would infer a greater value is placed on ‘Goodness of Consequence’ as we label it in Table 4.8, and means that potentially 60% of respondents attach a greater weight to death being instantaneous and are less preoccupied by ‘pure’ procedural intention as is described by behavioural economics or DDE.

We can apply this same type of analyses to whether classes of respondents display ‘warden-style’ preferences by considering their associated deer valuations. Assuming increments in ‘Small Deer’ values are attributable to Nature Connectivity, we would assess that around 75% of our sample (Class 1 and Class 2 members) adhere to this notion. The remainder of the sample, who place low or even negative value upon deer species, would be seen as less driven by this reasoning. Instead, their priorities may lie with either ensuring environmental sustainability or economic efficiency, given the retained valuation this class still place upon quality woodland and meat sales respectively.

Combining these two aspects could lead us to describe Class 1 members as ‘sensitive’ respondents. This is because this group are highly influenced by intention and caring for the wildlife they perceive as most vulnerable. By contrast, Class 3 subjects could be described as ‘practical’, showing preferences for efficient and sustainable deer reduction. Class 2 participants deliver a ‘mixed’ response, falling somewhere in between these two labels.

A reinforcing test we conduct here uses some of our behavioural or demographic sample characteristics to assess what types of factor may determine class membership and whether these adhere to the assumptions made above. With regression results given in Table 3 of Appendix 4.6, this analysis shows that those who agreed to a principle of badger culling are 68.1% less likely to be a Class 1 (‘sensitive’) member than a Class 3 (‘practical’) one. By contrast, respondents who gave to animal welfare charities are 84.9% more likely to appear in Class 1 than Class 3. Both findings seem intuitive, and this type of analysis gives us a further reason to suspect that whilst preference heterogeneity is likely to exist for contentious issues such as culling, there may be systematic indicators which allow us to estimate how likely particular groups of people are to support one way or thinking (or associated policy directive) over another.

Of course, the analyses we do here are purely conjectures, and this conclusion forms just one story that could be told from our results. This is not least because our values are subject to scrutiny given both our design concerns with respect to Status Quo Effects and our tenuous association between elevated values for small deer and warden-style preferences. However, these subjective thoughts still serve an important purpose, and we hope they can act as first steps for the field of environmental economics. If nothing else, they should stimulate thoughts on our need to address preference elicitation for ethical topics and how to account for the heterogeneity which will doubtlessly exist in this area. Furthermore, identifying the dynamics of both different classes and their relative memberships could profound implications for how to implement policy.

General Behavioural and Attitudinal Data

Regarding our behavioural data, 39% and 42.5% of those questioned had donated to an environmental or animal welfare charity within the last 12 months respectively. No restrictions were imposed upon an interpretation of 'donating', meaning that this could be understood as direct payment, environmental membership or engagement in conservation work. In contemplation of this broad definition, these ratios appear to reasonably reflect the proportion of people who contribute to this type of cause within the UK (www.coreofline.org; www.gov.uk). 63.5% said that they regularly fed birds, and this level is not exceptionally disparate from factual statistics for rates of bird-feeding and related activities in the UK (Saggese et al, 2011; Fuller et al, 2008),. It is encouraging that this level corresponds well to that of our previous study, which surveyed a similar demographic (Brock, Perino & Sugden, 2014).

	Fencing to Control Deer (%)	Culling to Control Deer (%)	Culling to Control Badgers (%)
Yes *(Agreed it was legitimate)*	62	76.5	26
No *(Disagreed it was legitimate)*	25.5	12	41
Don't Know *(was unsure or not sufficiently informed)*	12.5	11.5	33

Table 4.10: An Overview of the Animal Population Control Question

Regarding woodland management attitudes, Table 4.10 summarises the sample's levels of agreement with various animal population control policies. We exercise caution when assessing these distributions. This is because the question had been posed after the choice exercise, where we had explicitly informed respondents that fencing woodlands caused deer starvation. Nevertheless, it is interesting to see that nearly two thirds agree with a principle of fencing and over three quarters do so regarding deer culling. Such rates could reflect an above-average level of environmental understanding from our sample, especially given their self-selected participation in a woodland management survey. Yet, this may instead reveal a general realisation that deer populations must be reduced in order to sustainably safeguard forestry.

This conjecture could also explain the difference between the "don't know" responses for deer and badger questions. The latter, being more contentious and less scientifically-proven, may mean a higher proportion of respondents felt a disinclination to state a definite viewpoint. Conversely, the greater familiarity our sample may have with deer and woodland processes may endow them with an increased confidence to issue an opinion in both cases. On a broader note, these notions echo other research within the field which highlight that it is essential for policymakers and environmental managers to issue credible, factual information regarding animal population control if they are to receive a strong and unified backing to their proposal (Glaeser, 2014; Melstrom & Horan, 2014; Van der Made, 2014). This can also reduce attitudinal heterogeneity (Clucas et al, 2014) and scope effects (Czajkowski & Hanley, 2009), potentially dampening behavioural and statistical inefficiencies from participant responses.

Regarding frequency and type of use, 54% of respondents accessed forestry at least once per month, with only seven participants never visiting woodlands. The most popular use was walking (75%), with lower rates for nature watching (42%) and cycling or sport (26%). Stated "Other" uses included general recreation, spending time with family and photography. The frequency distributions differ significantly between the two sites (z = 21.497, $p(z)$ = 0.000), with respondents at the Thetford site accessing forests on a much more regular (weekly or even daily) basis. Data collected on forest usage potentially provide a direct linkage to aspects of nature connectivity, with certain users holding particular preferences regarding both deer populations and associated reduction methods. Take the example of cyclists. For these users, high populations of large deer are concerning as this increases the risk of personal injury through collision, yet this group voiced concerns over the widespread use of fencing given that it provides a physical barrier to their own recreational usage.

Meat sales and the Role of Economic Efficiency

Our penultimate discussion area investigates the perspectives of participants to the sale of culled deer meat. The 'Meat' variable is consistently positive and statistically significant, suggesting that whilst deer reduction methods may be contentious, people possess a desire to see a productive utilisation of any resulting carcasses. The magnitude of importance our sample attached to this variable certainly exceeded our expectations, with many respondents verbally expressing their dislike for alternatives which indicated a failure to sell meat. To this end, exploring this attribute further seemed sensible.

Considering our sample's apparent concerns over intention, Table 4.11 tests whether any attitudinal differences existed when the Commission sold venison as opposed to when the beneficiary was a licenced hunter. To do this, we include interaction terms between the 'Meat' attribute and each of the culling methods. Full regression results appear in Table 5 of Appendix 4.6, with the salient elements given in Table 4.11.

	Model 1	Model 5
Change in Value for 1% rise in Commission Culling *(at the expense of fencing)*	£0.12*	£0.00
Change in Value for 1% rise in Licenced Hunter Culling *(at the expense of fencing)*	£0.01	£0.04
Change in Value for: A switch in meat not being sold to meat being sold	£12.19*	£-0.10
Additional meat Value for an extra 1% rise in Commission Culling (relative to extra fencing)	--	£0.26*
Additional meat Value for an extra 1% rise in Licenced Hunter Culling (relative to extra fencing)	--	-£0.01

** Significant Coefficient (p<0.05)*

Table 4.11: The Impact of Who Sells the Meat

Adding these interactions may lead us to further contemplate the way in which we interpret our sample's responses. The results of Table 4.11 indicate that in cases where the meat from additionally culled deer will not be sold, individuals hold no clear preference for any of our three population reduction methods. This is shown by neither absolute culling coefficient holding statistical significance in Model 5. However, if additional deer death is to occur and the meat from those culled is to be sold, our participants revert to the method-based priorities given by profile (3). This involves a preference for Commission culling over both fencing and Licenced hunting, between which they remain indifferent.

These findings indicate that the ethical perspectives of our respondents are instrumented through the sale of meat. In a scenario where meat is sold, the preference for Commission culling over fencing shows a wish for economic efficiency and a willingness to see deer shot and healthy carcasses be sold as opposed to deer starving and this potential human food source going to waste. Yet this desire for economic efficiency is conditional on the notion that culling is undertaken by the party which does so for well-intended reasons. One assertion is that people are happy for the Commission to gain revenues from selling venison given that these huntsmen cull under the premise of sustainability and through their mandate to act as an 'environmental warden'. Another interpretation might conclude that the Commission huntsman does not personally profit from the meat revenues, which instead help to reduce the Forestry Commission's financial reliance upon the government.

Hence, it may be perceived that the benefits which accrue from these meat sales are publically distributed instead of being privately enjoyed by an ill-intending Licenced hunter.

The main focus of this study had been to explore our moral perspectives regarding deer reduction, and these findings may possibly dilute the ethical conjectures that are presented in this paper. Indeed, the impacts that our meat interactions create for our findings may signal that what we infer as procedurally-based preferences by our sample actually represent another element of forest management, for example the economic production and efficiency opportunities which it can yield. However, we approach these analyses with caution. The meat variable had been included only as a peripheral attribute, and had not been envisaged to have the impetus that it seemingly does for our sample. Given this underestimation, we are wary that it may not have been given adequate attention in either the choice set design or within the instructions of the tutorial. For example, this may mean that respondents fail to fully comprehend that venison revenues are already accounted for in the stated taxation threshold, and so do not constitute an additional 'bonus rebate' through these Commission revenues. Overall, such interactions and their possible impact illustrate once again the complexity which surround our choice construction for ethically sensitive subjects. This can only serve as an indication that future work is essential if we are to fully comprehend the intricacies involved in this type of research.

Income Effects and Public Forests as Inferior Goods

The final aspect judged here is how our sample's woodland values adjust with income. This information is contained in Table 4.6 and suggests that, on average, the value people place upon forest management may fall as they become wealthier. Whilst this appears surprising at first, considering public forestry as an inferior good seems highly plausible. Whilst travel costs may constitute a major determining factor in dictating people's choice of using forestry (Willis & Garrod, 1991; Boxall & MacNab, 2000), these amenities might be considered an reasonably 'open-access' public goods relative to other recreational alternatives. Therefore those on low incomes, who are relatively restricted in their range of substitutable activities, should prove the most intense users of this resource.

At the other extreme, wealthy people have a much broader spectrum of alternative activities which they may otherwise choose to partake in. This could involve national or international travel, attending sporting and entertainment events or visiting more 'prestigious' tourist attractions. Their affluence also raises their scope to gain a utility from engaging with the natural world via other sources, including national parks, international wild-scape, entry to zoos and safari parks or even owning a personal woodland estate!

From this one study we of course do not seek to conclude that public forests unequivocally inferior goods, unvalued by the wealthiest in society. Indeed, the field offers a mixed picture regarding the correlation between income, development and public natural asset value. Whilst overall it is perceived that greater worth is ascribed to protecting biodiversity and conservation as a country improves in its economic development (see Jacobsen & Hanley (2009) for a meta—analysis of this), questions still exist over how income distribution and variations in the type of amenity and its level of use value impact upon this relationship. This is particularly true if we consider notions such as 'Nature Connectivity' to exist, because the target population for value elicitation (i.e. local communities) may be very different from those within the type of biodiversity valuation studies contained in the meta-analyses mentioned above. Our latent class analyses have exemplified just how diverse such valuation patterns may be in such areas.

If public woodlands are indeed inferior goods, this could majorly influence how they are funded. Many public amenities rely upon contributions from wealthy benefactors to finance their upkeep, and this has been a lifeline for many art galleries, charities and museums. If rich and influential members of society place a relatively low value upon public forestry, the ability to either raise additional revenues or to defend the scale of existing ones could be severely jeopardised. This study provides only a first insight into this notion, and complementary studies would be needed to reinforce this idea. However, it is vital that this type of question is addressed if financial securities are to exist for the maintenance of or improvement to our local natural environment.

More generally, our findings above have illustrated how expressing people's environmental preferences in the form of economic values can invite valuable discussion. This in turn means "the costs and benefits of different policy designs can be compared"

(Hanley et al, 2003 p.123). Not only can a choice experiment like ours try to make some preliminary conjectures on people's attitudes to animal harm and towards their interaction with local wildlife, but also invites a wider discussion regarding forest management, utilising natural resources in an economically efficient way and the financing of public amenities.

4.7: <u>CONCLUSION</u>

Whilst behavioural economists have comprehensively illustrated that choice theories based purely on outcomes fail to replicate empirical decision making, scepticism also exists around the ability of these or traditional philosophical theory to meet these needs when a topic involves moral or 'sacred' values. We use discrete choice experiments to test the impacts of procedure, intention and justification upon the preferences people hold over the ethically sensitive subject of deer culling.

Overall, the results of this study have confirmed many *a priori* beliefs held within what exists of the affiliated literature. At the same time, they have introduced some fresh ideas and injected some new thoughts into this area. The preferences of our sample regarding the 'just' method of deer population control fails to fully adhere to those predictions given by any one traditional theory. Our moral code is neither rigid nor universally transferable (Machery et al, 2004; Greene et al, 2009; Iliev et al 2009), yet there are many instances, as with 'The Doctrine of Double Effect', where tested theories exist on our ethical beliefs even if these are built upon a 'complex set of rules, concepts and principles' (Gold et al, 2013 p.215). However, this complexity should not inhibit the use of techniques such as choice experiments to try and elicit further information regarding our ethics. As with this study, they can afford researchers the chance to test bold conjectures, using theories such as DDE to test the extent to which we can transfer our well-established moral perspectives on human harm to harm towards other animals via ethically charged real-world events such as deer culling. We would argue that in fact choice experiments present a nice compromise and, echoing the findings of other studies, feel they can be used alongside traditional methods in driving policy initiatives (Hanley et al, 2003; Jacobsen & Hanley, 2009). They offer a given participant the chance to construct a unique moral statement through the multiple cases presented to them. Yet through choice aggregation and analysis, researchers can explore preference trends across a sample, and supply these to policy-affiliated discussion.

Rational choice theorists, behavioural economists and moral philosophers do concentrate upon consequences, intentions and actions to varying degrees, yet this work suggests a more subtle blend of these characteristics is required if empirical choices are to be most accurately replicated. We echo the recommendations of other studies in ethically sensitive areas, suggesting a need to apply mixed methodology approaches given the futility of using outcomes-based, materialist or attitudinal analyses in isolation (Azjen, 1991; Falk et al, 2003). Relative to culling, researchers should consider the *type of harm* incurred by a victim from a given policy. For the wildlife of this study, these preferences may be highly influenced by our degree of 'nature connectivity' and the obligation we feel as a warden to protect and minimise the suffering of creatures in our local area.

Nature connectivity and our desire to act as a protector may also explain why lower values are held for large, remote or robust species against those which are smaller or more 'locally engaging'. These disparities are seemingly correlated to one's age, with older respondents possessing valuation structures more akin to that of a local environmental guardian. Other studies have made similar conclusions when analysing our attitude to culling, stating that humans could be 'likened to trustees responsible for protecting … resources' (Scholtz, 2005 p.24). Nature connectivity might prove problematic if a woodland manager finds opposition to culling from the public, who also perceive themselves as a form of 'trustee'. This group prioritise the welfare of individual creatures at the expense of the detrimental impacts deer cause for long-term sustainability. Another consequence of this work for policy is that stakeholders should issue "sound scientific evidence" (Lundhede et al, 2014, p.7) in an attempt to minimise the objections which arise through public misconception as opposed to well-informed ethical stance. The study also analyses the roles of income and efficiency, seeking to identify how and to what extent woodland habitats can be managed in a socially and economically viable way.

"Social Scientists need a number of tools in their behavioral toolbox to appeal to a variety of motivations" (Delmas & Lessem, 2014 p.366) and this work suggests the benefits which can accrue by combining economic and philosophic thought to morally-sensitive subjects. Through inter-disciplinary collaboration, it tries to synergise the strengths of each field in order to answer these questions, which for areas like environmental morality can be incredibly complex and intricate (Croson & Treich, 2014). This work provides only preliminary conjectures regarding how humans approach environmentally sensitive issues and how these correspond to our economic and ethical stance. Similar future research would be valuable, not only to corroborate or dismiss the claims made here, but to more widely question the transferability of morality between environmental topics. If verified, our results suggest that the existence of emotional and ethical attachments to nature and the environment must be acknowledged and incorporated into the associated academic field. If a more sound grasp can be gauged in such areas, collective decision-making will become more efficient, productive and welfare maximising, creating wider social and economic benefit.

SECTION 5

CONCLUSION

Over the course of this thesis, a recurring and persistent theme has emerged where people express positive valuations for local or common wildlife. Humans partake in a wide variety of environmental actions within close proximity to their home, and by doing so display a preference to connect with the natural world around them. Examples include decisions to undertake wildlife gardening, to access public parks or other green spaces and to volunteer within local conservation initiatives. Thus, it is perhaps unsurprising that mankind places a positive worth upon the creatures which coexist alongside them.

This work endeavoured to shed light on *why* such values persist, and the reasons that people invest their time, effort and/or money to engage in such practices. Overall, it has characterised the role that individuals take on in relation to local wildlife as that of a 'warden'. We apply this analogy because it aptly describes how an individual would fuse together a role of protection and responsibility with an action that is both repetitive and conducted in a routine fashion. Due to the fact that they reside on our doorsteps, this mixture of elements can be more readily attached to our interaction with creatures we are able to experience every day. Such engagement also remains consistent with the types of activity which are promoted in order to achieve lasting levels of life satisfaction. These include the time we spend with family, friends and community groups. Finally, it appears that such 'nature connectivity' attends to a very different element of our well-being than that of classic conservation or existence values, meaning this worth potentially offers a very new channel of exploration for environmental economists.

The first chapter of this thesis gave a good example of where a guardian mentality could present itself within an environmental setting. By conducting choice experiments that explored people's hypothetical preferences over seed purchases, it elicited the value held for garden birds. The results of this work showed that whilst an aesthetically pleasing appearance is highly sought, people seemingly yielded the greatest worth from those species which not only came to one's garden and fed with regularity, but that also instilled a sense of dependency which allowed the human feeder to feel like a carer or protector. If such conjectures are to be believed, this would have key policy relevance for a range of environmental economic settings. These include how we decide to approach urban planning, how to provide private and public urban green-space and a possible re-consideration of how we prioritise conservation expenditure.

The realisation that there existed an interaction between private and social benefits to bird-feeding motivated the second thesis chapter. Here a model was constructed whereby competing neighbours decided how much seed to dispense in an attempt to attract birds to *their* private gardens. The equilibrium results implied that behavioural influences such as competitive drive could potentially act as a tool for offsetting classic free-rider problems for (impure) public goods. How closely this offsetting enabled us to converge to a first-best solution was largely driven by the returns to scale of seed allocation in its ability to increase bird numbers within the local vicinity. A key feature of this work was that it provided a neat example of where attending to people's behavioural motivations could enable the procurement of environmental assets to their socially optimal thresholds. In terms of its practical application, decision-making authorities may be able to use quick, easy and/or cost-effective ways to adjust our perceptions or actions toward natural capital that simultaneously raise social and private well-being.

The third and final paper returned to choice modelling, this time testing whether respondent decision-making corresponded more towards procedural or consequentialist mind-sets if applied to ethically-contentious environmental issues such as deer culling. Perhaps more aligned to a protector than had been envisaged, people's choices are seemingly driven not only by human intention but also by the *type* of harm local wildlife may suffer. The care which people express for these animals echoed the findings of the first paper and appear consistent with a 'warden style' mentality. Interestingly, such welfare concerns seem quite disparate from those which humans attribute to creatures which are killed for food or because they are considered pests. In these latter cases, we seem to hold on average a much less stringent moral position. This perhaps reiterates our notion that local wildlife may constitute a distinct and unique set of creatures regarding the way in which we obtain utility from nature. Such ethics deliver serious food for thought, as they illustrate the incapability of many standard economic or environmental theories to fully capture the true preferences of the public for such emotive subjects. Regarding the empirical repercussions of this work, the attitudes explored in the third paper suggest that policy-makers may wish to expend time and effort explaining to people the necessity to conduct particular population or habitat alteration regimes. This could mean they are able to overcome a resistance to their action which the public have formed due to them holding an otherwise unsustainable attitude over animal welfare.

This thesis could also hold more general implications regarding the way in which decision-makers utilise man's desire to interact with the environment. One such impact concerns social infrastructure, and the presence of these local 'amenities' could provide an excellent avenue through which to reconnect vulnerable or isolated members of the community with the area in which they live. Another relevant opportunity involves taking advantage of people's behavioural motives in areas such as preoccupation with relativities or competitive drive to deliver environmental assets at their socially desirable levels. This could be extended beyond the investigations of Section 3, and are transferable to areas such as improving energy and water conservation, inviting greater instances of recycling or simply raising the frequency with which people exhibit green behaviour. These studies have also provided significant evidence to illustrate how our attitude to and interaction with 'the environment' is complex and multi-dimensional. Given this, a policy-maker must exercise extreme caution when applying a 'one size fits all' approach and assuming the one set of proposals will automatically transfer to other sites or topics which involve the natural world.

Whilst this work provides some first insights regarding how notions such as nature connectivity and the role to act as a warden could exist, it also raises two notes of concern when finding ways to uncover their scale and magnitude. The first relates to the mechanism by which value is derived. In each choice experiment, a clear and well-understood set of payment methods were used to elicit the values people held for the wildlife in question, but such research should not fall into the trap of desperately seeking any way to discover value. A hypothetical study of this kind must retain realism and credibility for respondents, requiring researchers in the field to remain innovative and aware to the potential criticisms which can arise from their survey conduct. The second note of caution is in remembering that valuation is not about discovering prices for environmental entities such as wildlife *per se*, but asking *why* the value might exist and why it might differ between species or settings. This may be because the species hold particular characteristics which heighten warden tendencies (as with garden birds and their potential to be 'cared for'), or through ethical, emotional or moral obligations which lead to humans engaging in costly actions and effort to prevent harm to creatures (as with deer culling or starvation). How these beliefs are constructed may well be very complex, and their accentuation or deflation might arise through private behavioural motivations, or through more subtle channels such as public perceptions and how we want others to see us.

Throughout this thesis and reinforced by others in the field (Hanley et al, 2003; Christie et al, 2006; Dunn et al, 2006; Jacobsen et al, 2008; Czajkowski & Hanley, 2009), the prior level of familiarity and background education which people hold on an environmental topic have heavily affected the perceptions and subsequent quantifications which they then place upon natural assets. This heterogeneity means that any given view could, at one extreme, represent a completely ill-informed and uncertain belief or at the other a genuine and well-grounded moral or social preference. As with the majority of decision-making, the trust and confidence one has in their preferences is widely determined by these personal levels of awareness. For environmental economics, the fact that so much conflicting evidence and uncertainty exists around important phenomena like climate change and environmental damage means that society can often feel unable to cast solid and consistent opinion. Educating the population through clear environmental information is no less relevant when applied to local-scale natural resources. This implies that key bodies need to provide sound, well-founded advice on such environmental situations if the associated public are to then make well-informed choices on how they act or react. In relation to our specific studies, this could to pertain to bird trusts giving advice on when and what to feed birds in order to maximise their welfare and abundance, or forest managers providing a simple yet informative explanation of why they intend to conduct a particular deer population reduction regime, and why this chosen course of action is one which is projected to create the maximised social benefits.

This thesis contributes to the field by its wish to use new and unusual approaches to uncover the worth people hold for wildlife. The cleanest way to test the robustness of inferences made here will be to apply the idea behind warden-style nature connectivity to a broader set of applicable environmental settings, or to reapply them to those scenarios considered here. Whatever the outcome, this work has served as a pioneering first attempt to combine interdisciplinary approaches in order to explore and reveal the exact nature of people's value for the natural world around them. If local animals and plants really can deliver mankind with a separate and real level of happiness then this should be embraced. The relationship between humans and 'everyday wildlife' appears mutually beneficial, allowing the former to achieve a guardian type of wellbeing whilst simultaneously facilitating the latter to flourish and thrive at sustainable and socially desirable thresholds. To maximise the potential for each party to prosper from this co-existence, the over-arching goal of the thesis has been that it has identified why the local environment should receive a real and appropriate weighting, and that this can be reflected in subsequent decision-making and policy arenas.

APPENDICES

APPENDIX 2.1: RANKINGS OF THE RSPB BIG GARDEN BIRD WATCH (BGBW) SURVEY 2012

Species	Average/Garden	Rank	% of Gardens	Rank	Rank
Blackbird	3.649	1	96.64	1	**1**
Blue Tit	2.628	4	84.28	3	**2**
Woodpigeon	2.546	5	77.47	4	**3**
House Sparrow	3.498	2	57.75	9	**4**
Collared Dove	2.162	7	73.62	5	**5**
Robin	1.394	10	85.13	2	**5**
Starling	3.032	3	48.95	10	**7**
Chaffinch	2.245	6	63.53	7	**7**
Great Tit	1.664	9	65.15	6	**9**
Goldfinch	2.013	8	42.36	11	**10**
Dunnock	1.326	11	61.78	8	**10**
Greenfinch	1.193	12	36.46	12	**12**
Long tailed tit	1.135	13	30.82	14	**13**
Coal Tit	0.584	14	32.56	13	**13**
Feral pigeon	0.552	15	17.44	17	**15**
Magpie	0.461	16	26.16	16	**15**
Wren	0.350	20	29.17	15	**17**
Jackdaw	0.425	17	13.92	19	**18**
Pheasant	0.369	19	17.18	18	**19**
Common gull	0.404	18	7.60	24	**20**
Carrion crow	0.336	21	11.73	21	**20**
Song Thrush	0.165	24	13.01	20	**22**
Black headed gull	0.270	22	5.29	25	**23**
Jay	0.143	26	10.11	22	**24**
Rook	0.200	23	4.15	27	**25**
Great spotted woodpecker	0.107	28	9.38	23	**26**
Moorhen	0.088	29	4.32	26	**27**
Fieldfare	0.151	25	2.57	34	**28**
Redwing	0.116	27	2.41	35	**29**
Nuthatch	0.056	33	4.03	29	**29**
Green woodpecker	0.043	35	4.07	28	**31**
Bullfinch	0.060	32	3.50	32	**32**
Pied wagtail	0.053	34	3.79	30	**32**
Tree sparrow	0.085	30	2.31	36	**34**
Mallard	0.085	31	2.05	38	**35**
Sparrowhawk	0.037	38	3.57	31	**35**
Siskin	0.042	36	2.05	38	**37**
Marsh tit	0.033	41	2.59	33	**37**
Stock dove	0.036	39	2.25	37	**39**
Red legged partridge	0.040	37	1.97	40	**40**
Redpoll	0.033	40	1.30	47	**41**
Blackcap	0.020	46	1.72	41	**41**
Reed bunting	0.027	42	1.34	46	**43**
Goldcrest	0.019	47	1.58	42	**44**
Red Kite	0.024	43	1.26	49	**45**
Grey heron	0.016	49	1.42	43	**45**
Mistle thrush	0.015	50	1.42	43	**47**
Treecreeper	0.015	51	1.38	45	**48**
Herring gull	0.024	44	0.89	53	**49**
Yellowhammer	0.023	45	0.99	52	**49**
Brambling	0.017	48	1.26	49	**49**
Barn owl	0.012	52	1.30	47	**52**
Kestrel	0.010	54	1.11	51	**53**
Willow tit	0.010	53	0.89	53	**54**
Lesser spotted woodpecker	0.009	55	0.79	55	**55**
Grey wagtail	0.008	56	0.77	56	**56**
Buzzard	0.008	57	0.53	57	**57**
Grey partridge	0.004	59	0.53	57	**58**
Linnet	0.005	58	0.39	59	**59**
Chiffchaff	0.004	60	0.36	60	**60**
Tawny owl	0.002	61	0.26	61	**61**
Little owl	0.001	62	0.20	62	**62**
Lapwing	0.001	63	0.14	64	**63**
Great black backed gull	0.000	64	0.16	63	**63**
Lesser black backed gull	0.000	65	0.12	66	**65**
Waxwing	0.000	68	0.14	64	**66**
Corn bunting	0.000	66	0.08	67	**67**
Raven	0.000	66	0.06	68	**68**
Skylark	0.000	69	0.06	68	**69**
Meadow pipit	0.000	70	0.02	70	**70**
Black redstart	0.000	70	0.00	71	**71**
Hooded crow	0.000	70	0.00	71	**71**
Ring necked parakeet	0.000	70	0.00	71	**71**

(Grey shading:) **Bird Selected for This Study**

APPENDIX 2.2: SURVEY INSTRUCTIONS KEY

You will need to use this to understand the cases you are presented with

Species

Cases will indicate the type and frequency of species that may come to your garden. Frequency estimations are described in the table below:

Rating	Description
	This species will not come to your garden
	Expect **1** bird of this species to come to your garden
	Expect an average of between **2 and 5** birds of this species to come to your garden

This is the frequency estimation for **each time** the food is dispensed. The average person would expect to obtain**20** feeding opportunities from each bag.

Visibility

If instead of being shown in full colour, a bird is shown faded, this will mean these birds will feed in your garden from the food you have dispensed, but you will not see them. An example illustrates this below. Here, whilst 2-5 of these birds will feed in your garden, you will only actually see one of them.

Here are the six different species that may be seen as a consequence of dispensing bird food. The species appear below in their natural plumage (colouring) and will always appear in the same position on a choice card if present.

Nutrition

Each option has a  rating. These act like 'Hotel ratings', ranging from one-star to three-star categories. A one-star option will provide basic nourishment, and options with more stars will provide a greater level of nutrition to each bird which is fed.

Price and Donations

The price of an option represents the amount you would have to pay to obtain that seed bag[Please remember no actual purchases will be made as part of this survey].

In some cases, this price includes a donation. This donation contributes toward habitat restoration which aims to raise the population of the Bittern in East Anglia.

The Bittern is a very rare and elusive species, and over two thirds of its remaining UK population live among East Anglian reedbeds currently. If a donation is being made, this will be clearly indicated on the choice case.

The Bittern

APPENDIX 2.3: BIRD QUIZ SHEET

Possible Bird Names	**Letter**
Chaffinch	
Robin	
Grey Heron	
Lesser-Spotted Woodpecker	
Blue Tit	
Woodpigeon	
Blackbird	
Bullfinch	
Song Thrush	
Kestrel	
Collared Dove	
Dunnock	
Mallard	
Tree Sparrow	
House Sparrow	
Great Tit	

Survey Number: [ ]

APPENDIX 2.4: TEMPLATE OF RESPONDENT SURVEY

Respondent Survey

1. Which of these best describes the garden space at the place where you live?

- [ ] No Garden
- [ ] Small Private Garden (area less than a tennis court)
- [ ] Large Private Garden (area larger than a tennis court)
- [ ] Farmland / Fields
- [ ] Communal Gardens

2. Which of these describe the food you put out for the birds (Tick all that apply)?

- [ ] I do not feed the birds
- [ ] Leftover food
- [ ] Bird food
- [ ] Other (please specify) ____________________

3. If you do feed them, at what times of year do you do so and how often?

	Never	Occasionally	Regularly
Winter			
Spring			
Summer			
Autumn			

4. In the last 12 months, have you contributed to an environmental charity?

- [ ] Yes
- [ ] No

5. Please rate each of the options below, which represent your reasons, if any, for feeding birds:
(1 = Not important to me; 5 = Very important to me)

	1	2	3	4	5
Enjoyment from looking at them	○	○	○	○	○
I feel they need the extra food	○	○	○	○	○
Help towards bird populations	○	○	○	○	○
It makes me feel good to think I am helping	○	○	○	○	○
Throwing leftover food in the bin is a waste	○	○	○	○	○

---

6. Gender: ☐ Male ☐ Female

7. Age: ☐ 18-25yrs ☐ 26-35yrs ☐ 36- 45yrs ☐ 46- 55yrs ☐ 56 - 65yrs ☐ 65yrs +

8. What is your approximate annual *(monthly)* post-tax household income?

☐ Below £20,000 *(Below £1,667)*
☐ £20,000- £29,999 *(£1,668 - £2,499)*
☐ £30,000 - £39,999 *(£2,500 - £3,333)*
☐ £40,000 - £49,999 *(£3,334 - £4,166)*
£50,000 - £59,999 *(£4,167 - £4,999)*
☐ £60,000 - £69,999 *(£5,000- £5,833)*
☐ £70,000 - £79,999 *(£5,834 - £6,666)*
☐ £80,000 - £89,999 *(£6,667 - £7,499)*
☐ Above £90,000 *(Above £7,500)*
Prefer not to disclose

This is the end of the survey! Thanks again for your participation; both your responses and time have been invaluable and essential to the research.

APPENDIX 2.5: CONDITIONAL LOGIT REGRESSIONS:

Model (1)

```
Conditional (fixed-effects) logistic regression   Number of obs   =      15990
                                                  Wald chi2(13)   =     202.53
                                                  Prob > chi2     =     0.0000
Log pseudolikelihood =  -4712.006                 Pseudo R2       =     0.1777

                                   (Std. Err. adjusted for 200 clusters in ind)
```

choice	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
blackbird2	.3983381	.1048255	3.80	0.000	.1928838	.6037924
sparrow2	.40951	.0814235	5.03	0.000	.2499228	.5690971
tit1	.3644564	.0603059	6.04	0.000	.2462591	.4826538
tit2	1.267644	.1337081	9.48	0.000	1.005581	1.529707
ewoodpigeon1	-.1778065	.0946256	-1.88	0.060	-.3632691	.0076562
woodpigeon1	-.1259185	.0943639	-1.33	0.182	-.3108682	.0590313
robin1	.6668358	.0955411	6.98	0.000	.4795788	.8540928
ebullfinch1	.4042217	.1062565	3.80	0.000	.1959627	.6124807
bullfinch1	.5039966	.0763845	6.60	0.000	.3542858	.6537074
nutrition	.574958	.0849568	6.77	0.000	.4084458	.7414702
Donation	-.0016471	.0006635	-2.48	0.013	-.0029474	-.0003468
nutnum	-.0553717	.0124918	-4.43	0.000	-.0798552	-.0308883
price	-.001226	.0003284	-3.73	0.000	-.0018697	-.0005823

Model (2)

```
Conditional (fixed-effects) logistic regression   Number of obs   =       8794
                                                  Wald chi2(13)   =     157.97
                                                  Prob > chi2     =     0.0000
Log pseudolikelihood = -2376.3008                 Pseudo R2       =     0.2460

                                   (Std. Err. adjusted for 110 clusters in ind)
```

choice	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
blackbird2	.2550205	.1603763	1.59	0.112	-.0593114	.5693524
sparrow2	.3523063	.1214526	2.90	0.004	.1142637	.590349
tit1	.2751902	.0832376	3.31	0.001	.1120475	.4383329
tit2	1.412778	.1843523	7.66	0.000	1.051454	1.774101
ewoodpigeon1	-.3401966	.1455245	-2.34	0.019	-.6254193	-.0549739
woodpigeon1	-.3181876	.1364508	-2.33	0.020	-.5856263	-.050749
robin1	.6041995	.1489067	4.06	0.000	.3123477	.8960513
ebullfinch1	.4179384	.149194	2.80	0.005	.1255235	.7103533
bullfinch1	.6555349	.118913	5.51	0.000	.4224696	.8886002
nutrition	.7705861	.1182932	6.51	0.000	.5387357	1.002436
Donation	-.0007911	.0010116	-0.78	0.434	-.0027738	.0011916
nutnum	-.0484847	.0170833	-2.84	0.005	-.0819674	-.015002
price	-.0012938	.0004564	-2.83	0.005	-.0021884	-.0003992

Model (3)

Conditional (fixed-effects) logistic regression   Number of obs = 5036
Wald chi2(13) = 158.91
Prob > chi2 = 0.0000
Log pseudolikelihood = -1327.0068   Pseudo R2 = 0.2647

(Std. Err. adjusted for 63 clusters in ind)

choice	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
blackbird2	.715099	.2211667	3.23	0.001	.2816204	1.148578
sparrow2	.7412322	.1774678	4.18	0.000	.3934017	1.089063
tit1	.6019213	.1290822	4.66	0.000	.3489248	.8549177
tit2	1.813992	.27298	6.65	0.000	1.278961	2.349023
ewoodpigeon1	-.4522015	.2166585	-2.09	0.037	-.8768443	-.0275587
woodpigeon1	-.1169137	.2242261	-0.52	0.602	-.5563887	.3225614
robin1	1.083229	.1937378	5.59	0.000	.70351	1.462948
ebullfinch1	.5244085	.2432173	2.16	0.031	.0477112	1.001106
bullfinch1	.4039508	.1709416	2.36	0.018	.0689115	.7389901
nutrition	.6117263	.1639323	3.73	0.000	.2904249	.9330278
Donation	-.0027573	.0013847	-1.99	0.046	-.0054712	-.0000433
nutnum	-.076274	.0238117	-3.20	0.001	-.122944	-.029604
price	-.0014955	.0007578	-1.97	0.048	-.0029808	-.0000102

Model (4)

Conditional (fixed-effects) logistic regression   Number of obs = 9914
Wald chi2(13) = 157.55
Prob > chi2 = 0.0000
Log pseudolikelihood = -2665.613   Pseudo R2 = 0.2497

(Std. Err. adjusted for 124 clusters in ind)

choice	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
blackbird2	.6012309	.1484305	4.05	0.000	.3103125	.8921493
sparrow2	.4995239	.1140249	4.38	0.000	.2760391	.7230087
tit1	.3533329	.0817502	4.32	0.000	.1931055	.5135603
tit2	1.347074	.1806959	7.45	0.000	.9929169	1.701232
ewoodpigeon1	-.0221013	.1246058	-0.18	0.859	-.2663242	.2221216
woodpigeon1	-.213981	.1259097	-1.70	0.089	-.4607594	.0327974
robin1	.750739	.1321144	5.68	0.000	.4917996	1.009678
ebullfinch1	.145893	.1419158	1.03	0.304	-.1322568	.4240429
bullfinch1	.6479146	.1105737	5.86	0.000	.4311941	.864635
nutrition	.6689339	.1177841	5.68	0.000	.4380813	.8997866
Donation	-.0007948	.0009656	-0.82	0.410	-.0026874	.0010977
nutnum	-.0576491	.0166544	-3.46	0.001	-.0902912	-.0250071
price	-.0012699	.0005356	-2.37	0.018	-.0023196	-.0002202

APPENDIX 2.6: STATISITCAL TESTS FOR REGRESSION OUTPUTS

Table 1: Tests of Parameter Differences Across Conditional Logit Models

	Model 1	Model 2		Model 3		Model 4	
Variable	Coefficients	Coefficient	χ^2 value (p-value)	Coefficient	χ^2 value (p-value)	Coefficient	χ^2 value (p-value)
Blackbird^{mult}	0.398	0.255	0.79 (0.37)	0.601	1.87 (0.17)	0.715	2.06 (0.15)
Bullfinch	0.504	0.656	1.62 (0.2)	0.648	1.69 (0.19)	0.404	0.34 (0.55)
$\text{Bullfinch}^{(e)+}$	0.404	0.418	0.01 (0.92)	0.146	3.31 (0.07)*	0.524	0.25 (0.62)
Robin	0.667	0.604	0.18 (0.67)	0.751	0.40 (0.52)	1.083	4.62 (0.03)**
Sparrow^{mult}	0.410	0.352	0.23 (0.63)	0.500	0.62 (0.43)	0.741	3.48 (0.06)*
Tit	0.364	0.275	1.04 (0.3)	0.353	0.01 (0.93)	0.602	3.51(0.06)*
Tit^{mult}	1.268	1.413	0.62 (0.43)	1.347	0.19 (0.66)	1.814	4.00 (0.05)**
Woodpigeon	-0.126	-0.318	1.98 (0.15)	-0.214	0.49 (0.48)	-0.117	0.00 (0.97)
$\text{Woodpigeon}^{(e)+}$	-0.178	-0.340	1.24 (0.27)	-0.022	1.57 (0.21)	-0.452	1.60 (0.20)
Nutrition	0.575	0.771	2.73 (0.10)*	0.669	0.64 (0.42)	0.612	0.05 (0.82)
Donation	-0.002	-0.001	1.43 (0.23)	-0.001	1.56 (0.21)	-0.003	0.30 (0.58)
Nutnum	-0.055	-0.048	0.15 (0.70)	-0.058	0.03 (0.87)	-0.076	0.80 (0.37)
Price	-0.001	-0.001	0.41 (0.51)	-0.001	0.25 (0.61)	-0.001	0.43 (0.51)

*Significant at 10% level ($p < 0.1$) ** Significant at 5% level ($p < 0.05$)

Table 2: Testing the Impact of Status Quo Effects

Variable	Coefficient	Z	P>|z|	Model 1 Parameter	ASC Value	Model 1 Value	χ^2 value (p-value)
Blackbird^{mult}	0.214	-1.94	0.052	0.398	3.80	8.46	5.61(0.02)**
Bullfinch	0.318	4.15	0.000	0.504	10.84	20.55	13.58 (0.00)**
$\text{Bullfinch}^{(e)+}$	0.200	1.9	0.057	0.404	6.83	16.49	7.10 (0.01)**
Robin	0.491	5.33	0.000	0.667	16.73	27.20	10.87 (0.00)**
Sparrow^{mult}	0.248	-2.83	0.005	0.410	4.40	8.70	7.47 (0.01)**
Tit	-0.050	-0.78	0.437	0.364	-1.70	14.86	56.76 (0.00)**
Tit^{mult}	0.374	2.84	0.004	1.268	7.52	19.18	74.62 (0.00)**
Woodpigeon	-0.437	-4.76	0.000	-0.126	-14.91	-5.14	9.87 (0.00)**
$\text{Woodpigeon}^{(e)+}$	-0.604	-6.06	0.000	-0.178	-20.61	-7.25	15.48 (0.00)**
Nutrition	-0.304	-2.49	0.013	0.575	-10.35	23.45	65.94 (0.00)**
Donation	-0.002	-2.4	0.016	-0.002	-0.05	-0.07	0.29 (0.59)
Nutnum	0.057	4.08	0.000	-0.055	1.96	-2.26	76.82 (0.00)**
SQ Effect	-1.637	-7.43	0.000				
Price	-0.001	-4.41	0.000	-0.001			0.00 (0.99)

** Significant at 5% level ($p < 0.05$)

Testing Species WTP Estimate Differences [for Conditional Logit Model (1)]

Robin – Bullfinch;	χ^2 = 1.58 (p = 0.21)	No difference between Robin and Bullfinch
Robin – $\text{Bullfinch}^{(e)+}$	χ^2 = 2.76 (p = 0.10)*	Robin greater in value than all those except Bullfinch
Robin – Tit	χ^2 = 9.41 (p = 0.002)**	
Bullfinch – Tit	χ^2 = 2.35 (p = 0.12)	No difference between Tit and Bullfinch
Bullfinch – $\text{Bullfinch}^{(e)+}$	χ^2 = 0.77 (p = 0.38)	No difference between $\text{Bullfinch}^{(e)+}$ and Bullfinch
Tit – Tit^{mult}	χ^2 = 0.00 (p = 0.96)	Constant marginal value
Tit – $\text{Bullfinch}^{(e)+}$	χ^2 = 0.16 (p = 0.69)	No difference between $\text{Bullfinch}^{(e)+}$ and Tit
Bullfinch - Sparrow^{mult}	χ^2 = 19.4 (p = 0.000) **	Bullfinch greater than all those below Sparrow
Tit - Sparrow^{mult}	χ^2 = 14.6 (p = 0.000) **	Tit greater than all those below Sparrow
Blackbird^{mult} - Sparrow^{mult}	χ^2 = 0.03 (p = 0.85)	No difference between Blackbird^{mult} and Sparrow^{mult}

*Significant at 10% level ($p < 0.1$) ** Significant at 5% level ($p < 0.05$)

Table 3: A Comparison of Mixed Logit and Conditional Logit Regression Results

	Mixed Logit Regression				Conditional Logit [Model (1)] Regression		Estimate Differences? χ^2 value (p-value)
Variable	Coefficient	Z	*P>/z/*	WTP Value	Coefficient	WTP Value	
Blackbird^{mult}	0.673	4.77	0.000	6.95	0.398	8.46	1.07(0.31)
Bullfinch	0.696	4.60	0.000	13.79	0.504	20.55	5.09(0.02)**
Bullfinch$^{(e)+}$	0.524	2.77	0.006	10.40	0.404	16.49	2.63(0.11)
Robin	1.259	8.39	0.000	24.96	0.667	27.20	0.56(0.45)
Sparrow^{mult}	0.551	5.32	0.000	5.69	0.410	8.70	7.89(0.01)**
Tit	0.352	9.28	0.000	6.98	0.364	14.86	16.25(0.00)**
Tit^{mult}	1.681	3.57	0.000	13.72	1.268	19.18	26.15(0.00)**
Woodpigeon	-0.071	-0.48	0.629	-1.41	-0.126	-5.14	1.61(0.20)
Woodpigeon$^{(e)+}$	-0.261	-1.75	0.081	-5.17	-0.178	-7.25	0.49(0.48)
Nutrition	1.084	8.16	0.000	21.50	0.575	23.45	0.55(0.46)
Donation	-0.001	-1.64	0.101	-0.03	-0.002	-0.07	6.58(0.01)**
Nutnum	-0.079	-5.85	0.000	-1.56	-0.055	-2.26	6.96(0.01)**
Price	-0.003	-7.43	0.000	-0.001	-0.001		0.01 (0.90)
Model Fit (χ^2)	2230.83		0.000				
Log likelihood Ratio	3456.5887						

*Significant at 10% level (p < 0.1) ** Significant at 5% level (p < 0.05)

Table 4: A Comparison of Latent Class and Conditional Logit Regressions

	Conditional Logit (Model 1) Log Likelihood: -4712.006		Latent Class Model Log Likelihood: -3403.5682					
			Class 1		**Class 2**		**Class 3**	
Variable	Coeff	*WTP Value*	Coeff	*WTP Value*	Coeff	*WTP Value*	Coeff	*WTP Value*
Blackbird^{mult}	0.398	8.46	0.253	3.29	1.237	2.93	-0.591	5.13
Bullfinch	0.504	20.55	0.576	3.01	3.923	9.29	-3.702	32.14
Bullfinch$^{(e)+}$	0.404	16.49	0.583	8.13	2.267	10.30	-0.014	0.23
Robin	0.667	27.20	1.007	11.88	11.404	21.63	0.468	-4.18
Sparrow^{mult}	0.410	8.70	0.231	-18.85	0.973	4.42	-3.736	62.27
Tit	0.364	14.86	0.325	-12.50	0.813	3.70	-2.368	39.47
Tit^{mult}	1.268	19.18	1.237	25.18	-10.414	-47.34	-0.132	2.20
Woodpigeon	-0.126	-5.14	-0.754	14.58	24.355	110.70	-3.796	63.27
Woodpigeon$^{(e)+}$	-0.178	-7.25	-0.5	14.40	15.885	72.20	-34.597	576.62
Nutrition	0.575	23.45	0.095	2.38	2.098	9.54	-2.522	42.03
Donation	-0.002	-0.07	-0.001	-0.03	0.008	0.04	-0.01	0.17
Nutnum	-0.055	-2.26	-0.003	-0.08	-0.127	-0.58	0.274	-4.57
Price	-0.001		-0.002		-0.011		0.003	
			Membership: 0.137		**Membership: 0.716**		**Membership: 0.146**	
		Number Correct		-0.162		0.299		Ref group
		Age (65+)		-1.082		0.255		Ref group

APPENDIX 2.7: ESTIMATED BIRD FEEDING PERCENTAGES BASED UPON HABIT AND DIET

	Maize	Sunflower Pellets	Mealworms	Fat	Nuts	Berries
Finches	3	1	0	3	4	2
Seed-Eaters	5	0	0	0	1	0
Thrushes	0	0	4	2	2	4
Tits	0	5	0	3	4	1

Score (from 0-5) of the 'attractiveness' of each feed constituent to bird feeding groups.

It is by compiling this information, plus data and advice from bird-feeding websites and forums such as that of the RSPB (www.rspb.org.uk) that best estimates can be made on the typical proportions of feeding groups which will be attracted to each of our 16 products below:

	Bird Feeding Groups (proportion)			
	Finches	Seed-Eaters	Thrushes	Tits
Fat Ball (100)	0	0	30	70
Fat Ball (28 x 6)	0	0	30	70
Fat Ball (50)	0	0	30	70
Berry Bird-Cake	30	0	50	20
Mealworm Bird-Cake	0	30	50	20
Original Bird-Cake	40	40	0	20
Hanging Berry Bird-Cake	30	0	20	50
Hanging Mealworm Bird-Cake	0	40	20	40
Hanging Original Bird-Cake	30	30	0	40
Dried Mealworm (90g x 6)	0	0	100	0
Dried mealworm (200g x5)	0	0	100	0
Dried mealworm (600g x1)	0	0	100	0
Bird Seed (12.55KG)	20	80	0	0
Suet Pellets (10kg)	0	0	0	100
Suet Pellets with Mealworms (10kg)	0	0	10	90
Sunflower Pellets (10kg)	10	0	0	90

APPENDIX 3.1: ALGEBRAIC PROOF THAT A CONCAVE RELATIONSHIP EXISTS BETWEEN 'S' AND OTHER FEED SOURCES ('M' AND 'Q')

$$s^* = \frac{\alpha Y}{p}\left[\frac{[M-1]s+Q}{(1-\alpha)s^* + [M-1]s+Q}\right] \qquad (3.18)$$

Rearranging this can create the following expression:

$$s^* = \frac{\alpha Y}{p}[M-1]\left[\frac{1}{(1-\alpha)s^* + [M-1]s+Q}\right] + \frac{\alpha Y}{p}Q\left[\frac{1}{(1-\alpha)s^* + [M-1]s+Q}\right]$$

These can then be differentiated with respect to M and Q to give expressions for each.

$$\frac{\partial s^*}{\partial M} = \frac{\alpha Y}{p}(1-\alpha)s^*[(1-\alpha)s^* + [M-1]s+Q]^{-2} \qquad (3.18A)$$

$$\frac{\partial s^*}{\partial Q} = \frac{\alpha Y}{p}(1-\alpha)s^*[(1-\alpha)s^* + [M-1]s+Q]^{-2} \qquad (3.18B)$$

Both terms will both be positive. However, when differentiating each again, we find negative second order conditions…

$$\frac{\partial^2 s^*}{\partial M^2} = -2\frac{\alpha Y}{p}(1-\alpha)s^*[(1-\alpha)s^* + [M-1]s+Q]^{-3} \qquad (3.18A')$$

$$\frac{\partial^2 s^*}{\partial Q^2} = -2\frac{\alpha Y}{p}(1-\alpha)s^*[(1-\alpha)s^* + [M-1]s+Q]^{-3} \qquad (3.18B')$$

The combination of these two sets of expressions (3.18A & 3.18A') and (3.18B & 3.18B') show that in each case, a concave relationship exists between the seed dispensation level (s^*) of the individual and the level of other feed sources…

APPENDIX 3.2: COMPARATIVE STATIC RESULTS USING IMPLICIT FUNCTION THEORY

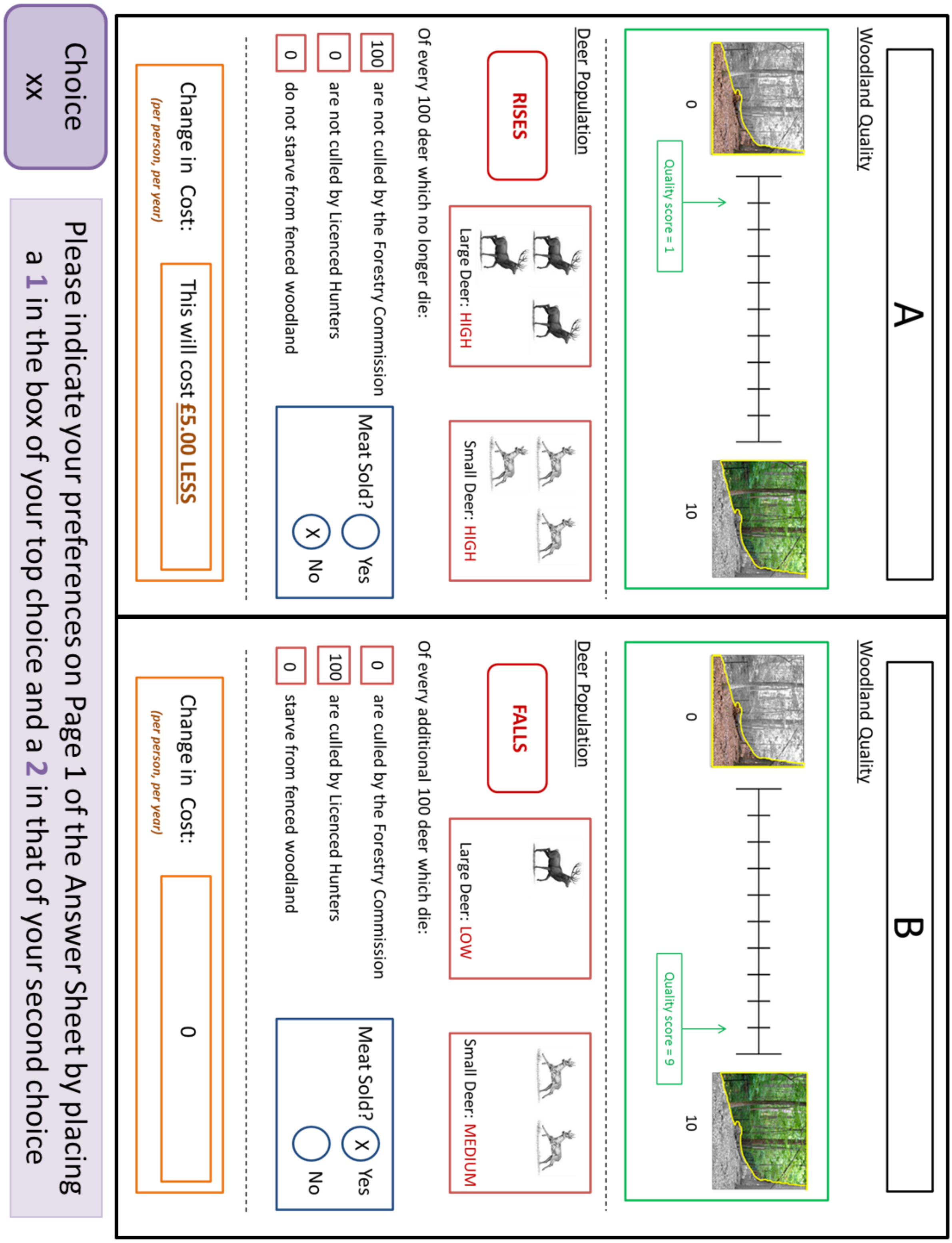
(I) FOR THE EXOGENOUS POPULATION MODEL

Nash Equilibrium: $s^* = \frac{\alpha Y}{p}\left[\frac{[M-1]s+Q}{(1-\alpha)s^* + [M-1]s+Q}\right]$		First-Best Solution: $s^F = \frac{\alpha Y}{p}\left(\frac{Q}{(1-\alpha)s^F + Q}\right)$	
Comparative Static (with s = s^*)	*Expected Sign*	*Comparative Static (with s = s^F)*	*Expected Sign*
$\frac{ds}{dp} = -\left(\frac{s[s(M-\alpha)+Q]}{P[2s(M-\alpha)+\mathrm{Q}]-\alpha\mathrm{Y}(M-1)}\right)$	Negative	$\frac{ds}{dp} = -\left(\frac{s[Ms(1-\alpha)+Q]}{p[2Ms(1-\alpha)+\mathrm{Q}]}\right)$	Negative
$\frac{ds}{dY} = \frac{Ps[s(M-\alpha)+Q]}{PY[2s(M-\alpha)+\mathrm{Q}]-\alpha\mathrm{Y}^2(M-1)}$	Positive	$\frac{ds}{dY} = \frac{s[Ms(1-\alpha)+Q]}{Y[2Ms(1-\alpha)+\mathrm{Q}]}$	Positive
$\frac{ds}{d\alpha} = \frac{Ps[Ms+Q]}{\alpha P[2s(M-\alpha)+\mathrm{Q}]-\alpha^2\mathrm{Y}(M-1)}$	Positive	$\frac{ds}{d\alpha} = \frac{s(Ms+Q)}{\alpha[2Ms(1-\alpha)+\mathrm{Q}]}$	Positive
$\frac{ds}{dM} = \frac{s(\alpha\mathrm{Y}-Ps)}{P[2s(M-\alpha)+\mathrm{Q}]-\alpha\mathrm{Y}(M-1)}$	Positive if $\alpha\mathrm{Y} > \mathrm{Ps}$	$\frac{ds}{dM} = -\left(\frac{s^2(1-\alpha)}{2Ms(1-\alpha)+\mathrm{Q}}\right)$	Negative
$\frac{ds}{dQ} = \frac{\alpha\mathrm{Y}-Ps}{P[2s(M-\alpha)+\mathrm{Q}]-\alpha\mathrm{Y}(M-1)}$	Positive if $\alpha\mathrm{Y} > \mathrm{Ps}$	$\frac{ds}{dQ} = \frac{\alpha\mathrm{Y}-Ps}{p[2Ms(1-\alpha)+\mathrm{Q}]}$	Positive if $\alpha\mathrm{Y} > \mathrm{Ps}$

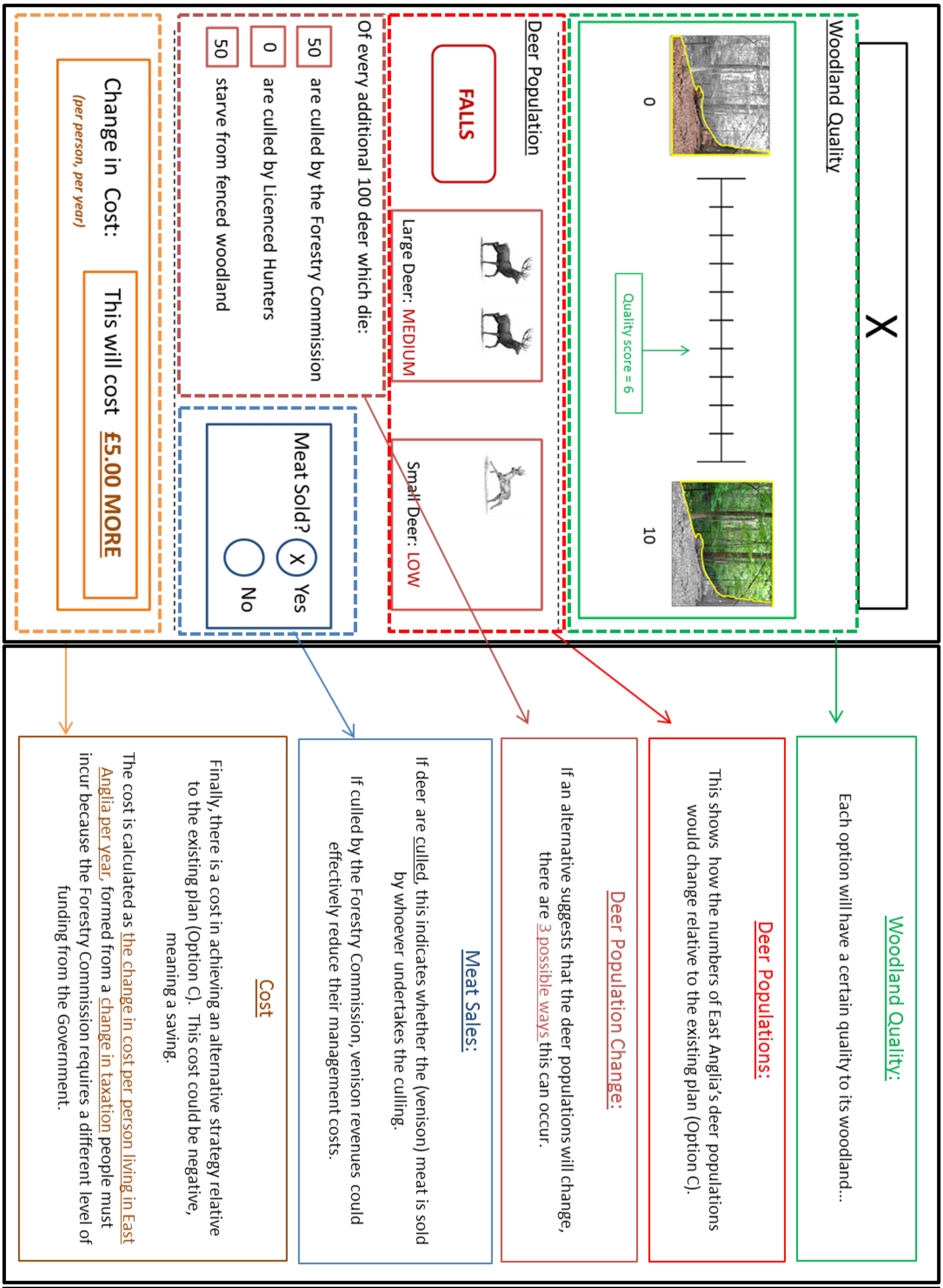
(II) FOR THE ENDOGENOUS POPULATION MODEL

Nash Equilibrium: $s^* = \frac{\alpha Y}{p}\left[\frac{\beta s + [M-1]s + Q}{(1-\alpha(1-\beta)s^* + [M-1]s + Q}\right]$		First-Best Solution: $s^F = \frac{\alpha Y}{p}\left(\frac{\beta M s^F + Q}{(1-\alpha(1-\beta))Ms^F + Q}\right)$	
Comparative Static (with s = s^*)	*Expected Sign*	*Comparative Static (with s = s^F)*	*Expected Sign*
$\frac{ds}{dp} = -\frac{s[s(M-\alpha(1-\beta))+Q]}{P[2s(M-\alpha(1-\beta))+Q]-\alpha Y(\beta+M-1)}$	Negative	$\frac{ds}{dp} = -\frac{s[Ms(1-\alpha(1-\beta))+Q]}{p[2Ms(1-\alpha(1-\beta))+Q]-\alpha Y\beta M}$	Negative
$\frac{ds}{dY} = \frac{Ps[s(M-\alpha(1-\beta))+Q]}{PY[2s(M-\alpha(1-\beta))+Q]-\alpha Y^2(\beta+M-1)}$	Positive	$\frac{ds}{dY} = \frac{Ps[Ms(1-\alpha(1-\beta))+Q]}{PY[2Ms(1-\alpha(1-\beta))+Q]-\alpha Y^2\beta M}$	Positive
$\frac{ds}{d\alpha} = \frac{Ps[Ms+Q]}{\alpha P[2s(M-\alpha(1-\beta))+Q]-\alpha^2 Y(\beta+M-1)}$	Positive	$\frac{ds}{d\alpha} = \frac{Ps(Ms+Q)}{\alpha P[2Ms(1-\alpha(1-\beta))+Q]-\alpha^2 Y\beta M}$	Positive
$\frac{ds}{dM} = \frac{s[\alpha Y - Ps]}{P[2s(M-\alpha(1-\beta))+Q]-\alpha Y(\beta+M-1)}$	Positive if $\alpha Y > Ps$	$\frac{ds}{dM} = -\frac{Ps^2(Ms+Q) - \alpha Y\beta s}{P[2Ms(1-\alpha(1-\beta))+Q]-\alpha Y\beta M}$	Negative
$\frac{ds}{dQ} = \frac{\alpha Y - Ps}{P[2s(M-\alpha(1-\beta))+Q]-\alpha Y(\beta+M-1)}$	Positive if $\alpha Y > Ps$	$\frac{ds}{dQ} = \frac{\alpha Y - Ps}{P[2Ms(1-\alpha(1-\beta))+Q]-\alpha Y\beta M}$	Positive if $\alpha Y > Ps$
$\frac{ds}{d\beta} = \frac{\alpha s(Y - Ps)}{P[2Ms(1-\alpha(1-\beta))+Q]-\alpha Y(\beta+M-1)}$	Positive if $\beta < 1$ Negative if $\beta > 1$	$\frac{ds}{d\beta} = \frac{\alpha Ms(Y - Ps)}{P[2Ms(1-\alpha(1-\beta))+Q]-\alpha Y\beta M}$	Positive if $\beta < 1$ Negative if $\beta > 1$

APPENDIX 4.1: AN EXAMPLE CHOICE SET



APPENDIX 4.2: ABBREVIATED TUTORIAL INSTRUCTIONS



APPENDIX 4.3: THE RESPONDENT QUESTIONNAIRE

Survey Number: ☐

Respondent Survey

1. On average, how often do you visit East Anglia's Forests?

- ☐ At least once per month
- ☐ Once every 2 -3 months
- ☐ Once or twice per year
- ☐ Less than once per year
- ☐ Never (Please move to Question **3**)

2. When visiting these forests, what is normally the reason for your visit? (Tick all that apply)

- ☐ Walking or Dog Walking
- ☐ Cycling / Sport
- ☐ Nature- Watching
- ☐ Other (please specify) ____________

3. Please indicate your view regarding the following:

	I agree with this action		
Erecting Fences to prevent deer from accessing woodlands in East Anglia in order to protect forestry	YES	NO	Don't know
Culling deer in woodlands in East Anglia in order to protect forestry	YES	NO	Don't know
Culling badgers in the UK under the assumption that this will prevent the spread of TB in livestock.	YES	NO	Don't know

4. In the last 12 months, have you donated to or done voluntary work for either of the following:

(a) An Animal Welfare Charity	☐ Yes	☐ No
(b) Another Environmental Organisation	☐ Yes	☐ No

5. Do you regularly feed birds in your garden?

☐ Yes ☐ No

6. Please indicate the extent to which you agree with the following statements:

*(**1** = Strongly Disagree; **2** = Disagree; **3** = Neither Agree or Disagree; **4** = Agree; **5** = Strongly Agree)*

		1	2	3	4	5
a)	Effective Forest Management is Important	○	○	○	○	○
b)	If deer populations must be reduced, culling is a better way than starvation.	○	○	○	○	○
c)	Educating children about nature and the environment is important	○	○	○	○	○

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7. Gender:
- ☐ Male
- ☐ Female

8. Age:
- ☐ 18-25yrs
- ☐ 26-35yrs
- ☐ 36- 45yrs
- ☐ 46- 55yrs
- ☐ 56 - 65yrs
- ☐ 65yrs +

9. What is your approximate annual *(monthly)* post-tax household income?
- ☐ Below £20,000 *(Below £1,667)*
- ☐ £20,000- £29,999 *(£1,668 - £2,499)*
- ☐ £30,000 - £39,999 *(£2,500 - £3,333)*
- ☐ £40,000 - £49,999 *(£3,334 - £4,166)*
- ☐ £50,000 - £59,999 *(£4,167 - £4,999)*
- ☐ £60,000 - £69,999 *(£5,000- £5,833)*
- ☐ £70,000 - £79,999 *(£5,834 - £6,666)*
- ☐ £80,000 - £89,999 *(£6,667 - £7,499)*
- ☐ Above £90,000 *(Above £7,500)*
- ☐ Prefer not to disclose

10. In the last 12 months, have you participated in either of the following activities?

(a) Game Hunting or Shooting	☐ Yes	☐ No
(b) Fishing	☐ Yes	☐ No

11. Are you Vegetarian or Vegan?

☐ Yes ☐ No

This is the end of the survey! Thanks again for your participation; both your responses and time have been invaluable and essential to the research.

APPENDIX 4.4: AGGREGATED RESPONSE DISTRIBUTIONS

1. Visit Frequency	%
At least Once per Month	54
Every 2-3 months	12.5
2-3 times per year	23
Less than Once per year	7
Never	3.5

2. Type of Use	%
Walk	75
Nature-Watching	42
Cycle	26
Other	21

3(a). Attitude to Fencing	%
Yes	62
No	25.5
Don't Know	12.5

4(a). Give to Animal Welfare Charity	%
Yes	42.5
No	57.5

3(b). Attitude to Deer Culling	%
Yes	76.5
No	12
Don't Know	11.5

4(b). Give to Environmental Organisation	%
Yes	39
No	61

3(c). Attitude to Badger Culling	%
Yes	26
No	41
Don't Know	33

5. Feeds Birds?	%
Yes	63.5
No	36.5

6(a). Mean Score on Effective forest Management	4.53
6(b). Mean Score on Culling better than Starvation	4.34
6(c). Mean Score on Educating Children	4.74

7. Gender	%
Male	45
Female	55

8. Age	%
18-25	11.5
26-35	12.5
36-45	13
46-55	17.5
56-65	22
65+	23.5

9. Income	%
Less the £20,000	27
£20,000 – 29,999	18.5
£30,000 – 39,999	10.5
£40,000 – 49,999	11.5
£50,000 – 59,999	5
£60,000 – 69,999	4.5
£70,000 – 79,999	2.5
£80,000 – 89,999	3
Above £90,000	2.5
Prefer not to Disclose	15

10(a). Partake in Hunting	%
Yes	4
No	96

11. Vegetarian or Vegan	%
Yes	13.5
No	86.5

Location	%
Norfolk	50
Suffolk	50

Voucher Used	%
Yes	74.5
No	25.5

10(b). Partake in Fishing	%
Yes	7
No	93

Survey Day	%
Weekday	50
Weekend	50

APPENDIX 4.5: VALUATIONS MATRIX

	Valuations in £0.00						
	QUALITY	**LARGE**	**SMALL**	**MEAT**	**FC CULL**	**TH CULL**	**N**
MAIN SAMPLE	3.85	3.51	9.46	12.19	0.12	0.01	200
1. VEGETARIANS	4.94	**8.76**	**18.15**	**17.55**	0.15	-0.06	27
2. WELFARE CHARITY	**4.68**	4.50	**13.56**	**14.10**	**0.16**	-0.01	85
3. BIRDFEEDERS	4.37	3.58	10.37	14.20	**0.16**	0.00	127
4. MEN	3.42	2.96	**6.90**	10.94	**0.10**	0.02	90
5. NON-VOUCHER USER	4.04	**5.73**	10.05	**9.74**	0.09	0.04	51
6. FREQ USER	3.69	3.50	9.27	**15.53**	0.14	0.01	108
7. PRO-BADGER CULLERS	**2.75**	**0.87**	**4.98**	11.20	**0.12**	0.06	52
8. CYCLISTS	3.54	2.87	7.65	13.75	**0.10**	-0.01	52
9. SUFFOLK	**3.30**	3.29	7.65	12.92	**0.12**	0.00	100
10. YOUNGEST	**5.92**	**9.89**	11.34	**9.04**	**0.03**	-0.08	23
11. AGE = 65+	**3.82**	**3.29**	7.09	**16.10**	0.14	0.00	47
12. WEEKENDERS	4.12	4.15	11.14	11.86	0.09	-0.02	100
13. INCOME LOW (< £20K)	**5.17**	**7.36**	11.61	**22.55**	**0.12**	-0.07	54
14. INCOME MED (£20-40K)	3.71	**3.57**	9.04	**9.22**	**0.10**	0.03	58
15. INCOME HIGH (> £40K)	3.44	3.17	8.71	**9.76**	**0.11**	0.01	58

Insignificant (p>0.1)	*Weakly Significant (p>0.05)*	***Statistically different from the main sample*** *(p<0.1)*

APPENDIX 4.6: FURTHER STATISTICAL TESTS

Table 1: Interacting Quality over Income

	Coefficient	Z	P>|z|	Model 1 Parameter	Interaction Model Value	Model 1 Value
Quality Level	0.243	12.23	0.000	0.249	3.76	3.85
Large Deer	0.227	6.27	0.000	0.227	3.51	3.51
Small Deer	0.612	10.80	0.000	0.612	9.46	9.46
FC Level	0.007	8.31	0.000	0.007	0.12	0.12
TH Level	0.000	0.28	0.778	0.000	0.01	0.01
Meat	0.789	15.72	0.000	0.789	12.19	12.19
Income*Quality	0.002	0.40	0.692		0.03	
Cost	-0.065	-12.39	0.000	-0.065		

Table 2: Status Quo Effects

	Coefficient	Z	P>|z|	Model 1 Parameter	ASC Value	Model 1 Value	Estimate Differences? χ^2 value (p-value)	SQ effects with Model (1) cost parameter	Estimate Differences? χ^2 value (p-value)
Quality Level	0.225	13.91	0.000	0.249	4.77	3.85	**7.17 (0.007)****	5.27	2.14 (0.143)
Large Deer	0.351	9.14	0.000	0.227	7.44	3.51	**23.33 (0.000)****	4.81	**10.46 (0.001)****
Small Deer	0.261	4.86	0.000	0.612	5.53	9.46	**11.96 (0.001)****	12.97	**42.83 (0.000)****
FC Level	0.007	7.33	0.000	0.007	0.14	0.12	0.97 (0.324)		
TH Level	0.001	1.13	0.260	0.000	0.03	0.01	0.57 (0.449)		
Meat	0.552	11.00	0.000	0.789	11.71	12.19	0.21 (0.651)		
SQ Effects	0.637	8.34	0.000						
Cost	-0.047	-9.71	0.000	-0.065					

Table 3: The Results of the Latent Class Model

	Conditional Logit (Model 1) Log Likelihood: -4821.5204		Latent Class Model Log Likelihood: -4421.62					
			Class 1		**Class 2**		**Class 3**	
Variable	Coeff	*WTP Value*	Coeff	*WTP Value*	Coeff	*WTP Value*	Coeff	*WTP Value*
Quality Level	0.249	*3.85*	0.487	*5.07*	0.325	*2.56*	0.195	*4.24*
Large Deer	0.227	*3.51*	0.618	*6.44*	-0.122	*-0.96*	0.213	*4.63*
Small Deer	0.612	*9.46*	1.593	*16.59*	0.772	*6.08*	-0.114	*-2.48*
FC Level	0.007	*0.12*	0.002	*0.02*	0.02	*0.16*	0.004	*0.09*
TH Level	0.000	*0.01*	-0.016	*-0.17*	0.014	*0.11*	0.002	*0.04*
Meat	0.789	*12.19*	0.768	*8.00*	1.301	*10.24*	0.488	*10.61*
Cost	-0.065		-0.096		-0.127		-0.046	
			Membership: 0.375		**Membership: 0.387**		**Membership: 0.238**	
	Animal Welfare		+0.849		+0.629		Ref. Group	
	Badger Cullers		-0.681		+0.14		Ref. Group	

Table 4: Age Interaction (Model 4)

```
. clogit choice1 quality large small fclevel thlevel smallage largeage meat cost
> , cluster(ind) group(  Sets)

Iteration 0:   log pseudolikelihood = -4862.2001
Iteration 1:   log pseudolikelihood = -4810.0955
Iteration 2:   log pseudolikelihood = -4809.8227
Iteration 3:   log pseudolikelihood = -4809.8227

Conditional (fixed-effects) logistic regression   Number of obs    =     16000
                                                  Wald chi2(9)     =    607.79
                                                  Prob > chi2      =    0.0000
Log pseudolikelihood = -4809.8227                 Pseudo R2        =    0.1611

                                  (Std. Err. adjusted for 200 clusters in ind)
```

choice1	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
quality	.2506024	.0159989	15.66	0.000	.2192452	.2819597
large	.5664263	.1165519	4.86	0.000	.3379888	.7948639
small	.4939271	.146155	3.38	0.001	.2074686	.7803855
fclevel	.0074436	.0008989	8.28	0.000	.0056819	.0092054
thlevel	.0003354	.0012943	0.26	0.796	-.0022014	.0028722
smallage	.030071	.0331622	0.91	0.365	-.0349258	.0950678
largeage	-.0848544	.0271396	-3.13	0.002	-.138047	-.0316618
meat	.7909037	.050511	15.66	0.000	.6919039	.8899035
cost	-.0651221	.0052688	-12.36	0.000	-.0754488	-.0547954

Table 5: Meat Interaction (Model 5)

```
. clogit choice1 quality large small fclevel thlevel thmeat fcmeat meat cost, cl
> uster( ind) group( Sets)

Iteration 0:   log pseudolikelihood = -4790.9295
Iteration 1:   log pseudolikelihood = -4745.0854
Iteration 2:   log pseudolikelihood = -4744.5169
Iteration 3:   log pseudolikelihood = -4744.5167

Conditional (fixed-effects) logistic regression   Number of obs    =     16000
                                                  Wald chi2(9)     =    760.56
                                                  Prob > chi2      =    0.0000
Log pseudolikelihood = -4744.5167                 Pseudo R2        =    0.1725

                                  (Std. Err. adjusted for 200 clusters in ind)
```

choice1	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
quality	.2722683	.0168543	16.15	0.000	.2392345	.3053021
large	.1665162	.0395247	4.21	0.000	.0890492	.2439832
small	.5543545	.0571382	9.70	0.000	.4423657	.6663433
fclevel	.0001613	.0009679	0.17	0.868	-.0017356	.0020583
thlevel	.0028037	.0017252	1.63	0.104	-.0005776	.0061849
thmeat	-.0010469	.0025546	-0.41	0.682	-.0060538	.0039601
fcmeat	.0185006	.0019952	9.27	0.000	.01459	.0224112
meat	-.0071354	.1488758	-0.05	0.962	-.2989266	.2846557
cost	-.0698278	.0055178	-12.65	0.000	-.0806426	-.0590131

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