The Role of Education as a Tool for Environmental Conservation and Sustainable Development

Caroline Howe

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For my parents and sister

The Unit!

As you set out for Ithaka
hope your road is a long one,
full of adventure, full of discovery . . .

Keep Ithaka always in your mind
Arriving there is what you're destined for.
But don't hurry the journey at all.
Better if it lasts for years,
so you're old by the time you reach the island,
wealthy with all you've gained on the way,
not expecting Ithaka to make you rich.

Ithaka gave you the marvellous journey.
Without her you wouldn't have set out.
She has nothing left to give you now.

And if you find her poor, Ithaka won't have fooled you.
Wise as you will have become, so full of experience,
you'll have understood by then what these Ithakas mean.

From Ithaka by C.P. Cavafy

Abstract

The UN has declared 2005 to 2014 the Decade of Education for Sustainable Development. However, education is often viewed as an unalloyed good and consequently, there have been few empirical studies on the costs and benefits of different forms of education within the fields of environmental conservation and sustainable development. Likewise, studies quantifying success of conservation and sustainable development projects are also limited. Without quantitative data on either of these aspects it is difficult to translate research into action, which is vital if conservation and sustainable development strategies are to succeed.

This study explores educational policies at global and local scales based on conservation interventions funded by the DEFRA Darwin Initiative. At the global scale, I carry out an analysis of the role of educational activities in projects funded by the Darwin Initiative since its inception. At the local scale, I carry out an in-depth case study of the success of a Darwin-funded project for the conservation of the saiga antelope (*Saiga tartarica*) conservation in Kalmykia, Russia. The geographically small area studied meant that cultural and demographic influences could be controlled, allowing for an in-depth exploration of a media-based public awareness campaign in comparison with other conservation interventions. Fieldwork was carried out over three months, using willingness-to-pay (WTP) as an indicator of behavioural intention. Analysis involved generalised linear modelling techniques. To expand the study from a case-by-case scenario to a global comparative analysis, a database was developed of Darwin Initia-

tive project reports, as the scheme has been promoting biodiversity conservation and sustainable resource use worldwide for many years and emphasises the importance of education within its remit. It therefore offers a range of education initiatives both in terms of scale and strategy providing the variance required for such a meta-analysis. The study involved a combination of quantitative statistical and cost-benefit analyses alongside qualitative in-depth interviews with project leaders.

This may be one of the few studies on environmental conservation and sustainable development success in which intervention effectiveness has been properly quantified and robustly examined. WTP, as an indicator of behavioural intention, was established as a practical measure of conservation success at field-level. At the larger scale, consistent measures of success can be developed that can be used to analyse large datasets in a quantitative manner. These measures have been used successfully to establish education as a useful tool for environmental conservation and sustainable development and to demonstrate important distinctions in cost-effectiveness of different educational strategies. It is hoped that this comprehensive and quantitative comparative assessment of the effectiveness and success of different conservation interventions will be used in future implementation of conservation, and in particular environmental education policies, to ensure that sustainable development and environmental conservation strategies are both cost-effective and successful.

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provided evidence against the existence of a creationist God, but I think even he would struggle to find evidence to disprove the fact that you are all in fact Angels; for loving me through the bad times as well as the good. Thank you!

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"Man tends to increase at a greater rate than his means of subsistence"

Charles Darwin, The Descent of Man, 1871

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Introduction

Success *n. a favourable outcome; doing what was desired or attempted; . . .(OED, 1990)*

According to The Oxford English Dictionary definition, the fulfilment of a set of goals, no matter how easy or difficult they are to attain, counts as a success. A goal may be a simple output, for example the production of an educational poster, or a more fundamental outcome such as a reduction in poaching behaviour. Conservation is a process that links the environment, both human and natural, and inputs and outputs to produce desired outcomes. These outcomes may be achieved using a variety of conservation tools, the choice of which depends on background factors such as the species being conserved, the culture of those dependent on that species, and funding available. This thesis, using the example of education as a tool for conservation, evaluates the effectiveness of different conservation interventions at achieving their goals, providing a comparative analysis of conservation success at both the global and local scales.

1.1 Conservation success

Resources for conservation, particularly funding and time, are limited and therefore deciding where to invest, what conservation tools to employ and how to adapt con-

servation programmes in response to monitoring and evaluation is vital in order to ensure that conservation is both cost-effective and successful (Salafsky *et al.*, 2002). However, evaluation of conservation programmes is rare (Ferraro & Pattanayak, 2006, Kleiman *et al.*, 2000, Saterson *et al.*, 2004), and very few conservation budgets set aside money for detailed monitoring and evaluation (Gratwicke *et al.*, 2007). Project evaluation is well established in many fields, such as public health, engineering and business and consequently there is wealth of information available on the science and practice of programme evaluation (Shadish *et al.*, 1991). The primary problem is, that conservationists rarely take advice from these other fields (Stem *et al.*, 2005).

Programme evaluations determine how well a programme has performed and assign responsibility for successes or failures (Clark, 1996). They differ from monitoring and assessment as they introduce values into the determination of what constitutes success (Salafsky & Margoluis, 1998). They must also include both the substance and process of the project, as a project may achieve its scientific goals but do so inefficiently or operate smoothly but fail to deliver its biological objectives (Kleiman *et al.*, 2000).

There are a number of hurdles that have slowed down the progress of conservation evaluation. Firstly, both the definition of biodiversity and the causes of biodiversity loss are complex ideas (Collen *et al.*, 2009). Biodiversity exists in a diverse landscape of public and private lands and is influenced by a variety of individuals and organisations and therefore developing measures of success that include biological, ecological, social, economic and political aspects is not a simple process (Saterson *et al.*, 2004, Stem *et al.*, 2005). Secondly, as a result of the context in which conservation is carried out, monitoring data can be difficult, expensive and time-consuming to collect (Barton *et al.*, 2009, Salafsky & Margoluis, 1999). Finally, organisations depend on external sources for funding and are therefore often loath to report perceived failures, inhibiting the process of improvement by learning (Gratwicke *et al.*, 2007, Jepson & Canney, 2003, Saterson *et al.*, 2004).

1.1.1 Conservation priorities

At the global scale, a number of approaches aimed at prioritising areas for conservation investment have been developed, including biodiversity hotspots (CI, 1999, Myers *et al.*, 2000), the Global 200 established by World Wide Fund for Nature (WWF, 2000) and endemic bird areas used by Birdlife International (Stattersfield *et al.*, 1998). Overall there have been nine major institutional templates of global biodiversity conservation prioritisation published over the last decade which use the framework of irreplaceability relative to vulnerability (Brooks *et al.*, 2006b). At the regional level, systematic conservation planning is used to determine sites for protected areas using a combination of species and environmental data (Brooks *et al.*, 2004, Margules & Pressey, 2000). Approaches may vary in that they will either aim to maximise protection or minimise loss. The choice of which approach to use depends upon the specific conservation problem (Pressey *et al.*, 2004).

For these frameworks, one measure of their relative success is the extent to which they have influenced globally flexible donors, however, although hotspots have mobilised a considerable amount of funding, overall funding for conservation is still an order of magnitude less than required (James *et al.*, 1999). Very few of these frameworks or systematic planning processes incorporate costs in a formal return-on-investment (ROI) analysis (Murdoch *et al.*, 2007). This is often because traditional priority setting for conservation identifies biodiversity hotspots as priorities for conservation, however density of species does not necessarily imply conservation efficiency (Underwood *et al.*, 2008). A number of studies have been undertaken to explore the benefits of incorporating costs into project prioritisation (Joseph *et al.*, 2009), and they illustrate that even a simple return-on-investment analysis can yield significant improvements in resource allocation (Murdoch *et al.*, 2007). Identifying cost-effective conservation strategies is therefore essential in the current biodiversity crisis (Underwood *et al.*, 2008).

1.1.2 Conservation tools

Conservation prioritisation frameworks provide guidance for effective broad-scale targeting of funding, but the lessons learnt from these need to be drawn down to a much finer scale in order to achieve biodiversity conservation on the ground (Brooks *et al.*, 2006b, Groves *et al.*, 2002). There are a number of examples of evaluation of individual tools that demonstrate that assessment is possible, including Payments for Ecosystem services and the use of umbrella species (Barton *et al.*, 2009, Roberge & Angelstam, 2004). The appraisal of these tools also illustrates that these tools need to be effectively targeted. Unfortunately, there are very few studies that attempt to disaggregate different components of conservation and provide a comparative analysis of different tools (Brooks *et al.*, 2006a, Kleiman & Mallinson, 1998).

Choosing an appropriate conservation tool cannot be done without comparing the efficiency of a proposed tool with alternative management strategies and through learning from past examples of conservation in practice (Roberge & Angelstam, 2004, Saterson *et al.*, 2004). As with priority setting, the costs and benefits of different strategies must be included in comparative evaluations (Hughey *et al.*, 2003). There can be a huge range in costs and benefits under different management strategies (Cullen *et al.*, 1999, 2001) and the choice of conservation objective may also influence the effectiveness of funding investment (Underwood *et al.*, 2009). Once again, the number of studies exploring the return-on-investment (ROI) from different conservation tools are limited and therefore a more concerted effort is required to record and include costs of conservation actions (Murdoch *et al.*, 2007).

1.1.3 Evaluating conservation success

Measures of success

Many conservation organisations only report outputs and not the fundamental outcomes of a project, often because it is cheaper and easier to do so and it is more

likely that outputs are successfully achieved, particularly in the short-run (Gratwicke *et al.*, 2007). This type of evaluation; known as implementation evaluation, only reports whether grantees do what they say they would (Elmore, 1982) and does not truly report either the impact or effectiveness of a conservation programme.

Status assessment gauges the condition of a particular conservation entity (e.g. species or ecosystem), generally irrespective of the intervention designed to affect the variable (Stem *et al.*, 2005). There are many high profile indicators, such as State of the Environment Monitoring used in the State of the World Reports by the Worldwatch Institute (WI, 2008) and the Millennium Assessment, established in 2001 in response to the Convention on Biological Diversity (MEA, n.d.). More recently, larger organisations have begun to standardise indicators such as the United Nations Millennium Development Goals (MDG, 2000, CMP, n.d.). All of these frameworks are based on biological indicators. Likewise, evaluation of projects on the ground is also often done from a biological perspective, ultimately because improvement in biodiversity is the fundamental aim of conservation (Noss, 1990). These approaches tend to assess biological parameters at a given site, and these serve as indicators for changes in overall biodiversity (Olson & Dinerstein, 1997, Sparrow *et al.*, 1994). However, biological methods can be difficult and expensive to implement as they rely on expert knowledge required for identification (Salafsky & Margoluis, 1999). They are also not suited to the short-term time frames that are often employed by project managers and are hard to use in post-hoc assessments (Salafsky & Margoluis, 1999).

Monitoring and evaluation (M&E) provides a key to understanding the biological situation, however at the programme level it is necessary to carry out effectiveness evaluation in order to assess how successful a particular intervention has been (Stem *et al.*, 2005). This type of evaluation falls into two categories: impact assessment and adaptive management. Impact assessment, such as Environmental Impact Assessment (EIA) assesses the negative environmental impacts associated with development (OECC, 2000). However, although this has been fundamental in minimising adverse environmental effects of development, it often fails to consider the wider ecological impacts, or the social, cultural or economic effects associated with development and

consequently does not promote proactive alternatives (Bagri & Vorhies, 1997, Brooke, 1998). There have been a number of takes on EIA such as Biodiversity Impact Assessment used by the World Conservation Union (IUCN) and the Convention on Biological Diversity (CBD) but once again there is a feeling that these may result in inadequate analyses of indirect and cumulative impacts (Stem *et al.*, 2005). As a consequence of these criticisms, adaptive management has evolved as an iterative process designed to integrate all aspects of project design and monitoring in order to be able to adapt and learn throughout the conservation process (Salafsky *et al.*, 2001). This has now been adopted by various organisations such as The Nature Conservancy in their five-step programme for conservation and the IUCN's project cycle management approach (Woodhill, 2000, TNC, n.d.).

Substantive biological criteria are based on ultimate goals of conservation, such as increases in species populations (Mace & Lande, 1991) or changes in biodiversity such as the United Nations 12 percent rule for preserving ecosystems (Kleiman *et al.*, 2000). Substantive social measures on the other hand, include public support, values, attitudes and knowledge (Reading & Kellert, 1993). Although limited in number, there are a few studies that have attempted to try and compare conservation interventions taking into consideration both biological and socio-economic factors. Of those studies that have attempted it, some provide quite specific guidance; such as the application of a common structure for scoring diverse projects for elephant conservation from a conceptual framework, as described by Jepson *et al.* 2004; or the threat reduction approach developed by Salafsky and Margoluis 1998, 1999, based around assessing the importance of different threats affecting a system and measuring the impact of different interventions on reducing those threats. Others are in more of a development phase and provide a framework for future work, such as the conceptual framework developed by Garnett *et al.* 2007 and a methodology for measuring the conservation success of projects funded by zoos described by Mace *et al.* 2007. As conservation takes place in a complex context influenced by human populations, ignoring the social aspects of conservation when evaluating projects does not provide a complete picture of success (Stem *et al.*, 2005).

Methods of evaluation

Before undertaking an evaluation it is necessary to agree on the goals and objectives of the conservation programme, what is to be evaluated and the criteria for defining success (Kleiman *et al.*, 2000). Specific measures of effectiveness, not uniform indices, must focus on the specific goals of the project and evaluation process and it is often necessary to depend on static measures for dynamic systems, bearing in mind the fact that correlation is not necessarily equivalent to causation (Saterson *et al.*, 2004). Evaluations can be carried out internally, normally precipitated by progress reports or funding proposals, or externally which tends to be less frequent but broader in focus (Backhouse *et al.*, 1996). Choosing which method to employ depends on the purpose of the evaluation and the available resources (Kleiman *et al.*, 2000). Methods of evaluation may include; moderated workshops with members of the project team or individuals affected by the project, case-study analyses of individual conservation initiatives and meta-analyses for comparative examinations across of a number of sites (Saterson *et al.*, 2004). Comparative evaluations may require collaboration between both natural and social scientists in order to get the perspective needed to synthesise and integrate the findings (Saterson *et al.*, 2004) whilst, where possible, both quantitative and qualitative approaches to data collection should be employed to obtain the depth and range of information required to truly evaluate success (Browne-Nunez & Jonker, 2008).

As discussed in the section on measures of success, conservation can be evaluated and monitored at global, regional and site-specific levels. However, assessment of success varies depending on the geographical scale considered (Reading & Miller, 1994). The information used by institutions to monitor the status of biodiversity at all scales rarely connects with the institutions attempting to conserve biodiversity at ground level (Saterson *et al.*, 2004). Consequently, strengthening the links between global monitoring and local evaluation will help to place site-specific conservation in the larger context and to ground-truth larger scale conclusions (Saterson *et al.*, 2004).

Evaluation is necessary in order to maximise conservation success (Kleiman *et al.*,

2000, Saterson *et al.*, 2004, Stem *et al.*, 2005). However, as conservation takes places in a dynamic landscape of human and biological needs and influences it is necessary to constantly redefine success (Kleiman *et al.*, 2000). As success may depend on the conservation activities undertaken, the issues covered and standards set, as well as the geographical and temporal scale of the conservation project (Reading & Miller, 1994), evaluations and measures of success must be site or project specific and multiple types of evaluations maybe required to obtain a full understanding of the biological and social outcomes of a conservation intervention (Saterson *et al.*, 2004). Ultimately conservationists need to report their progress so as to be able to adapt over time and so that successes and failures across different sites, using a variety of different conservation tools, may be used as a learning experience for future conservation (Salafsky *et al.*, 2001, 2002, Sutherland *et al.*, 2004).

1.2 Education as a tool for conservation

The UN has declared 2005 to 2014 the Decade of Education for Sustainable Development; the overall goal being to utilise education as a means of integrating the principles of sustainable development with human values and perspectives in order to create a sustainable society (UNESCO, 2005). However, education is often viewed as an unalloyed good and, consequently there have been few empirical studies on the costs and benefits of different forms of education within the field of environmental conservation. Therefore, there is an urgent need for a comprehensive, quantitative and critical assessment of the role of education in order to determine how educational policies may be carried out in the most cost-effective manner to aid the implementation of environmental conservation strategies.

1.2.1 Definition of environmental and conservation education

Education is defined in the Oxford English Dictionary as *"systematic training and instruction designed to impart knowledge and develop skill"* (OED, 1990); effectively, both the acquisition of knowledge and the ability to evaluate that knowledge. However, environmental education, first defined by the World Conservation Union (IUCN) in 1970, includes the element of behaviour; the idea that through knowledge, changes in behaviour at a personal, societal and global level will occur (IUCN, 1970). Environmental or conservation education aims; to provide learners with the opportunity to gain an awareness or sensitivity to the environment, knowledge and experience of the problems surrounding the environment, to acquire a set of values and positive attitudes, to obtain the skills required to identify and solve environmental problems and, the motivation and ability to participate (Jacobson *et al.*, 2006).

Education is often only considered to be the formal aspect, undertaken in schools or higher education. However, Agenda 21, drawn up at the Rio Earth Summit in 1992, states that: *"Education, including formal education, public awareness and training should be recognised as a process by which human beings and societies can reach their fullest potential. Education is critical for promoting sustainable development and improving the capacity of the people to address environmental and development issues. . . . Both formal and non-formal education are indispensible to changing peoples attitudes"* (UNESCO, 1992). This highlights the importance of education as critical for achieving sustainable development but also emphasises that both formal and non-formal aspects have to be included as part of the curriculum. Consequently, environmental education, and therefore conservation education, should be considered to include, not just formal education and training, but also public awareness-raising (e.g. posters and media campaigns), school environmental clubs and transfer of indigenous knowledge etc.

1.2.2 The development of environmental education

The first IUCN conference in Paris, held in 1948, was the first time that the term environmental education was used (Palmer, 1998), however it was not until the 1960s that the term began to gain more common usage. In 1970, at an IUCN meeting in Nevada, US, the official definition of environmental education was coined (IUCN, 1970), but it was not until the late 1970s that the first international conferences were held specifically on the subject of environmental education (UNESCO, 1975, 1977). In 1980 the World Conservation Strategy was launched (IUCN *et al.*, 1980), followed by the Tbilisi Plus Ten Conference and The Brundtland Report (UNESCO, 1987, WCED, 1987), all of which served to consolidate the international principles of environmental education laid down the decade before. The Brundtland Report was later revised into *Caring for the Earth: A Strategy for Sustainable Living* (IUCN *et al.*, 1991), which was widely considered to be a timely contribution to the debate on the definition of environmental education, with its focus on translating ideas and principles of sustainable living into practical actions (Palmer, 1998). The declaration of 2005 to 2014 as the Decade of Education for Sustainable Development heralds a new phase in the continuous evolution of environmental education and its subsidiary, conservation education. This initiative, for which UNESCO is the lead agency, is an international educational effort that aims to encourage changes in behaviour that will create a more sustainable future in terms of environmental integrity, economic viability and a just society for present and future generations (UNESCO, 2005).

Approaches to environmental education have evolved dramatically from their natural science base of the 1960s to a social sciences orientated perspective in the 1990s and present day (Palmer & Birch, 2005). Originally environmental education was considered to be simply nature studies and it was only in the 1970s that environmental studies and conservation education first emerged. In the 1980s, the promotion of environmentally responsible behaviour became the primary goal of environmental education (Hungerford & Volk, 1990, Mappin & Johnson, 2005), so that the broad title of environmental education now included global education, politics and development

studies. In the last 15 to 20 years this has been expanded to incorporate capacity building and action research aimed at the resolution of socio-economic problems (Palmer & Birch, 2005). In effect environmental education has become education for behavioural, personal and social change (Mappin & Johnson, 2005).

1.2.3 Quantification of the effect of education

Studies attempting to quantify the effect of formal education on conservation are limited. On the whole they agree that it has a beneficial effect (Alix-Garcia, 2007). For example, one study estimated that between 4 and 21.5 percent less annual area of old-growth forest was cut per household for each additional year of education that the household head received, depending on the society being studied (Godoy & Contreas, 2001, Godoy *et al.*, 1998). The effect however, is non-linear and there is a turning point when the returns from education decrease (Godoy *et al.*, 1998, Van, 2003). The positive influence of education also depends on the type of conservation being carried out. For example, Gotmark *et al.* 2009, in a study in Sweden, show that education contributes to the conservation of mature trees but not to the planting of saplings.

The quantitative relationship between education and agricultural productivity has been studied in greater detail and the results provide a useful foundation for developing models to study the impact of education on environmental conservation. A large number of studies have shown education to have a positive effect on agricultural productivity (Asadullah & Rahman, 2009, Godoy *et al.*, 2000, Jamieson & Lau, 1982). However, in a comparative study of 37 data sets by Lockheed *et al.* 1980, six were found to have a negative, although statistically insignificant effect, whilst in the remaining 31, the effect was positive. This finding may be due to the fact that the environment in which education is implemented influences the effect it has on agricultural productivity. A number of studies have shown that in a modernising environment, where there is access to well developed markets or during a period of rapid technological progress, education has a significant positive effect (Foster & Rosenzweig, 1996, Laszio, 2008). This does not occur in traditional agricultural settings (Pudasaini, 1983). Other studies

have shown that a threshold of development needs to passed before education can have an effect (Bravoureta & Evensou, 1994).

Educational studies within the energy sector also provide useful cross-disciplinary information. Within the field of renewable energy and energy efficiency, an important area of sustainable development, education is considered as one of the most powerful tools in raising the awareness of the need for rational energy use (Dias *et al.*, 2004). In developed countries, studies have demonstrated a positive correlation between education and willingness-to-pay for utility investments in energy efficiency (Zarnikau, 2003). Likewise, in developing countries, research has shown that there is an improvement in awareness of energy efficient technologies with increasing education (Kumar *et al.*, 2003).

Most of the studies discussed above only consider the effect of formal education, perhaps due to its more easily quantifiable nature. However, as previously stated, Agenda 21 considers education to include both formal and non-formal aspects (UNESCO, 1992). It has been argued that non-formal education is a necessary supplement to formal education (Weladji *et al.*, 2003), and that if delivered through existing local organisations may have a more immediate impact and be better able to absorb and utilise local knowledge than traditional, formal education (Nyhus *et al.*, 2003). A number of studies exploring non-formal education have been undertaken in the agricultural field, and have shown that while formal education is not a significant factor in agricultural productivity, non-formal education is (Kalirajan & Shand, 1985, Parra-Lopez *et al.*, 2007).

1.2.4 Attitude-behaviour framework

For an education programme to achieve a more long-lasting effect and consequently, conservation success, a change in attitudes, behavioural intention, and ultimately behaviour has to occur. Attitudes have been defined as people's *"feelings, values or beliefs"* (Henerson *et al.*, 1987), whilst behaviour is *"the decisions, practices and ac-*

tions of people, as individuals and as groups' (Byers, 1996). There is evidence that livelihood activities and outreach programmes, undertaken as part of protected area management schemes, may have a conservation impact by helping to change both attitudes and behaviour (Abbot *et al.*, 2001). This is understandable as attitudes of local residents are often influenced by the costs incurred from conservation initiatives, therefore programmes established to reduce or relieve these costs should go some way to reversing negative opinions. For example, de Boer and Bauete 1998 provide evidence that attitudes of residents close to the Maputo Elephant reserve in Mozambique are inversely related to the number of species invading their agricultural fields.

Education specifically has also been shown to influence attitudes. In a study on manatee conservation, it was shown that greater knowledge about manatees was positively correlated with support for manatee protection (Aipanjiguly *et al.*, 2002). Formal education level, even when not specifically tailored to conservation, also correlates with positive attitudes (Infield, 1988) and may be used as a predictor of local attitudes (Mehta & Heinen, 2001). For example, it has been shown that undergraduates' knowledge of conservation biology may affect the environmental opinions that they hold (Caro *et al.*, 1994).

The term *"behaviour"* is harder to define. There are a number of definitions of this seemingly simple term: some educators define any learning as a change in behaviour, often without the presumption that this will, in turn, lead to changes in any form of expressed behaviour (Jacobson *et al.*, 2006). Another definition is often referred to as environmental literacy and requires a transferral of skills and increase in motivation to act in an *"environmentally responsible"* manner (Jacobson *et al.*, 2006).

Recent research findings demonstrate that awareness and knowledge of environmental issues alone are not sufficient to elicit positive environmental behaviour (Hungerford & Volk, 1990, Palmer, 1995, Palmer & Birch, 2005) and that although community outreach initiatives and education may be effective in shaping attitudes towards conservation, they cannot automatically be related to behavioural changes. To take a parallel example, sex-education programmes, although shown to have a positive influence on

adolescent sexual knowledge, do not necessarily influence sexual behaviour (Somers & Surmann, 2005). This may be because demographic and socio-economic factors exert important influences on the attitudes an individual holds (Foxall, 1984). Consequently, relating such initiatives to behavioural changes through an attitudinal assessment requires understanding of other potential social, economic, economic and cultural factors (Holmes, 2003).

It was originally assumed, during the first half of the 20th century, that attitudes were the key to understanding human behaviour. After 70 years of research however, it eventually became evident that attitudes are poor predictors of behaviour (Wicker, 1969). In the 1970s, research began on using intentions to predict behaviour. It has been shown that, as a general rule, when people have control over the performance of behaviour, they tend to act in accordance with their intentions (Ajzen & Fishbein, 2005). Originally developed as the Theory of Reasoned Action, the Theory of Planned Behaviour, and its associated attitude-behaviour framework, has been developed by Ajzen and Fishbein over the last 30 years (Fishbein & Ajzen, 1975). Effectively it states that human action is governed by behavioural beliefs, normative beliefs and control beliefs that interact to give rise to perceived behavioural control (Ajzen, 1985, 1991), where a belief is an individual's opinion about an object, and in the case of possible behaviour, the consequences of that act on the object (Bateman & Willis, 2001).

Figure 1.1 illustrates how the Theory of Planned Behaviour may be applicable to conservation. Intention is based on the attitude an individual holds toward the behaviour, the perception of social pressure to conduct the behaviour, and the awareness that one has the ability to conduct the behaviour (Jacobson *et al.*, 2006). Overall the attitude is a function of beliefs about personal control and actual control (Jacobson *et al.*, 2006).

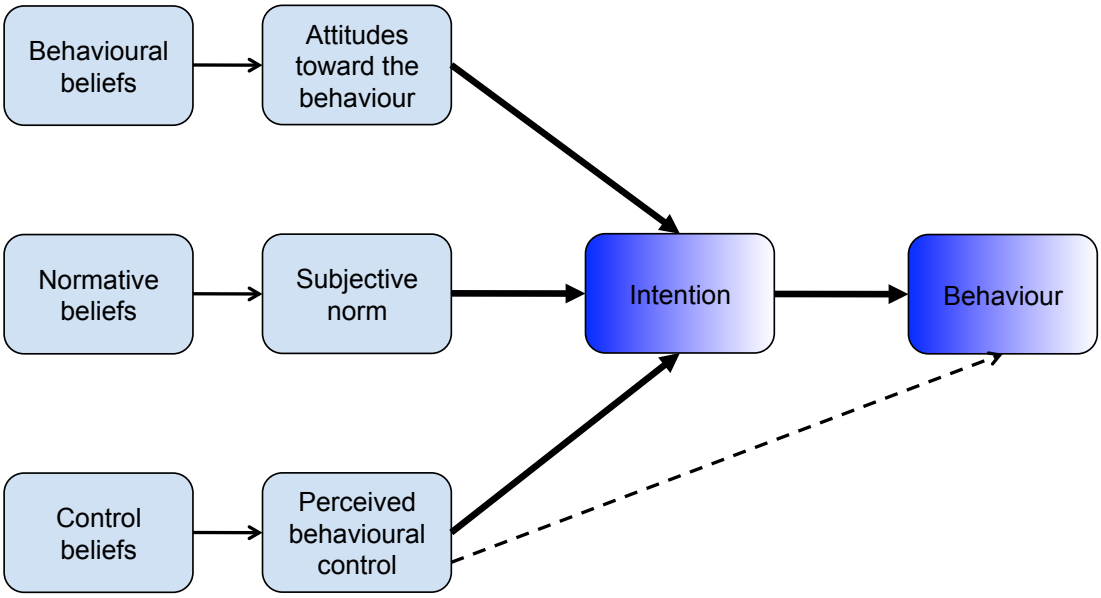

Figure 1.1: The Theory of Planned Behaviour suggests three types of attitudes that may contribute to the intention to conduct a conservation behaviour (Ajzen, 1991).

1.3 Aim and objectives

1.3.1 Aim

The number of studies that specifically attempt to compare the relative success of different conservation interventions, considering both socio-economic and biological aspects of conservation, are severely limited. There is also a lack of integration between global monitoring and local evaluation. Through the development and testing of indicators of success at both the global and local scales, a comparative analysis of different conservation interventions will be undertaken with the aim of providing scientific evidence that will guide cost-effective implementation of conservation and deliver results that will further the debate on the measurement of conservation success and the process by which, conservation should be carried out. As empirical evidence for the effectiveness of education, as a conservation tool, is also lacking, this study will use education as a specific example of a conservation instrument, drawing upon the findings of the comparative analysis to produce an in-depth study of how an individual conservation intervention can be applied most effectively. The thesis aims to provide a quantitative understanding and critical assessment of the role that conservation education can play in conservation efforts.

1.3.2 Objectives

1. To develop and test indicators of conservation success across and within conservation projects, in order to provide guidance for future evaluation of conservation success.

2. To explore the factors contributing to conservation success across and within conservation projects, to obtain an understanding of how conservation interventions may be applied most effectively.

3. To quantify, where possible, the effect of education on project success in order to deliver rigorous scientific evidence to guide the effective use of education as a tool for conservation and to provide an example of the effect of a specific conservation instrument on overall conservation success.

4. To investigate the return-on-investment (ROI) in education to explore the educational types and quantities of education that provide the most cost-effective intervention combinations, and to demonstrate the use of ROI as an instrument enabling the cost-effective implementation of conservation.

"....false views, if supported by some evidence, do little harm, for every one takes salutary pleasure in proving their falseness "

Charles Darwin, The Descent of Man, 1871

2

Methodology Overview

2.1 Database: The UK Government's Darwin Initiative

The Darwin Initiative (DI) was established in 1992 by the British Government at the Rio Earth Summit, to assist countries rich in biodiversity but poor in resources to fulfil their obligations with regard to the Convention on Biological Diversity (CBD, 1992, Defra, 2009). The scheme has an international reputation as a world-class programme promoting biodiversity conservation and sustainable resource use worldwide. As a long-running initiative, it provides a large database of information on project results required for the study. Confounding variables are reduced as all projects have the same duration (3 years), the same underlying purpose, similar size, similar backgrounds of implementers and quantitative and consistent measures of inputs and outputs (i.e. Darwin Standard Output Measures, Defra 1996). Communication, Education and Public Awareness (CEPA) is recognised as fundamental to achieving the objectives of the CBD (CBD, 1992), and consequently, the Darwin Initiative places high emphasis on conservation education and awareness as one of the four priority areas that projects are invited to focus on (ECTF *et al.*, 2007a). This makes it an ideal background source of data for this research.

2.2 Methodological approach: combined embedded case-study and meta-analysis

Conservation success can be measured at different scales, from overall project success covering both biological and socio-economic aspects of conservation, to a finer level exploring the specific contribution of an intervention or facet of an intervention, such as educational type. As discussed in the introduction, conservation suffers from a lack of links between global monitoring and site-specific evaluation. Evaluation of the relative effectiveness of various approaches across a range of sites and specific goals requires the use of both meta-analytical tools and case-studies (Saterson *et al.*, 2004). Quantifying the effect of education requires controlling for background confounding variables, which can be done more easily at a smaller scale. However, exploring the cost-effectiveness of different types of education requires data from a broader range of projects, to provide the variation needed.

Case studies have been increasingly used as a research tool (Hamel, 1992), and although originally seen as an exploratory methodology, can be used for descriptive and explanatory purposes as well (Yin, 2003). They may be designed in a holistic, or purely qualitative manner or embedded, involving more than one object of analysis and integrating both quantitative and qualitative methodologies (Scholz & Tietje, 2002). They can also be designed to be single or multiple case, in which circumstance each individual case should serve a purpose within the overall scope of inquiry (Yin, 2003). Choosing when to use a case study methodology depends on the type of research question posed, the extent of control an investigator has over actual behavioural events and the degree of focus on contemporary as opposed to historical events (Yin, 2003).

Satisfying a set of research questions requires answering “how”, “why”. “what”. “who”, “where”, and “how many” or “how much”. “How” and “why” questions are more explanatory and deal with operational links needing to be traced over time (Yin, 2003). In the Kalmykian chapters (Chapter 6 and Chapter 7) I will explore “how” and “why” education has an effect on the environmental attitudes and behaviour of the

local communities. This indicates the use of a case-study methodology, which is supported by the fact that it is not possible to control behavioural events and the focus is a contemporary one. Due to the nature of my research question however, and the extent of its focus, an entirely case-study based methodology would not be appropriate. The understanding of "what', "who', "where', "how many' or "how much' is necessary when the research goal is to describe the prevalence of a phenomenon or to be able to predict certain outcomes (Yin, 2003). These questions are better answered using a meta-analysis, as used in the Darwin Initiative chapters (Chapter 4 and Chapter 5).

Due to the nature of my research question, I have employed a multiple embedded case study methodology (see Figure 2.1). Firstly, in response to the lack of linkage between large-scale monitoring and site-specific assessment I have chosen to embed a local scale case-study (Kalmykia; see Chapter 6 and Chapter 7) within a global meta-analysis of the UK Government's Darwin Initiative (Chapter 4 and Chapter 5). Secondly, in order to carry out a exploration of the factors and interventions contributing to conservation success, I have undertaken a comparative analysis of conservation success at both the global and local scales (Chapter 4 and Chapter 6), in which I have embedded a examination of education as a specific example of a conservation tool (Chapter 5 and Chapter 7).

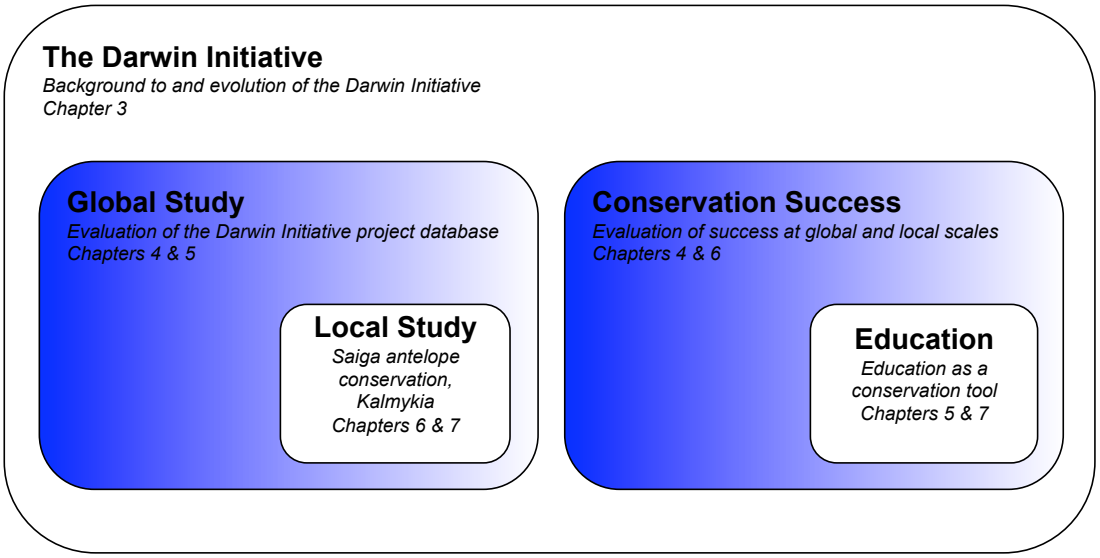

Figure 2.1: An overview of the multiple embedded case study methodology employed

2.3 Thesis framework

2.3.1 The Darwin Initative

Having funded over 600 projects worldwide, the Darwin Initiative was chosen as the database for the meta-analysis. Meta-analyses, such as a study by Brooks *et al.* 2006a testing hypotheses concerning drivers of the success of different conservation strategies, are often based entirely on self-reports. By using papers on case-studies from around the world, a huge amount of data and the requisite variation can be obtained, and consequently such studies are beneficial to furthering the field of comparative evaluations of conservation strategies (Brooks *et al.*, 2006a). However, the results of these studies are often not strong due to the lack of quantitative and rigorous monitoring within the case-studies themselves (Brooks *et al.*, 2006a). In this study therefore, a combination of independent evaluation (measures of success developed independently of the Darwin Initiative) and self-reporting was used to explore both biological and socio-economic aspects of conservation. The data are based on project leaders final reports for the DI (self-reports), whilst the evaluation involves the development and use of success measures similar to those of Salafsky & Margoluis 1999 and Mace *et al.* 2007.

The methods for this section are described in detail in Chapter 4 Section 4.2 with supplementary material found in Appendix A. These methods are applied in Chapter 3, Chapter 4 and Chapter 5.

2.3.2 Kalmykia

In the 2003 round of DI funding, a saiga conservation project in Kalmykia, Russia, was awarded a three-year grant, followed by a 20-month post-project award in 2006. The project provided a unique opportunity as three different interventions had been carried out in neighbouring areas, on the same animal population, and therefore their influence

on behavioural intention could be compared. As the project was funded by the DI, it also enables conclusions made at the global level to be drawn down to the project scale and vice versa. Data collection in this section was carried out independently in the field. This method of data collection provides significant benefits as long as the data collection is rigorous, scientific, and comprehensive, although it is necessary to be aware of the potential pitfalls of human bias and the time and costs required to do such a study (Gardner *et al.*, 2007).

The methods for this section are described in detail in Chapter 6 Section 6.2. Supplementary materials are found in AppendixB. These methods are applied in Chapter 6 and Chapter 5. Questionnaires are provided in Appendix C.

2.3.3 Framework

Below, Figure 2.2 illustrates how the embedded case-study and meta-analysis framework has been constructed and where each of the following data chapters fits within that structure. The thesis has been constructed around 4 papers, alongside an introductory chapter to the Darwin Initiative, introduction to the thesis subject matters, overview methodology, and discussion and conclusions. Chapter specific literature reviews are provided as part of the introduction to each main data chapter.

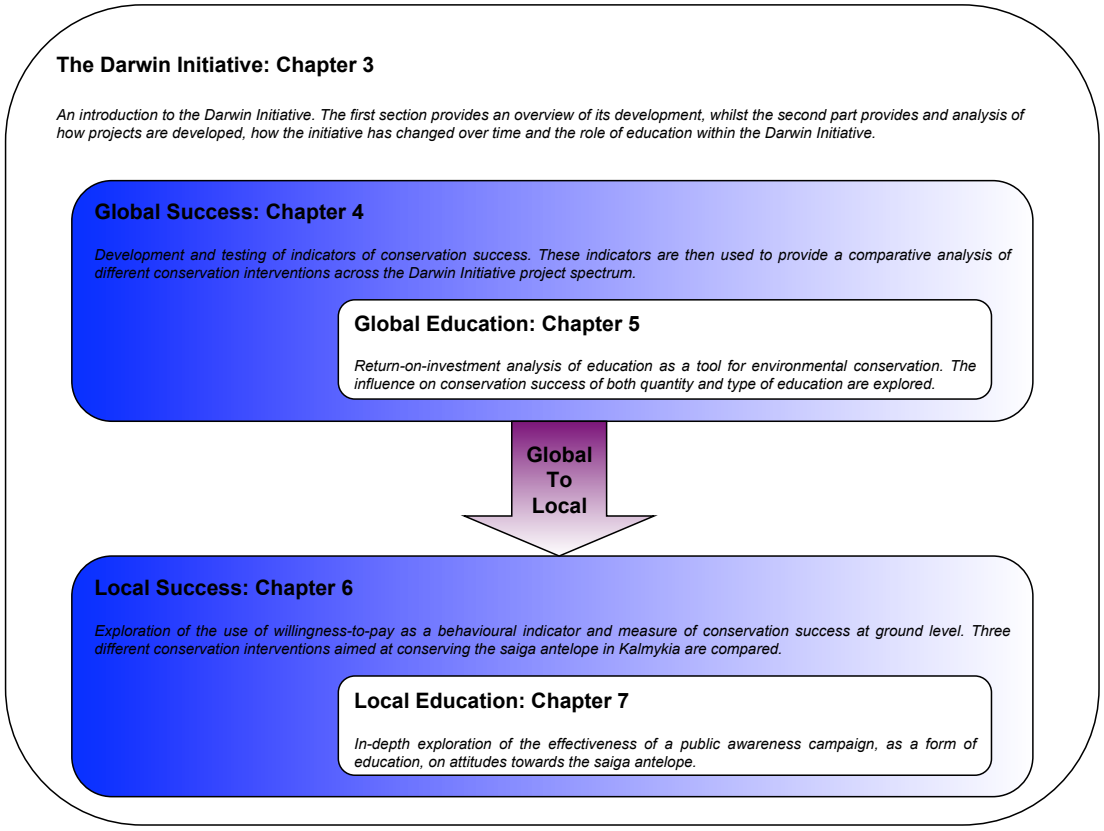

Figure 2.2: Illustration of how the different chapters interlink within the embedded case-study and meta-analysis framework.

"In the long history of human-kind, those who learned to collaborate and improvise most effectively have prevailed"

Charles Darwin,The Descent of Man, 1871

3

Evolution of the Darwin Initiative

Charles Darwin's observations and research placed humans firmly within the natural world. He appropriately became the namesake of the Darwin Initiative, a UK Government programme that seeks to conserve biological diversity through sustainable development. 2009 is the 200th anniversary of his birth, and therefore it is perhaps particularly timely and appropriate to carry out this study evaluating the impacts of the scheme, and in particular the value of using education as a tool for environmental conservation.

3.1 The establishment of the Darwin Initiative

The Darwin Initiative (DI) was established by the British Government in 1992 at the Rio Earth Summit and aims to *"assist countries that are rich in biodiversity but poor in financial resources to meet their objectives under one or more of the three major biodiversity Conventions: the Convention on Biological Diversity (CBD); the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES); and the Convention on the Conservation of Migratory Species of Wild Animals (CMS), through the funding of collaborative projects which draw on UK biodiversity expertise."*

The Rio Earth Summit was called by the United Nations (UN) to discuss ways to combat the intensifying biodiversity crisis, increasing rate of environmental degradation, and growing threat of climate change (UN, 1992). Five agreements were drawn up at the meeting: The Rio Declaration of Environment and Development, Agenda 21, the Convention on Biological Diversity (CBD), Forest Principles, and the Framework on the Convention on Climate Change (UNFCCC). Of these agreements two were legally binding: CBD and UNFCCC.

The CBD aims to conserve biological diversity, to use biological diversity in a sustainable fashion, and to share the benefits of biological diversity fairly and equitably (CBD, 1992). It is based around a series of articles, which covers a range of conservation tools, including; identification and monitoring (article 7), incentive measures (article 11), public education and awareness (article 13); access to genetic resources (article 15) and technical and scientific cooperation (article 18) (CBD, 1992). Consequently, DI projects use a huge variety of conservation tools including research and training, taxonomy and impact assessment, payment for ecosystem services, policy and legislation and tenure (Defra, 2009). The CBD also involves a series of thematic programmes, based on ecosystem biomes, which has meant that the Darwin Initiative has carried out work across latitudes and longitudes, from polar habitats to tropical grasslands and savannah, in boreal forests, wetlands and marine and coastal habitats. During the last year, the Darwin Initiative has begun to address another two conventions: the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES); and the Convention on the Conservation of Migratory Species of Wild Animals (CMS), expanding its remit further.

Darwin Initiative projects attempt to mitigate a huge range of threats; including invasive species, pollution, over exploitation, habitat change and climate change, all of which have to be answered within the framework of ensuring sustainable use and development. Coupled with the diversity of ecosystems and species which the scheme encompasses, as well as the range of tools used by project leaders, the DI provides an unrivalled variety and scope of conservation practice and delivers a treasure-trove of information and lessons for the future of biodiversity conservation.

3.2 Reporting within the Darwin Initiative

In the 17 years since its establishment, the initiative has spent £73,602,461, on average £110,000 per project, funding 674 projects in 148 countries. This has involved 213 UK organisations and 862 partner organisations in host countries around the world (Defra, 2009). The scheme has a number of funding opportunities: three-year Darwin projects, Darwin fellowships, pre-project scoping awards and post-project awards, with projects being chosen by a committee of experts from government, academia, and the NGO and private sectors.

The DI requires annual and final reports, providing summaries of progress from all project leaders. Detailed guidelines are provided for project leaders as to the substance of these reports, a key section of which is the Standard Measures or outputs (Defra, 1996). These are a series of indictors used by the DI to assess the achievements of its projects and are grouped as training, research, dissemination, publicity and financial. Although not definitive they are provided as a guideline of easily identifiable measures of projects progress (Defra, 1996). They provide the Darwin Initiative with the distinction of being a funding body that considers all aspects of a project that may contribute to conservation success; including biological measures, such as new contributions to taxonomic research, as well as social and developmental indicators, for example the number of people trained (Defra, 1996).

Since its establishment, the Darwin Initiative has also commissioned a number of workshops and thematic reviews, coupled with annual reports for the Initiative as a whole. The annual reports provide a commentary of how the Initiative has changed over time, from a poverty focus in the mid 2000s to a more biodiversity focus in the present (Defra, 2003, 2008), whilst the workshops and reviews provide a wealth of information as to the successes and failures of the scheme, as well as suggestions for how the initiative could be improved in the future. In 2009, a new website was unveiled (developed by Edinburgh Centre for Tropical Forests (ECTF)) providing access the whole database of reports, training materials used by project leaders, workshop

proceedings etc., providing an incredible learning resource for both the Initiative, as well as conservation practitioners around the world (Defra, 2009).

The project final reports formed the basis of an analysis of the development of DI projects, the application of education within the DI, and changes in funding patterns of the Initiative over time. Projects started between 1997 and 2004 were chosen at random and a subset of 100 projects (43.5% of the total) was created. A preliminary database of 46 explanatory variables covering administrative, financial, geographic, conservation target, threats, actions and educational parameters was created. Using graphical and statistical methods these variables were reduced to those 15 that had the greatest explanatory power. These 15 variables were categorised as either *"project type"* variables or *"project resources"*. Background variables were also included. Chapter 4 provides detailed methodology of how the database was developed.

3.3 Darwin Initiative project development

3.3.1 Organisational influences

The organisation to which the UK project leader belongs to influenced aspects of project development. The UK organisation had an effect on the choice of conservation target: whether it was flora or fauna ($\chi^2 = 22.27, df = 6, \rho = 0.001$) and if it was a flagship species or not ($\chi^2 = 10.16, df = 3, \rho = 0.017$). This is expected, as the organisation to which a project leader belongs will have a specific aim or remit that will influence the choice of projects its members will run or contribute to. The host-country organisation, on the other hand, did not influence either project type or project resources.

3.3.2 Project type

Project aim or target (as defined by Project Leaders (PLs) in the final reports, based on percentage of aims and objectives) was broadly grouped into species, habitat, education or training and research or infrastructure. The type of species being conserved influenced the overall aim of a project ($\chi^2 = 43.93, df = 15, \rho = 1.13e-04$). Birds, for example only formed the basis of species-specific projects, and not educational or research-focused projects. Mammals, on the other hand, were often the targets of education-focused projects. Research and infrastructure projects were not biased toward any particular species.

The project aim was also influenced by the conservation threat (IUCN-CMP, 2006b) being faced. As expected, habitat projects dealt with loss and disturbance threats, whilst educational projects and research/infrastructure projects focused on a lack of knowledge and/or infrastructure in the host country. Species projects however, were more general and tackled a variety of different threats (Figure 3.1).

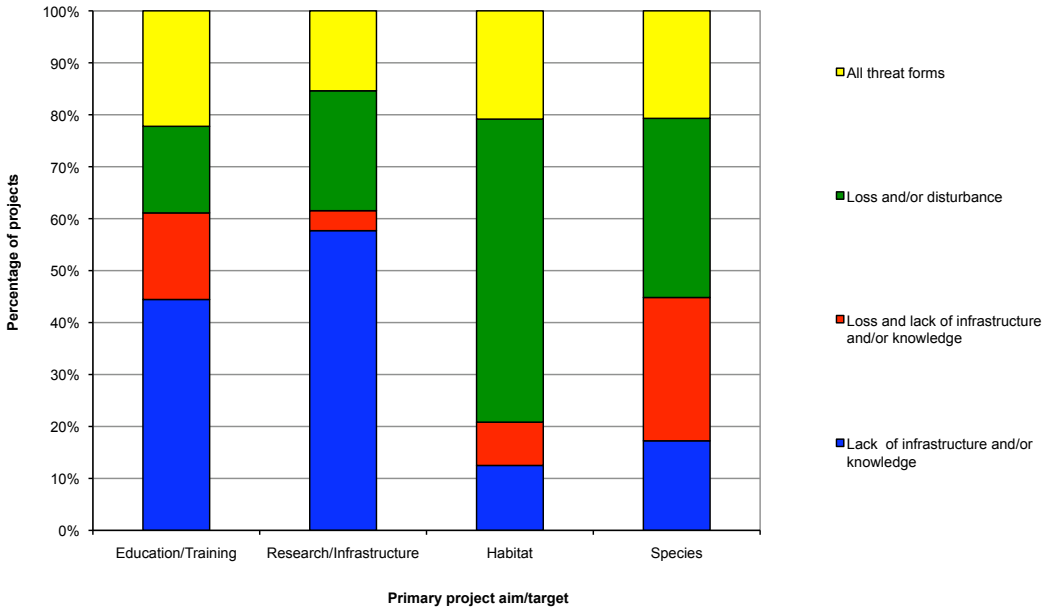

Figure 3.1: Interaction between main conservation threats faced (IUCN-CMP, 2006b) and the overall aim of a Darwin Initiative (DI) project ($\chi^2 = 49.38, df = 24, p = 0.002$).

3.3.3 Project resources

An analysis of the effect of conservation threat type on the amount of effort or resources provided illustrated that, for those projects where the main threats included loss and/or disturbance of habitats or species, the number of actions (IUCN-CMP, 2006a) implemented was significantly greater than in those projects where lack of infrastructure and/or knowledge were the main threats ($W = 6426.5, p = 7.02e-05, n = 97$). This relationship was also true for the number of weeks the UK staff spent in the host country during the course of the project ($W = 8556, p =< 2.2e-16, n = 98$).

Unlike project type, project resources were also influenced by the geographical location of the host country and its human development index (HDI). The number of weeks spent in the host country varied with geographical location ($W = 9191.5, p =< 2.2e-16, n = 96$). There was an average of 40% less time spent on continental projects in comparison with island-based ones, whilst on average, project leaders spent 12 weeks less on coastal projects than island ones but 17 more than on continental projects. In the case of HDI, the number of weeks spent in the host country by the PL declined with increasing HDI ($\rho = -0.247, p = 0.026, n = 81$).

3.3.4 Interactions between project type and project resources

There were a number of interactions between project type variables and project resource variables. In general the number of actions (IUCN-CMP, 2006a) and quantity of education provided decreased at larger geographical scales, for example, almost twice as much education was carried out at the local scale in comparison to projects working at the national level. Habitat and species projects carried out, on average, 1.5 times as many actions than education/training and infrastructure/research projects. Surprisingly, quantity of education provided was slightly greater for species projects, as opposed to education/training projects. On average, research/infrastructure projects carried out 3 times less the amount of education than other project types. These findings and interactions are summarised in Table 3.1 and Figure 3.2.

Table 3.1: Correlations and descriptions of relationships between different project resource and project type variables.

Project Resource Variable	**Project Type Variable**	W	$p-$**value**	n	**Relationship**
Number of actions	Project scale	7680	$1.38e-11$	100	Local & Regional > National > Continental/Global
Number of actions	Target/Aim	7266.5	$1.25e-08$	100	Habitat & Species > Infrastructure/Research > Continental/Global
Quantity od education	Project scale	8512	$< 2.2e-16$	100	Local > Regional > Continental/Global > National
Quantity of education	Target/Aim	8456	$< 2.2e-16$	100	Species > Education/Training > Habitat > Research/Infrastructure
Quantity of education	Type of education	7820	$2.72e-13$	98	Formal & Training > All Education Types > Training > Formal > Awareness

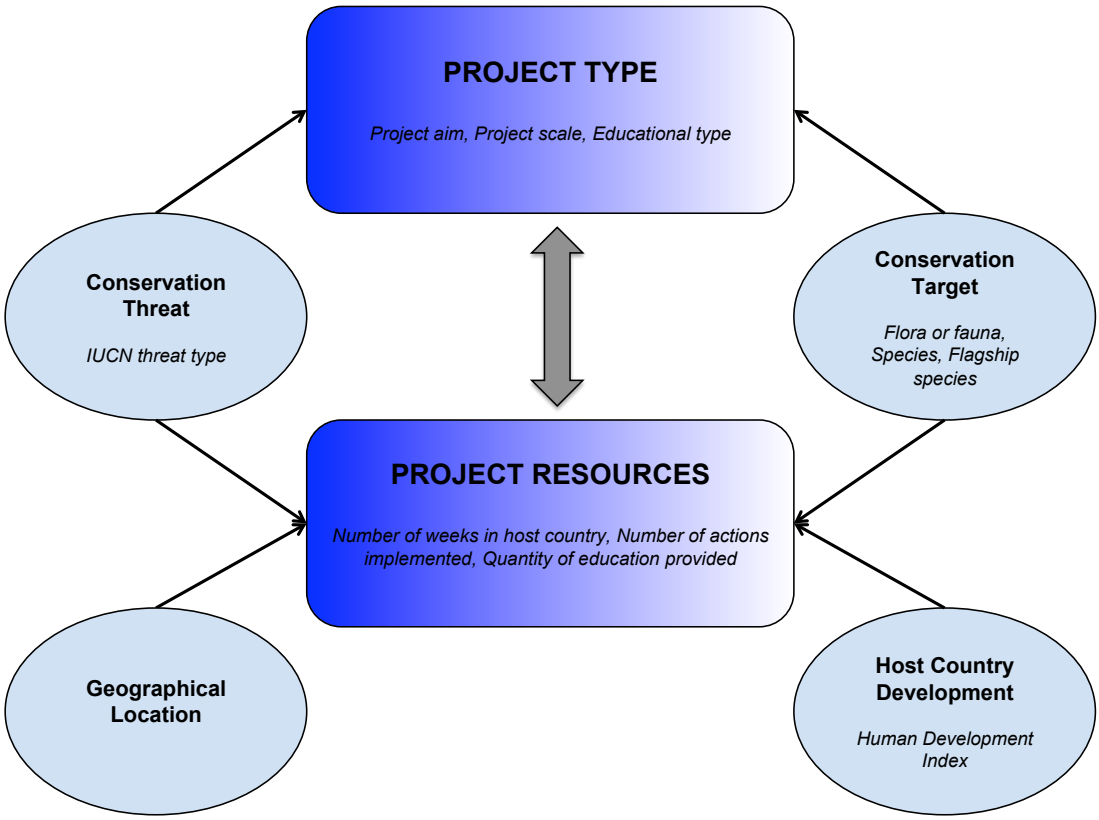

Figure 3.2: Interaction between the variables influencing the development of a Darwin Initiative (DI) project based on empirical analysis of 100 DI projects. The two aspects are: the type of project planned and the resources required. These are influenced by external variables including: conservation target, conservation threat, geographical location and host country development level.

3.4 The role of education within the Darwin Initiative

Communication, Education and Public Awareness (CEPA) is recognised as an essential part of achieving the objectives of the CBD and there are two articles that specifically refer to education as a tool for environmental conservation: research and training (article 12) and public education and awareness (article 13) (CBD, 1992). Consequently, the Darwin Initiative places high emphasis on environmental awareness and education as one of the four priority areas that projects are invited to focus one, with 125 projects (up to 2007) including CEPA (ECTF *et al.*, 2007b).

The overall profile of educational types (formal, training, awareness-raising and media and ad-hoc informal education such as theatre groups) used in Darwin Initiative projects between 1997 and 2004, shows that a combination of either formal education and training, or all educational types were used most often. The use of one single type of education was least favoured, in particular informal education (Figure 3.3). There was a variation in the use of education dependent on the overall project aim ($W = 8456, p =< 2.2e-16, n = 100$). Those projects that were species-focused used the most education, closely followed by education-focused projects. Both research/infrastructure projects and habitat-focused projects used much less education.

Between 1997 and 2004, the use of education by DI projects increased ($\rho = 0.257, p = 0.010, n = 100$). There was a peak in the use of combined formal and training and the use of all education types in an individual project in 1999-2000 and in 2003-2004 (Figure 3.4). Likewise, the use of educational materials increased over time, with 2001 being the last year in which several projects did not include any educational materials, this accounted for 25% of projects in that year ($\rho = 0.901, p = 0.002, n = 8$).

Conservation target affected the choice of educational type employed ($\chi^2 = 30.51, df = 15, p = 0.010$). Those projects conserving flora used training most often. This maybe due to the need for experts trained in identification of closely related plant species, which is often technically difficult. Faunal projects on the other hand, used a variety of strategies and unlike floral projects also used awareness-raising as the sole strategy.

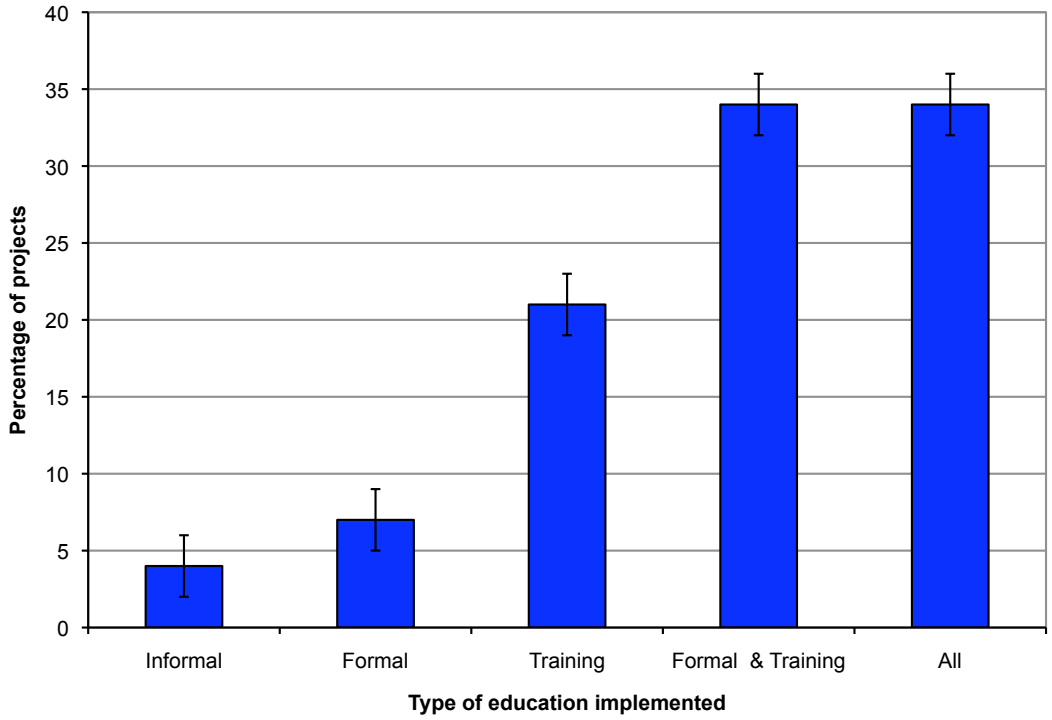

Figure 3.3: Percentage of Darwin Initiative projects carrying out different types of education between 1997 and 2004.

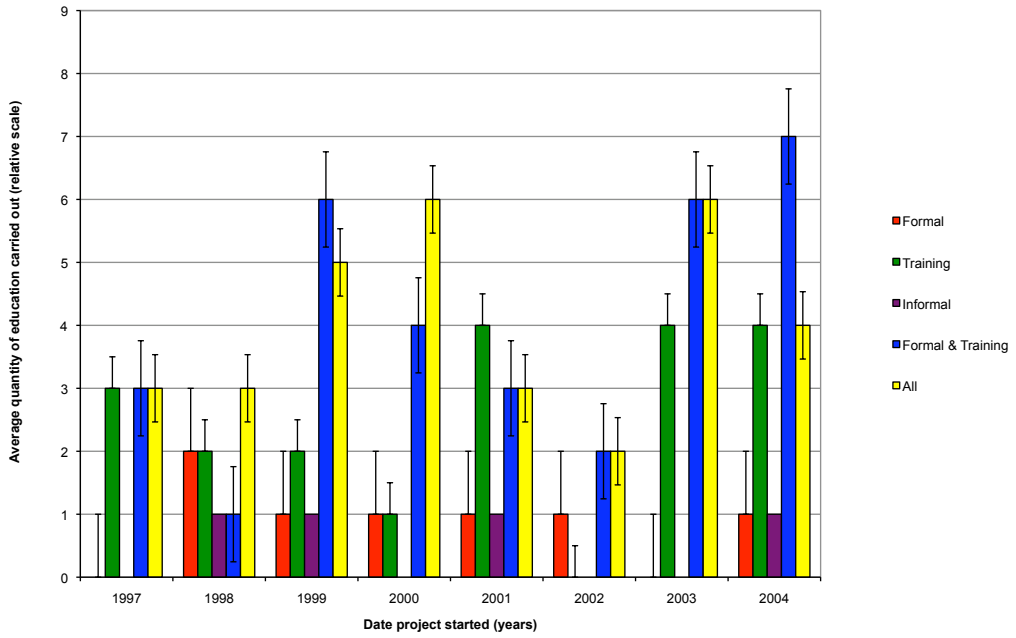

Figure 3.4: Changes in the use of different educational types between 1997 and 2004.

Those projects with a species focus showed differential patterns in their use of education, depending on the type of species being conserved and whether it was a flagship species or not (Caro & O'Doherty, 1999, Leader-Williams & Dublin, 2000). Projects involving flagship species used, on average, twice as much education as those projects that did not conserve flagship species ($W = 4027, p =< 2.2e-16, n = 43$). There was also variation in the quantity of education used across different types of species, with more education being carried out when amphibians, reptiles or fish and mammals were the subject of conservation (Figure 3.5).

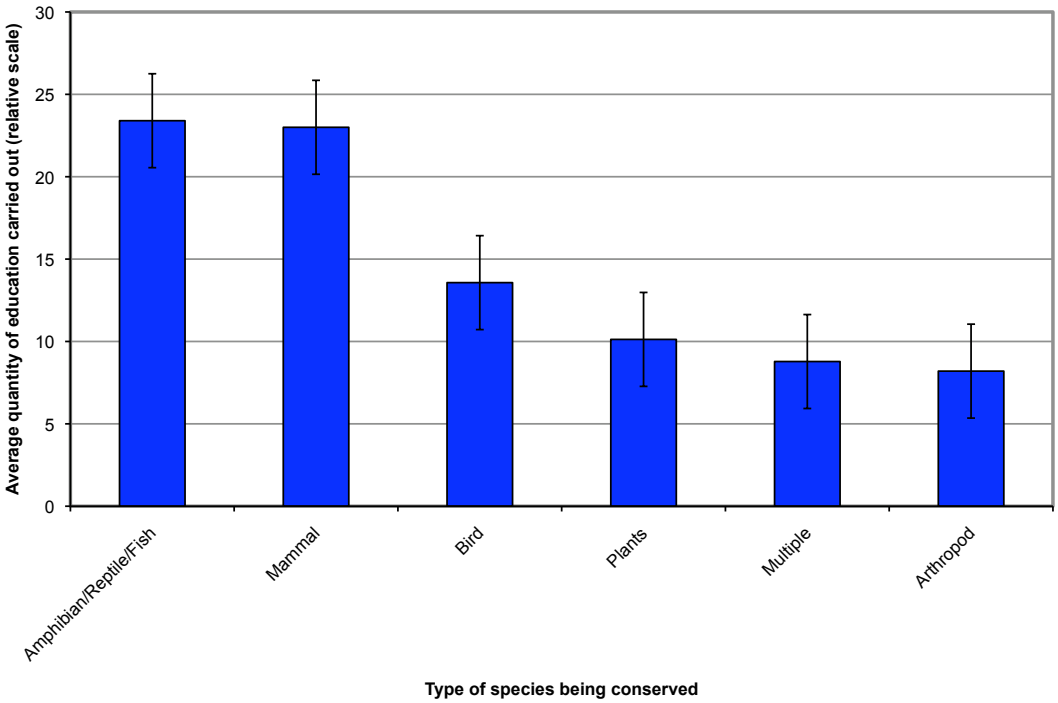

Figure 3.5: Variation in the use of education by project leaders when different species are conserved ($W = 4662.5, p = 1.67e-08, n = 61$).

3.5 Changes in Darwin Initiative funding patters over time

Overall, the DI has funded 105 island-based projects, accounting for 23% of total number of projects funded (ECTF *et al.*, 2007a). However, there has been a change

in ecosystem/biome focus over time. In 1997, island-based projects accounted for 30% of all projects funded. By 2004 this figure had dropped to 10% with coastal and inland projects accounting for 23% and 67% of projects respectively. Although this could be an effect of sample size, there has been a gradual shift in the Darwin Initiative aims from a more concentrated focus on the conservation of biodiversity (islands are specifically mentioned by the CBD due to their high levels of biodiversity and endemism (CBD, 1992)) and UK overseas territories, to one which must now also consider the global threats such as climate change or trade (ECTF *et al.*, 2008b).

Between 1997 and 2004, the profile of organisations receiving funding has also changed. In 1997, UK research organisations (e.g. universities) successfully receiving funding from the Darwin Initiative, accounted for 67% of funded projects. By 2004 this figure had dropped to 22%. In the same period non-governmental organisations (NGOs) receiving funding rose from 11% to 61%. Educational institutes (e.g. botanical gardens and museums) remained constant, accounting for about 15% of projects.

Figure 3.6 illustrates how funding of DI projects has changed over time. Overall there has been an increase in total funding for DI-sponsored projects, accounted for mainly by an increase in external funding (i.e. non-DI sources). This led to an observed decrease in the percentage contribution of the DI to project funding. There are two small peaks in DI contribution in 2000 and 2002. These potentially correlate with the announcement of the Millennium Development Goals (MDGs) in 2000 and £7 million in additional funding for DI announced in 2002 at the World Summit for Sustainable Development.

3.6 The future of the Darwin Initiative

In the 17 years since its' establishment, the Darwin Initiative has provided a major contribution to the conservation of biodiversity as well as important input into generating knowledge and skills development to support conservation, in particular within certain

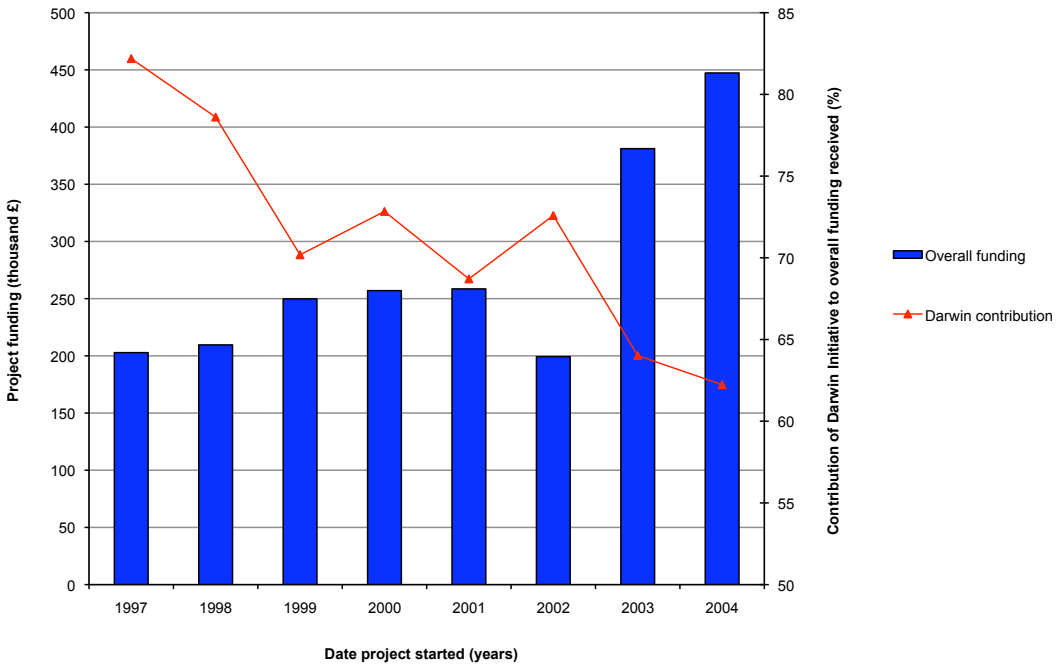

Figure 3.6: Changes in funding of Darwin Initiative (DI) projects over time (External (non-DI) funding: $\rho = 0.266, r = 0.009, n = 100$; DI funding: $\rho = -0.210, r = 0.042, n = 100$).

biomes such as island habitats (ECTF *et al.*, 2007a). They have also made a significant addition to the reinforcement of protected areas for biodiversity (DI, 2003). On the downside there have been calls for the Darwin Initiative to take more of a lead in forest rehabilitation and climate change as it has been felt that, despite the topicality of these issues, very few of the projects work on these issues directly (ECTF *et al.*, 2008b,a). Likewise, it has also been suggested that the presence of the Darwin Initiative in UK Overseas territories has not covered all conservation needs (DI, 2004). However, the last year has seen this particular issue being resolved (Defra, 2008).

At the policy level as well, the range of projects carried out since the inception of the DI provides a vast experience from which current and new project leaders, as well as the DI, as an institution, can draw from. For example, it has been recommended that the DI should develop Best Practice guides for human and institutional capacity building, and for methods to influence policy frameworks of relevance to the conservation of biodiversity (DI, 2006, 2007). Whilst, due to the problems of involving local people in conservation projects (ECTF *et al.*, n.d.), the importance of developing strong

partnerships with host institutions has been strongly recommended (DI, 2008).

The regular reporting and evaluation of individual DI projects, as well as the initiative itself, alongside the new website and database unveiled at the beginning of 1999 means that all of these issues will be able to be addressed allowing for the constant evolution of the Darwin Initiative, ensuring its place as one of the foremost funders and promoters of conservation both now and in the future.

"A moral being is one who is capable of reflecting on his past actions . . . , of approving of some and disapproving of others"

Charles Darwin, The Descent of Man, 1871

4

Developing consistent indicators of conservation success: a comparative analysis of projects funded by the UK's Darwin Initiative

4.1 Introduction

The conservation world is plagued by lack of resources, both in terms of time and money, and consequently there is an ever-growing need to evaluate the success and cost-effectiveness of investments in conservation (Salafsky *et al.*, 2002, Saterson *et al.*, 2004). High profile conservation approaches, such as Integrated Conservation and Development Projects and currently Payments for Ecosystem Services, are often highly controversial in terms of their effectiveness at achieving conservation goals (Robinson, 2006). There have been few quantitative comparative evaluations of the outcomes of particular conservation approaches (Brooks *et al.*, 2006a). This highlights the need for continuous and independent evaluations of performance to ensure appropriate and adaptive management (Gubbi *et al.*, 2008, Sutherland *et al.*, 2004).

Measures of conservation outcomes are usually focused on biological indicators, such as changes in the status of target populations, because biological improvement is usually the ultimate aim of conservation interventions (Noss, 1990). Unfortunately, these

indicators are often not suited to the short time frames of project managers, they are difficult and expensive to implement, require expert knowledge to interpret and may not yield meaningful comparisons across sites (Salafsky, 1994, Salafsky & Margoluis, 1998). They are also hard to use post-hoc as they require baseline data against which to compare change (Ferraro & Pattanayak, 2006). Hence, although true project evaluation should be based on outcomes (Mace *et al.*, 2007), this is often set aside in favour of measuring outputs (whether or not an intervention has met its objectives), which are easier to evaluate and more immediately achievable than outcomes (Miller *et al.*, 2004).

There are a number of recent initiatives that aim to develop measures of conservation success, including the Conservation Measures Partnership Open Standards for the Practice of Conservation and The Nature Conservancy's Five Step Framework for Site Conservation (CMP, n.d., TNC, n.d.). The fields of public health and engineering have a long history of developing techniques for project evaluation (Shadish *et al.*, 1991) and their principles of having well-defined objectives and hypothesised causal links between interventions and outcomes can be applied to conservation (Machlis & Forester, 1996, Salafsky & Margoluis, 1999). One such approach is the "Pressure-State-Response" framework, which explores the state of the system being evaluated, the pressures it is facing and the necessary responses required to alleviate those pressures (Tunstall *et al.*, 1994).

Another approach, "Threat Reduction Assessment" as developed by Salafsky and Margoluis, appraises the importance of different threats affecting a system and measures the effectiveness of different interventions in reducing those threats (Salafsky & Margoluis, 1999). A more species-specific method, evolved by Jepson for monitoring the success of conservation projects aimed at conserving Asian elephants, uses a conceptual framework of components required for successful conservation (Jepson, 2004). More recently, an approach to measuring conservation success in zoos was developed by Mace *et al.* 2007. This aimed to calibrate projects against a common standard, regardless of the action being carried out. They measure impact as a function of the importance of the conservation target, the volume or scale of the project and its effect

(success in terms of outcomes).

All of the frameworks above require indicators in order to track and measure change. Indicators must be scientifically rigorous, repeatable, and easy to communicate (UNEP, n.d.). However, biodiversity is a multifaceted term and consequently, a single indicator would not be able to track or measure its full complexity (Collen *et al.*, 2009). A number of indicators have been developed and tested including: the Living Planet Index, which is one of 22 headline indicators developed by the Convention on Biological Diversity (Collen *et al.*, 2009), and the IUCN Red List Index (Butchart *et al.*, 2006). Both of these are major initiatives and therefore have been scrutinised in-depth, and although they do provide useful terms of reference and a coherent methods for measuring changes in biodiversity, they depend strongly on high quality data which are often lacking (Collen *et al.*, 2009). They also need to be presented with explicit clarification of the assumptions that have been made (Quayle & Ramsay, 2005). Another study, looking at Natura 2000 sites, demonstrated that general indicators may not be the most cost-effective way of measuring conservation changes and that a framework that could be adapted to the specific characteristics of individual sites may be more useful (Cantarello & Newton, 2008).

The Darwin Initiative was established in 1992 by the British Government at the Rio Earth Summit, to assist countries rich in biodiversity but poor in resources to fulfill their obligations with regards to the Convention on Biological Diversity (CBD, 1992, Defra, 2009). It was chosen as a database for this study due to its international reputation as a world-class programme, promoting biodiversity conservation and sustainable resource use worldwide. As a long-running and well-documented initiative, it provides a large database of information on project results required for the study. Confounding variables are reduced as all projects have the same duration (3 years), the same underlying purpose, similar size, similar backgrounds of implementers and quantitative and consistent measures of inputs and outputs (i.e. Darwin Standard Output Measures (Defra, 1996)).

Environmental education, and its subsidiary conservation education, is a broad set of

interventions that may include; the formal curriculum, skills-specific training, public awareness-raising using the media and/or posters and leaflets, workshops and discussion groups, or a combination of these. The UN has declared 2004 to 2015 the "Decade of Education for Sustainable Development" (UNESCO, 2005). Education is highlighted as an important tool for conservation in a number of high profile reports and agreements (CBD, 1992, UNESCO, 1992, WCED, 1987) as well as in the Darwin Initiative (ECTF *et al.*, 2007a). Despite this, there are very few studies that attempt to quantify the effect of education on conservation success. Of those that have, there is general agreement that education produces a positive effect (Alix-Garcia, 2007, Godoy *et al.*, 1998, Gotmark *et al.*, 2009). However, this effect is non-linear and the return-on-investment (ROI) in education declines after a certain point (Godoy & Contreas, 2001, Van, 2003). In this study, education was used as an example to explore the influence of a specific conservation tool on the success of a conservation project.

Comparisons of different conservation strategies can be carried out in a number of ways. As gathering a large amount of data at the field level is both expensive and time consuming, an analysis based on self-reports can be undertaken, such as that of Brooks *et al.* 2006a. They carried out a numerical analysis of 28 selected Integrated Conservation Development Projects (ICDPs) drawn from a pool of 150 published papers (Brooks *et al.*, 2006a). However, this study did not produce strong results due to a lack of rigorous and quantitative reporting in the published papers (Brooks *et al.*, 2006a). An alternative to self-reporting is independent evaluation. At the field level this can produce very precise and reliable results (Gardner *et al.*, 2007), whilst at the meta-analysis scale it can be used to compare a number of different case studies using rigorous indicators and measures (Mace *et al.*, 2007). However, this approach is also susceptible to human-bias, as the indicators will inevitably have been developed based on a series of assumptions and opinions as to what constitutes success. In this study, both methodologies were combined by undertaking an independent analysis based on indicators of success from Darwin Initiative final reports (self-reporting). This is similar to the methodologies used by Mace *et al.* 2007 and Salafsky & Margoluis 1999.

A database of Darwin Initiative project reports was developed and used to address the

following questions:

1. Does a reviewer's perception of what constitutes conservation success affect the consistency and reliability of success indicators?
2. How do different indicators of success compare? Are there differences between measures of outcomes and measures of outputs?
3. Does the choice of success indicator influence the explanatory variables that contribute to success?
4. Are the quantity of education undertaken or the type of education employed, significant predictors of project success? And how does the effect of education vary between success indicators?

4.2 Methods

4.2.1 The Darwin Initiative (DI)

Since its establishment in 1992, the DI has funded 674 projects in 143 countries, working with 213 UK organisations and 862 organisations in the countries where the projects have been carried out (host countries). So far, the scheme has invested £72,602,461, on average about £110,000 per project (Defra, 2009).

4.2.2 Data collection

Permission to undertake the study was granted by Defra in January 2007. The Darwin Initiative requests a final report at the end of each three-year project and these formed the basis of the database created. This study explored standard three-year projects starting between 1997 and 2004, a period in which there was relative stasis in the aims

of the DI, and for which the reporting process is complete. Projects starting between 1993 and 1996 proved very difficult to track down and were therefore excluded, whilst those begun in 2005 or later were not complete and were therefore also not taken into consideration. Final reports were requested directly from UK project leaders (PLs) in order to obtain their permission for use of their data, and any relevant additional materials or information were also requested, in order to have a better understanding of the data provided. Projects during the study period were chosen at random to create a subset of 100 projects (43.5% of the total). This was the minimum sample size to ensure adequate power in subsequent analyses (Kirk, 1995). As some PLs did not reply (34%), there is potential bias in that all 100 projects used in the database came from PLs who were prepared to engage with the study, and this may also be reflected in their project success.

In order to aid interpretation of results, interviews were carried out with 10 PLs chosen for their expertise in carrying out DI projects (each had completed at least 2 DI projects), from a range of UK organisations including NGOs, universities, museums and botanical gardens, covering a range of project types from pure education through research to species management and alternative livelihoods. PLs were asked a series of qualitative questions exploring the meaning of conservation success and the use of education as a tool for conservation (Appendix A section A.5). Interviews were carried out between October and December 2008.

4.2.3 Database development

Darwin final reports, although officially standardised, often come in a variety of formats, making data extraction difficult. A preliminary database of 46 explanatory variables covering administrative, financial, geographical, conservation target, threats, actions and educational parameters was created. Using graphical and statistical methods (including Spearman's Rank Correlation, Mann-Whitney and Chi-Squared Test), variables were removed based on lack of substantive explanatory power, too many missing data points, and in situations where another variable provided similar information but

was more reliable. The final database consisted of 15 explanatory variables (Appendix A section A.3.1).

Each project was categorised according to its overall aim or target (e.g. whether it is species, habitat, research, educational or infrastructure -focussed), geographical scale (e.g. local, regional, national, continental) and the type of educational activities carried out (formal, training, primary/secondary schooling, and informal such as awareness-raising, media and ad-hoc (e.g. theatre groups) or a combination of these). Educational types were grouped into: training & formal, formal alone, and all types of education. Due to data limitations, it was not possible to test other combinations of educational type. This set of factors is characterised as *"project type"*. *"Project resources"* are defined as; the size of the Darwin grant and the quantity of funding received from external (non-DI) sources. All prices were converted to 2008 prices using the Consumer Price Index (CPI) to correct for inflation (www.statistics.gov.uk/statbase).

$$\text{Relative Budget in 2008 (£)} = \text{Budget in Project Year (£)} \times \frac{\text{CPI in 2008}}{\text{CPI in Project Year}} \tag{4.1}$$

Although many of the costs were incurred in-country and therefore affected by exchange rates, the questions being answered concerned expenditure from the point of view of the funder (DI) and not the in-country implementer, therefore Sterling prices were used. Project resources also included the number of weeks spent by the UK staff in the host country, the number of conservation actions employed, using the action categories defined by IUCN (IUCN-CMP, 2006a), and the quantity of education provided (calculated based on the number of students, training weeks, leaflets etc; see Appendix A section A.3.2). Background variables included the biome, conservation target (whether it was flora, fauna or habitat-based), conservation threat as defined by IUCN (IUCN-CMP, 2006b), 2008 Human Development Index (UN, 2008) of the host country (chosen as it combines three basic dimensions of development; adult literacy, life expectancy at birth, and Gross Domestic Product; as used by Dias *et al.* 2006; Jha & Bawa 2006), the institutional affiliation of the UK and host country PLs (e.g.

university or museum) and the date the project was initiated. See Appendix A section A.3.1 for details.

4.2.4 Indicators of conservation success and model selection

Three indicators of success were used as dependent variables: *"Darwin Outputs"* (DO) based on a subjective scoring of standard outputs provided in DI final reports (Defra, 1996; Appendix A section A.1); *"Impact Assessment"* (IA) based on a methodology used to explore the success of conservation projects run by zoos (Mace *et al.*, 2007); and *"Ranked Outcomes"* (RO) created by ranking the project outcomes stated in the text of DI final reports (Appendix A section A.4). The Mace *et al.* 2007 methodology was chosen because it is neither species nor project-specific, and can be carried out post-hoc. Each project was scored by Caroline Howe (CH) using each measure of success.

In order to validate the IA indicator, five students from Imperial College's MSc in Conservation Science were given a short workshop on the DI, this study and the IA methodology. Each student was then asked to score 10 projects and these were compared to CH's score using graphical methods and Spearman's Rank Correlation (as each student only scored 10 projects it was not possible to use the Kappa Statistic and comparisons were made by grouping all student scores into a single variable where n=50 and exploring general trends). There is potential bias in terms of non-independence of outlook, in that all students were on the same course, taught by EJ Milner-Gulland (EJMG).

In order to score projects according to RO, statements referring to actual positive and negative outcomes (as opposed to outputs) were extracted from the final DI reports and ranked by CH according to their importance for conservation success (Appendix A section A.4). Each project was then given a score based on a sum of the rankings for each outcome delivered. For validation purposes, five conservation professionals and one professional in a related field (pest management), based at Imperial College (not students), were asked to repeat the methodology, and their overall scores for each

project were compared with that of CH's using a combination of graphical methods and the Kappa Statistic (used for exploring observer variability). There are differences of opinion in the literature as to what constitutes a reasonable level of agreement for a Kappa Statistic, and in this study interpretation was based on the usage of Kappa in the medical field. What people believe constitutes conservation success is often based on personal opinion and experience, which is similar to interpretation of medical results where a number of different conclusions can be drawn (McGinn *et al.*, 2004, Viera & Garrett, 2005). Once again, the choice of experts may have potentially affected the results obtained, as they came from a relatively narrow pool. All three indicators of success were then compared using a combination of graphical and statistical methods (Kappa Statistic and Spearman's Rank Correlation).

The three indicators of success were modelled against the explanatory variables to explore factors predicting project success, the influence of education on success, and to elucidate the differences between the different indicators of success. For all three, in order to control for the effect of project initiation date, linear mixed effects models (LMEs) were used with date treated as a random effect. Coding projects according to the IA methodology required separating projects according to their overall aim or target (Mace *et al.*, 2007), consequently aim/target was considered as a random effect for IA.

The error structure was defined by the distribution of the response variable (DO = quasipoisson; IA = Gaussian; RO = Gaussian; Appendix A section A.2). IA was strongly skewed and was discretised into a six-level variable in order to allow a Gaussian error structure to be applied. Explanatory variables were chosen from the 15 initial variables using a tree model, which highlighted the variables that explained the greatest amount of variance in the dependent variable (Crawley, 2007). Two-way interactions between explanatory variables, which *a priori* could be of interest, were included. Where necessary, the squared and cubed roots of explanatory variables were included based on the examination of their relationship with the dependent variables. Stepwise deletion was carried out based on non-significant p-values (5% and 10% significance), with largest p-values and two-way interactions removed first. Non-significant main ef-

fects were removed only if they were not involved in two-way interactions. After each variable removal, the model was checked with an ANOVA or F-test (where overdispersion occurred), to assess the significance of the subsequent increase in deviance (Crawley, 2007). Fixed effects were analysed using Maximum Likelihood (ML) and random effects using Restricted Maximum Likelihood (REML). In those cases where the random effect explained little or no variation, a generalised linear model (GLM) was tested against the simplified LME using ANOVA and accepted as the minimum adequate model (MAM) if there was no significant difference between the two models (Crawley, 2007). Residuals versus fitted values plots were used for informal exploration and the Breusch-Pagan test used to test for heteroscedasticity. R.app GUI 1.19 (R Foundation for Statistical Computing, 2007) was used for all statistical analyses.

4.3 Results

4.3.1 Validation of indicators of success

Impact Assessment (IA)

Projects were ordered from low to high levels of success based on the scoring of CH (A). Scores provided by the other assessors (B-H; MSc students in Conservation Science) were then plotted against A (Figure 4.1a). The results indicate general agreement, with all scores following a similar trend, regardless of assessor. However, in general assessors B-H marked lower than A (Figure 4.1a). This may be because A's opinion is based on more direct experience of DI projects, and consequently an understanding of how difficult it may be to achieve an outcome that on paper does not appear very impressive. Given this consistency, A's scores for the IA were taken as the dependent variable.

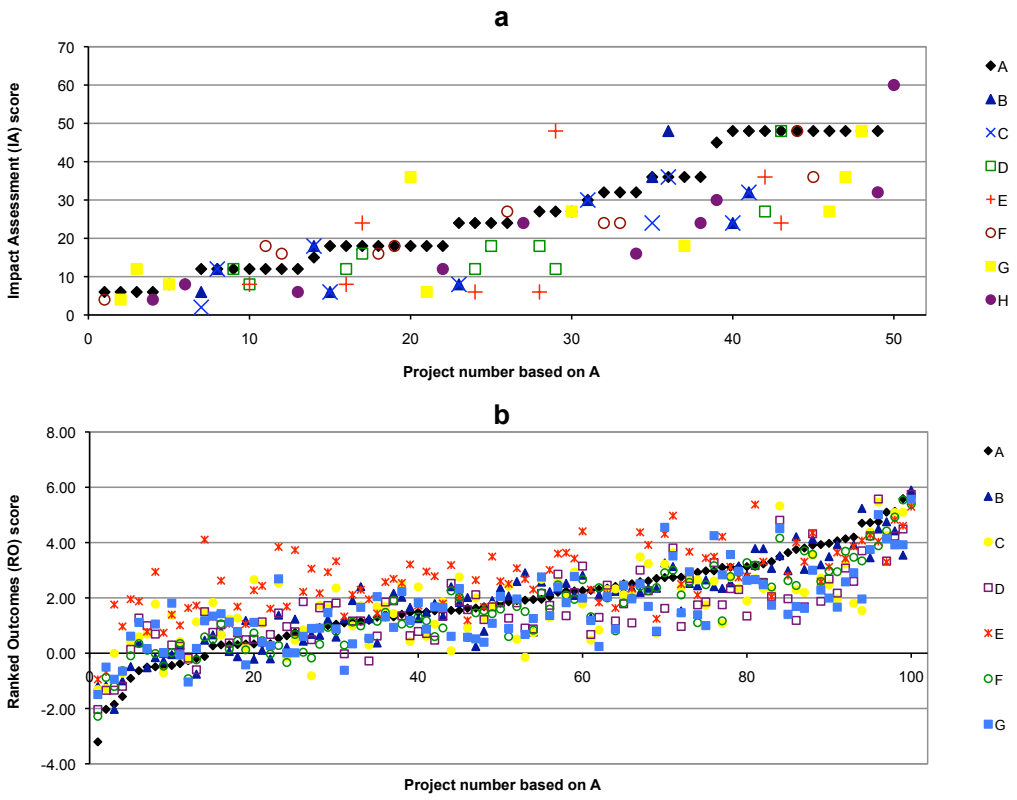

Figure 4.1: a) Relationship between the Impact Assessment scores (IA), based on Mace *et al.* 2007, provided by independent assessors ($\rho = 0.825, p = 1.68e-13, n = 50$); b) Relationship between scores assigned by assessors marking projects according to ranked outcomes (RO).

Ranked Outcomes (RO)

Projects were ordered from low to high levels of success based on A's scores. The results indicate general agreement, regardless of assessor (Table 4.1), however, substantial agreement was only found between A, B and F. Considering the range of outcomes that assessors had to rank and the influence of personal opinion on what constitutes conservation success, a fair or greater agreement was considered reasonable given that the observed trend was consistent (Figure 4.1b). Although the Kappa results suggest a moderate level of agreement between A and E, the graph indicates a difference between E and the other assessors, with E generally being a more generous marker. E had a background in pest management in developing countries rather than in conservation. The difference in opinion between E and the other assessors therefore suggests that there are certain outcomes that are considered as more indicative of conservation success and that, in general, conservationists agree on these, whilst those with field experience in other systems may judge outcomes very differently. The validation exercise was considered as adequate evidence to allow A's scores to be used as the dependent variable for RO.

4.3.2 Comparison of indicators of success

There was a fair agreement between the three indicators (Table 4.2). However, although there is a similar general positive correlation between all three (Table 4.2), the Darwin Outputs and Ranked Outcomes indicators are more generous than Impact Assessment, with RO scoring more projects higher overall (Figure 4.2).

4.3.3 Factors influencing project success

The minimum adequate models (MAMs) for each indicator are provided in Table 4.3. For all three indicators of success, the amount of Darwin Initiative funding provided was positively correlated with success. For DO and IA, external funding was also

Table 4.1: Results of Kappa test of agreement against assessor A for Ranked Outcomes (RO). Agreement levels taken from (McGinn *et al.*, 2004, Viera & Garrett, 2005). $n = 100$.

Assessor	Kappa	Agreement
B	0.730	Substantial
C	0.354	Fair
D	0.400	Fair
E	0.415	Moderate
F	0.760	Substantial
G	0.340	Fair

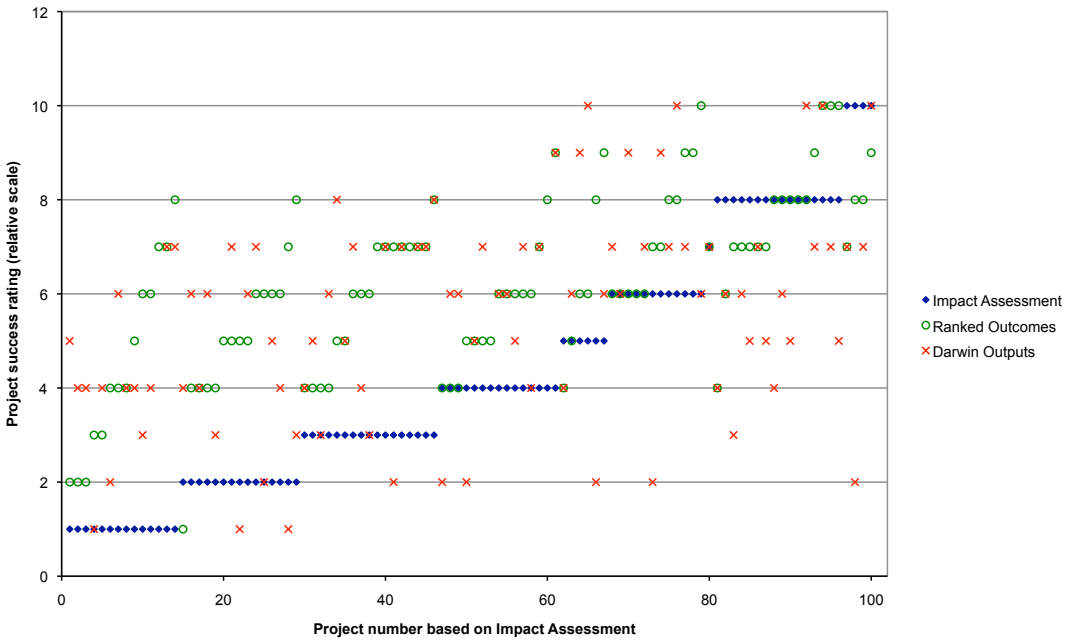

Figure 4.2: Similarities and differences between the indicators of success, based on Impact Assessment (IA).

Table 4.2: Cross-comparison of indicators of success. Kappa Statistic (agreement levels taken from (McGinn *et al.*, 2004, Viera & Garrett, 2005) and Spearman Rank Correlations. $n = 100$

	Impact Assessment					Ranked Outcomes				
	Kappa	**Agreement**	ρ	$p-$**value**	n	**Kappa**	**Agreement**	ρ	$p-$**value**	n
Darwin Outputs	0.258	Fair	0.354	$5.84e-04$	91	0.209	Fair	0.433	$1.77e-05$	91
Impact Assessment						0.325	Fair	0.599	$4.62e-11$	100

positively correlated with success, however, for RO external funding appears to have had a negative effect (Table 4.3). The models also indicate the importance of "project resource" variables: the number of weeks spent by the UK PL and the number of conservation actions undertaken had a positive influence on both DO and IA. For DO, where external funding (non-DI funding) was less than £24,999, number of weeks had a positive influence on success. However, this relationship did not hold where total funding provided was greater or equal to £25,000. Project resources were not significant variables for RO.

4.3.4 Effect of education on project success

Education provided was a significant predictor for all three indicators of success. However the effect varied between indicators. Quantity of education, but not educational type, was significant for DO and IA, whilst the type of education provided was important for RO. In the case of IA, the quantity of education provided interacted with the HDI of the host country. In countries with low (< 0.600) and high ($0.800+$) HDIs, quantity of education provided had a positive effect on project success. However, for mid-development countries ($HDI = 0.600 - 0.799$), the quantity of education provided had little or no effect on project success (Figure 4.3).

The shape of the relationship between quantity of education provided and DO indicates that effect of education on project success varied with quantity. There was a linear relationship between project success and quantity of education when quantity of education provided was equal to or less than 14 on a relative scale (Figure 4.4a, see Appendix A section A.3.2 for calculation of quantity of education). After this point, increases in the quantity of education provided had little or no influence on project success. This relationship is best fitted in the MAM by the cube-root of quantity of education. For IA, quantity of education increased success when Darwin funding was less than £149,999. After this level of funding, there was no relationship between quantity of education and success.

Table 4.3: Minimum adequate models (MAMs) for indicators of success. Model for Darwin Outputs (DO) fitted using a GLM with quasipoisson errors. Models for Impact Assessment (IA) and Ranked Outcomes (RO) fitted using an LME with Gaussian errors. The random effect of date for RO explains 5.94% of the variance. The random effect of project aim explains 10.17% of variation for IA. The type of education provided is a nominal factor. All other factors are continuous. (GLM = generalised linear model, LME=linear mixed effects model, significance: $^{*} = 0.050 - 0.099$, $^{**} = 0.010 - 0.049$, $^{***} =< 0.010$).

	95% Confidence Interval			
	Estimate	**Standard Error**	$t-$**value**	$p-$**value**
(a) Model for Darwin outputs ($n = 91$)				
(intercept)	1.253	0.216	5.813	$1.24e{-}07$ ***
Quantity of education provided	-0.012	0.006	-1.903	0.061 *
$\sqrt[3]{\text{Quantity of education}}$	0.422	0.104	4.059	$1.15e{-}04$ ***
Number of weeks spent by UK PL in host country	0.004	0.104	2.720	0.008 ***
Darwin Initiative funding	$2.52e{-}06$	$8.60e-07$	2.929	0.004 ***
External funding	0.042	0.023	1.843	0.069 *
External funding : Number of weeks	$-8.23e{-}04$	3.58e$-$04	-2.298	0.024 **
(b) Model for impact assessment ($n = 96$, $df = 58$)				
(intercept)	-1.966	1.872	-1.050	0.298
Quantity of education provided	0.488	0.165	2.947	0.005 ***
Number of conservation actions implemented	0.348	0.124	2.804	0.007 ***
Human Development Index (HDI)	2.040	2.091	0.975	0.333
Darwin Initiative funding	$1.31e{-}05$	$6.80e{-}06$	1.924	0.059 *
External funding	0.160	0.085	1.877	0.066 *
Quantity of education : HDI	-0.386	0.167	-2.310	0.025 **
Quantity of education : Darwin Initiative funding	$1.30e{-}06$	$6.00e{-}07$	-2.109	0.039 **
(c) Model for ranked outcomes ($n = 100$, $df = 80$)				
(intercept)	-0.046	0.756	-0.061	0.951
Type of education provided	0.071	0.176	0.405	0.687
Darwin Initiative funding	$9.40e{-}06$	$4.00e{-}06$	2.350	0.021 **
External funding	-0.551	0.208	-2.654	0.010 **
Type of education : External funding	0.155	0.051	3.062	0.003 ***

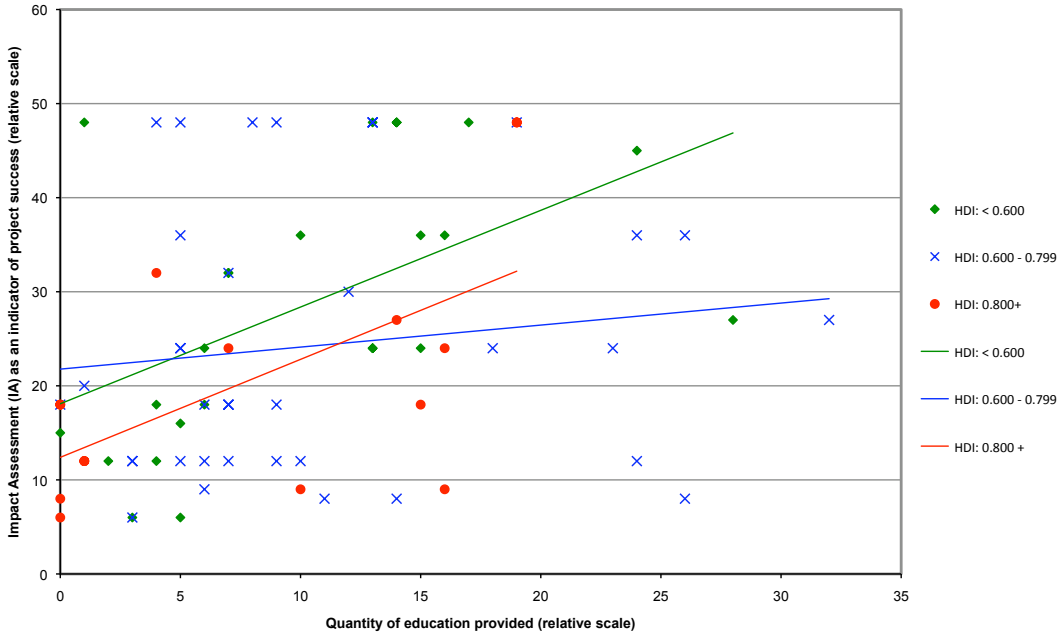

Figure 4.3: Relationship between quantity of education provided, Human Development Index (HDI) of the host country and Impact Assessment (IA) as an indicator of conservation project success. (HDI $=<$ 0.600, $n = 21$; HDI $=$ 0.600$-$0.799, $n = 32$; HDI $=$ 0.800 $+$, $n = 12$)

Quantity of education was not a significant explanatory variable for RO, however project success depended on the type of education provided and varied according to investment from external (non-DI) sources. Training alone had very little effect on success. When external funding provided was less than £24,999, the likelihood of achieving project success was increased by investing in a combination of formal education and training. For sums larger than £24,999, investment in a range of educational activities including schooling and public awareness-raising was more likely to increase project success (Figure 4.4b).

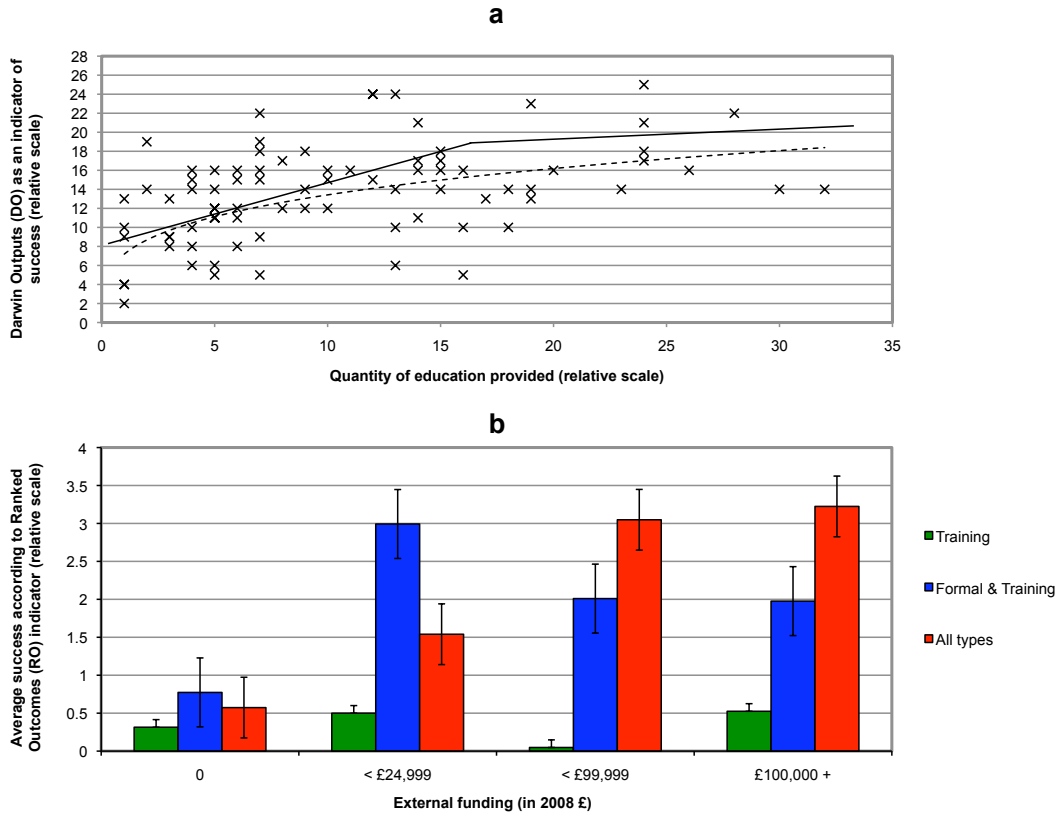

Figure 4.4: a) Relationship between quantity of education provided and success as indicated by Darwin Outputs (DO). The black lines illustrate the two halves of this relationship, whilst the dotted line gives the equation for the relationship ($y = 7.19x^{0.27}$); b) Effect of educational type on ranked outcomes (RO), and its interaction with external (non-Darwin Initiative) funding.

4.4 Discussion

Developing an indicator of conservation success that gives a reliable and consistent evaluation of conservation projects, regardless of whether they are biological or socio-economic in focus, depends very much upon the answer to the question: what is success (Axford *et al.*, 2008)? Validation of both the "Impact Assessment" (IA) methodology and the development of the "Ranked Outcomes" (RO) indicator highlighted the, sometimes vast, differences between individuals as to what is considered an important measure of success. In the case of IA, these results suggest that those with less experience of Darwin Initiative projects have much higher standards as to whether or not they believe a project has effectively contributed to relevant conservation outcomes. More experienced researchers, who know how difficult certain outcomes are to achieve, may be more generous in their assessment. Likewise, the comparison of assessors using the RO methodology illustrated a difference in opinion between conservationists and a non-specialist. In a world where it is necessary for businesses, charities and academic institutes alike, to be accountable for their investments, this difference in opinion as to what constitutes conservation success between established conservationists and non-experts in the field may cause difficulties for environmentalists seeking to gain support for their work from external funding bodies. However, despite these differences in opinion as to what constitutes success and how it may be measured, interviews with DI project leaders led to the general consensus, that in order to have achieved a lasting impact a project must act as a *"catalyst"* (Julia Willison, BGCI) and *"evolve"* to take on a life of its own (Dr Steve Tilling, FSC).

All three indicators highlight the importance of funding, both internally from the Darwin Initiative and externally from other sources. They also demonstrate that project success is not necessarily a linear function of conservation intervention (in this case education) or project resources (number of weeks spent in host country), and that the actual function depends on the amount of funding provided. Consequently, as money is both vital for success, but also limited (James *et al.*, 1999), it is important to account for costs explicitly when deciding on what conservation intervention(s) to apply,

and the amount of resources required to maximise conservation success (Joseph *et al.*, 2009, Underwood *et al.*, 2008).

Education, both in terms of quantity and quality, is shown to be a vital contributor to the success of a conservation project. Its relationship with success however, is not linear and its influence on project outcome is dependent on the HDI of the host country and the type of education employed. *"Provision of information alone is not education"* (Dr David Minter, CABI International), and the conversion of information provided into actual behavioural change is a contextual process that depends on intervening experiences and circumstances (Foxall, 1984). Taking background socio-economic circumstances into account is therefore vital when planning an education campaign as part of conservation. It is not surprising that education has a non-linear relationship with success, as it is one of a number of tools that contributes to the overall outcome of a conservation project. *"Like a winning football team where the outcome is the sum of all its players and not individual performances, education is a tool which contributes to success but is not alone in producing it"* (Mr Barrie Cooper, RSPB).

Although the Darwin Initiative's Output Measures (DO) highlight similar variables as contributing to success to those emphasised by the impact assessment and ranked outcome indicators, they provide less in-depth information regarding, for example, the relationship between education and project success. Both IA and RO methodologies highlight interactions between HDI, funding and the type of education employed. These interactions should be considered when planning a conservation project, due to their potential to influence overall success. However, the fact that there are differences between the models for all three methodologies indicates that attempting to evaluate all project types using a similar measure maybe like trying to *"value apples against oranges"* (Mace *et al.*, 2007). The RO methodology developed here is still only at the pilot stage and consequently, a more in-depth quantitative and qualitative analysis of what is considered to be success, and how that affects the development of RO as an indicator, is required.

This study is an example of an independent evaluation of self-reports. It therefore at-

tempts to combine the positives and negatives of both methods. By using self-reports, a huge range of conservation projects can be evaluated. Independent evaluation, using established and novel indicators of success, allows interpretation of the self-evaluations of the project leaders. As the evaluation has been made based on DI final reports, this is a static insight and further data would be required to assess conservation success over time. The lack of rigorous, quantitative monitoring within conservation projects is still an issue, as found by Brooks *et al.* 2006a, and the establishment of independent indicators of success is also a problem due to differences in opinions between reviewers. This issue was also highlighted by Mace *et al.* 2007.

This study supports the suggestion, by Mace *et al.* 2007, Salafsky and Margoluis 1999, and Brooks *et al.* 2006a, that it is both vital and possible to develop a method for monitoring project outcomes that considers both socio-economic and biological aspects. However, understanding how the indicator has been developed and who has evaluated it is vital, as the choice of a particular measure and evaluator can strongly influence the inferences drawn. This study lends support to the case for effective monitoring of conservation investment whilst highlighting important points for consideration whilst doing so. It also delivers strong backing for the strategic use of education as an effective tool for conservation.

"Ignorance more frequently begets confidence than does knowledge"

Charles Darwin, The Descent of Man, 1871

5

Return-on-investment in education as a component of conservation interventions

5.1 Introduction

Resources required to deal with the deepening biodiversity crisis are limited, and consequently deciding on how to distribute these has become a pressing concern (Possingham *et al.*, 2001). Although there are a large number of priority-setting frameworks in use by NGOs which emphasise efficiency (CI, 1999, WWF, 2000), none of these actually incorporates costs in a formal return-on-investment analysis (Joseph *et al.*, 2009). Biodiversity hotspots and threats to biodiversity are distributed unevenly, and often located in the economically most vulnerable countries (Brooks *et al.*, 2006b). Whilst, choosing where to conserve based on density of species does not necessarily lead to conservation efficiency (Underwood *et al.*, 2008). Consequently, without estimates of costs, claims of wise investment in conservation are difficult to justify (Naidoo *et al.*, 2006).

Allocating scarce resources to achieve specific goals is a textbook definition of an economic problem and therefore solutions to the current conservation crisis may be found using economic tools (Polasky *et al.*, 2001). There are three main economic

approaches that can be adapted to conservation: cost-benefit analysis (CBA), cost-utility analysis (CUA) and cost-effectiveness analysis (CEA). CBA seeks to find out if the benefits of a particular programme exceed the costs, whilst CEA is used to find the least-cost means to meet a particular objective (Hughey *et al.*, 2003). CUA on the other hand can be used to make comparisons between competing alternatives, and is often used in the development of health-care programmes (Drummond *et al.*, 1997). As it can be used to compare projects that are trying to achieve different results, it has been used in the conservation world to evaluate the output from different species conservation projects (Cullen *et al.*, 1999, 2001). This makes it particularly relevant as a tool for the evaluation and comparison of specific conservation tools (Hughey *et al.*, 2003). It must be noted however, that not all benefits and costs of conservation may be measured in monetary terms and therefore it is important that economic evaluations are used pragmatically (Hanley & Spash, 1993). Purely economic studies may fail to use a meaningful ecological-benefit function (Dreschler & Watzold, 2001).

Return-on-investment (ROI) analysis can be used for cost-utility or cost-effectiveness. A study illustrating the application of ROI methodology to conservation demonstrates the enormous savings that can be made using this form of analysis when planning conservation interventions, particularly in areas where biodiversity and costs are not well correlated and the costs of alternatives vary by orders of magnitude (Murdoch *et al.*, 2007). Recommended priorities for action are often also different when costs are included, in comparison to when only biological factors are considered, and may even demonstrate a negative relationship between expenditure and ecological benefits (Underwood *et al.*, 2008). The studies that incorporate cost-utility or cost-effectiveness in the assessment of conservation management outcomes illustrate both the benefits and difficulties of applying economic theory to conservation. They also provide support for the need to include costs during planning and adaptive management in order to achieve the greatest ecological benefits with limited resources (Cullen *et al.*, 1999, 2001, Metrick & Weitzman, 1998). It has been shown that developing a prioritisation protocol can substantially improve conservation outcomes for threatened species (Joseph *et al.*, 2009). This process of efficient allocation of conservation resources has been referred

to as conservation triage (Bottrill *et al.*, 2008).

Education in general is considered to be an attractive investment (Psacharopoulos, 1994) and a number of studies on rates-of-return from investment in human capital in agriculture have demonstrated a significant effect of education on productivity (Asadullah & Rahman, 2009, Godoy *et al.*, 2000, Jamieson & Lau, 1982). Likewise, there are a few studies that illustrate the positive effect of education on household income and economic growth (Baldacci *et al.*, 2008, Jung & Thorbecke, 2003, Yunez-Naude & Taylor, 2001). In relation to conservation, it has been shown that education can contribute to improved environmental behaviour. For example, a number of studies have shown a reduction in deforestation around homesteads with additional schooling of the household head (Alix-Garcia, 2007, Carr, 2005, Godoy & Contreas, 2001, Godoy *et al.*, 1998). The above studies however, only consider the effect of formal education and not the ROI from different educational types, and there are no studies that specifically explore the return-on-investment for conservation education in cost terms and in the context of other conservation activities.

The Darwin Initiative was established in 1992 by the British Government, at the Rio Earth Summit, to assist countries rich in biodiversity but poor in resources to fulfil their obligations with regards to the Convention on Biological Diversity (CBD, 1992, Defra, 2009). It was chosen as a database for this study due to its international reputation as a world-class programme promoting biodiversity conservation and sustainable resource use worldwide. As a long-running initiative, it provides a large database of information on project results required for the study. Confounding variables are reduced as all projects have the same duration (3 years), the same underlying purpose, similar size, similar backgrounds of implementers and quantitative and consistent measures of inputs and outputs i.e. Darwin standard Output Measures (Defra, 1996).

This study seeks to answer the following questions using a database of Darwin Initiative project reports:

1. How does education, as a component of conservation interventions, influence

project success? Does its influence vary depending on the proportion of the project budget that it represents?

2. What types of education contribute most to educational success and what factors influence this?

3. How do background variables, such as the Human Development Index (HDI) of the host country and the type of species being conserved, influence the ROI for education?

5.2 Methods

The methods are as described in Chapter 4 Section 4.2, with the addition of:

5.2.1 Database development

Where permission was granted (68 projects), the financial breakdown on how the Darwin Initiative funding was spent on different types of education was also collected and used to carry out the return-on-investment (ROI) analysis.

As the questions being answered concerned the return-on-investment (ROI) in education from the point of view of the funder (DI), only the amount of funding invested in education by the Darwin Initiative and not external sources of funding was considered. All costs were in Pounds Sterling and converted to 2008 prices (Chapter 4 Section 4.2.3).

5.2.2 Indicators of conservation and educational success and model selection

Overall project success was measured using *"Darwin Outputs"* (DO) based on a subjective scoring of Standard Outputs provided in DI final reports ((Defra, 1996); see Chapter 4 Section 4.2 and Appendix A Section A.1 for details of calculation of DO). In order to score *"Educational Success"* of a project (ES), statements referring to positive educational outcomes (as opposed to outputs) were extracted from the final DI reports and ranked by Caroline Howe (CH) according to their importance for conservation success (Appendix A Section A.4). Each project was then given an educational score based on a sum of the rankings for each outcome delivered. For validation purposes, five conservation professionals and one related professional (pest-management), based at Imperial College, were asked to repeat the methodology, and their overall scores for each project were compared with that of CH using a combination of graphical methods and the Kappa Statistic (used for exploring observer variability). The validity of this method was addressed in Chapter 4 Sections 4.2 and 4.3.1. There are differences of opinion in the literature as to what constitutes a reasonable level of agreement for a Kappa Statistic, and in this study interpretation was based on the usage of Kappa in the medical field. What people believe constitutes conservation success is often based on personal opinion and experience, which is similar to interpretation of medical results where a number of different conclusions can be drawn (McGinn *et al.*, 2004, Viera & Garrett, 2005). Both indicators of success were then cross-compared using a combination of graphical and statistical methods (Kappa Statistic and Spearmans Rank Correlation).

Complex models of return-on-investment (ROI) in education include functions for income generation (as a function of age) to account for potential loss of earnings whilst in education (Johnson, 1970, Psacharopoulos, 1994). This is necessary in societies where all age groups are expected to work in order to support the household economy. The education carried out in Darwin Initiative projects rarely involves loss of earnings, as it is often provided in the form of supplementary materials, for example media re-

ports, leaflets or after-school clubs. Where it involves more formal education, such as training workshops or PhDs, it is often carried out part-time so trainees can still continue to work. For this reason, a less complex ROI analysis was used to calculate ROI per additional £1000 invested in education by the Darwin Initiative project (based on Murdoch *et al.* 2007):

$$\text{ROI in education per £1000 invested} = £1000 \times \frac{\text{Benefits (DO or ES)}}{\text{Amount spent on education}} \quad (5.1)$$

Although there are number of complexities that this equation does not consider such as complementarity, investment risk, start-up costs, or weighting of costs, even a simple model can demonstrate the fundamental role of costs and consequently, the effect they have on the choice of investment in different conservation interventions (Murdoch *et al.*, 2007).

Educational types (formal, training, primary/secondary schooling, informal e.g. media and public awareness and ad-hoc e.g. theatre groups), and combinations of these, were modelled as explanatory variables against ES to determine which had the greatest influence on the educational success of a project. A generalised linear model (GLM) with a Gaussian error structure (as defined by the distribution of ES) was developed. The saturated model included all educational types and all multi-way interactions as well as key background variables. A mixed-effects model could not be developed for ES, as the number of combinations of different educational types coupled with the size of the database meant that there was not enough variation available to run the model.

An LME was also developed for return-on-investment (ROI) for education as a function of overall project success. ROI was log-transformed and a Gaussian error structure was used. As ROI was calculated by dividing by expenditure on education, total DI budget and total amount spent on the education section of the project were fit as random effects. In the saturated model, the total amount spent on education was also included as a fixed effect, to explore the effect of expenditure on education on ROI over and above the variation caused due to the method of calculation of ROI. The number

of conservation actions implemented in the project as defined by IUCN (IUCN-CMP, 2006a), percentage of total DI budget spent on education and project aim plus all 2-way and 3-way interactions were also included as fixed effects in the saturated model.

For all models, stepwise deletion was carried out based on non-significant p-values (5% and 10% significance), with largest p-values and multiple interactions removed first. Non-significant main effects were removed only if they were not involved in interactions. After each variable removal, the model was checked with an ANOVA or F-test (where overdispersion occurred), to assess the significance of the subsequent increase in deviance (Crawley, 2007). Fixed effects were analysed using Maximum Likelihood (ML) and random effects using Restricted Maximum Likelihood (REML). Residuals versus fitted values plots were used for informal exploration and the Breusch-Pagan test used to test for heteroscedasticity. R.app GUI 1.19 (R Foundation for Statistical Computing, 2007) was used for all statistical analyses.

5.3 Results

5.3.1 The influence of project context on educational activity

An analysis of the effect of project context on implementation of different educational types shows changes over time in the use of different educational types. Amount spent on ad-hoc education within a single project increased over time ($\rho = 0.255, p = 0.036, n = 68$), whilst the use of training (although not the amount spent) per project also increased since 1997 ($\rho = 0.268, n = 83, p = 0.015$). Overall, there was no univariate relationship between project budget, percentage of the budget allocated to education and either quantity of education provided or educational type employed. Less money was spent on training with increasing HDI ($\rho = -0.31, p = 0.022, n = 68$) whilst there was no variation in funding with HDI for other educational types. There was also no variation in whether projects make use of a particular educational type as HDI varies. Finally, projects that sought to conserve both flora and fauna were

more likely to use ad-hoc education than projects that only conserve one or the other ($\chi^2 = 8.04, df = 2, p = 0.018$).

5.3.2 Effect of investment in education on overall project success

A project's return-on-investment (ROI) for every additional £1000 spent on education was calculated using Darwin Outputs (DO) as an indicator of project success. As education is one of a number of interventions that can be implemented, in order to account for the potential confounding effect of other conservation actions on project success, a linear mixed-effects model (LME) was fitted for ROI, considering total numbers of actions, project aim, total spent on education and percentage of DI project budget spent on education as fixed effects and overall DI budget and total spent on education as random effects. The minimum adequate model (MAM) is given in Table 5.1.

The model indicates that project aim and total number of actions implemented did not have a significant independent effect on ROI from education, but did interact with the total amount of money spent on education. Total amount spent on education was significant but percentage of the overall DI budget spent on education was not. ROI was greatest in projects where either education or research/infrastructure were primary aims. In both of these types of projects, however, the number of conservation actions implemented was much lower than in habitat or species-focused projects (Figure 5.1). Consequently, it was deduced that ROI in education was greatest where education is one of the primary conservation actions implemented. For education and research/infrastructure projects, ROI in education declined with increasing funding for education, and was greatest when total amount spent on education was less than £5,000. This indicated, that where education was a primary aim of a conservation project, less money needed to be spent on education in order to maximise ROI, and therefore education was a cost-effective action. In habitat and species projects, project leaders tended to implement a greater number of actions (Figure 5.1). For these projects ROI in education was greatest when between £5,000 and £9,999 was spent on education.

Table 5.1: Minimum adequate model (MAM) for return-on-investment (ROI) in education on total project success fit by LME with Gaussian errors. Dependent variable was log-transformed. Number of conservation actions implemented (IUCN-CMP, 2006a), total amount spent on education and Darwin Initiative (DI) funding per per project are continuous. Project aim is nominal. Random effects of total DI funding and total amount spent on education explained 40.08% and 42.11% of the variation respectively (LME = linear mixed-effects model, significance: $^{*} = 0.050 - 0.099$, $^{**} = 0.010 - 0.049$, $^{***} =< 0.010$, $n = 59$, $df = 49$).

	95% Confidence Interval			
	Estimate	**Standard Error**	$t-$**value**	$p-$**value**
(intercept)	0.630	0.150	4.194	0.000 ***
Number of conservation actions implemented	−0.019	0.033	−0.570	0.571
Project aim	−0.039	0.047	−0.843	0.403
Total amount spent on education (£)	$-6.63e-05$	1.77e−05	−3.740	0.001 ***
Number of actions : Total spent on education	1.67e−05	4.96e−06	2.162	0.035 **
Project aim : Total spent on education	1.42e−05	6.43e−06	2.217	0.031 **
Number of actions : Project aim : Total spent on education	$-3.20e-06$	$1.72e-07$	−1.868	0.067 *

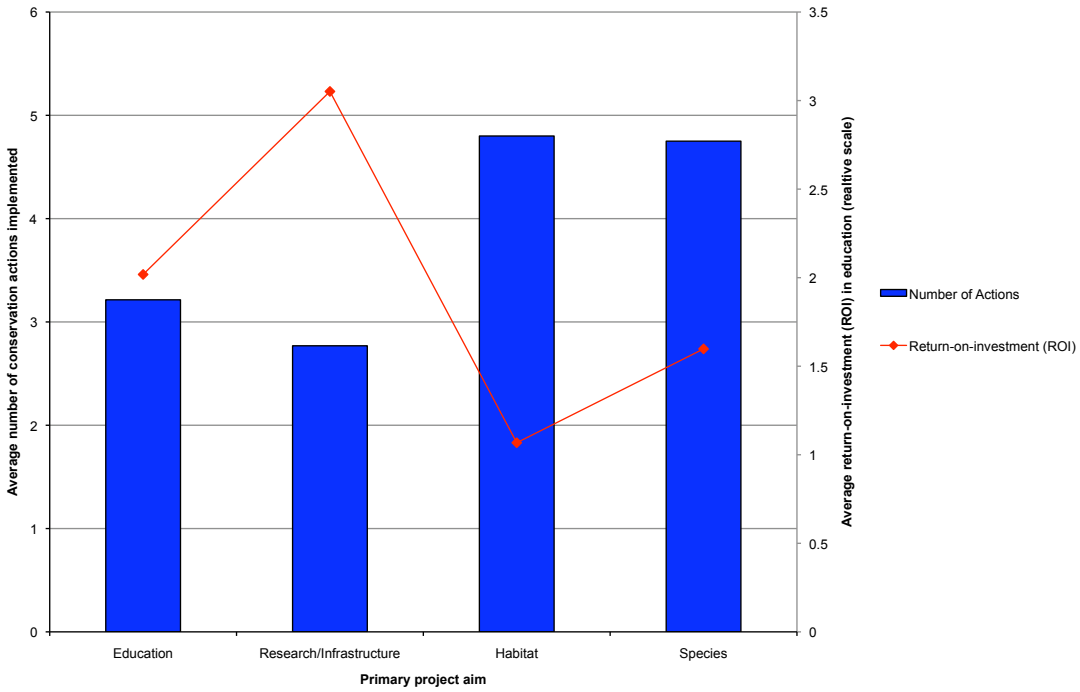

Figure 5.1: Interaction between the number of conservation actions implemented based on IUCN (IUCN-CMP, 2006a), project aim and return-on-investment (ROI) in education on overall project success.

When three or fewer conservation actions were carried out, ROI in education was maximised when less than or equal to £5,000 was spent on education. When the number of actions carried out was greater than three, this figure rose to £5,000-£9,999. These results suggest that as the total number of actions increases, education becomes a less cost-effective measure for conservation. Unfortunately, the break down for spending on other types of actions was not available, which would have allowed a proper assessment of the level of cost-effectiveness of education compared to other potential activities.

5.3.3 Influence of educational type on education success

A generalised linear model (GLM) with Gaussian errors was developed to explore which combination of educational types were more likely to lead to education-specific success (ES) in a project. The minimum adequate model (MAM) is given in Table 5.2. As expected, no individual educational type is solely responsible for high levels of ES. The model indicates that two different combinations of educational types tended to produce high levels of education success: formal education and informal education (in the form of public awareness and the media) and training in combination with school-based education (Table 5.2). This result is illustrated by an analysis of the ROI from different types of education based on the percentage spend of the educational budget. Figure 5.2 indicates that the ES of the project was maximised by spending 40-60% of the educational budget on formal or informal education whilst there was no similar effect for either ad-hoc education or training. Illustrating the effect of the interaction of training and schooling on ES was not possible, as there was no budgetary data available for the amount of money spent on education in schools as part of DI projects.

5.3.4 Effect of project context on ROI in education

Project context had an influence on educational activity therefore it was assumed it would also have an effect on ROI in education. A number of background variables were

Table 5.2: Minimum adequate model (MAM) for education success (ES) fit by GLM with Gaussian errors. All factors are continuous. (GLM = generalised linear model, significance: $^{*} = 0.050 - 0.099$, $^{**} = 0.010 - 0.049$, $^{***} =< 0.010$, $n = 87$).

	95% Confidence Interval			
	Estimate	**Standard Error**	$t-$**value**	$p-$**value**
(intercept)	0.654	0.088	7.451	$2.01e-10$ ***
Formal education	0.017	0.016	1.083	0.283
Training	0.010	0.005	2.010	0.048 **
Public awareness	0.162	0.088	1.844	0.069 *
Media	−0.016	0.100	−0.155	0.877
Schools	$-7.35e-04$	0.113	−0.000	0.995
Formal : Public awareness	-0.040	0.015	−2.649	0.010 **
Public awareness : Media	−0.043	0.020	−2.201	0.031 **
Training : Schools	0.018	0.007	2.686	0.010 **
Formal : Public awareness : Media	0.012	0.004	2.775	0.007 ***

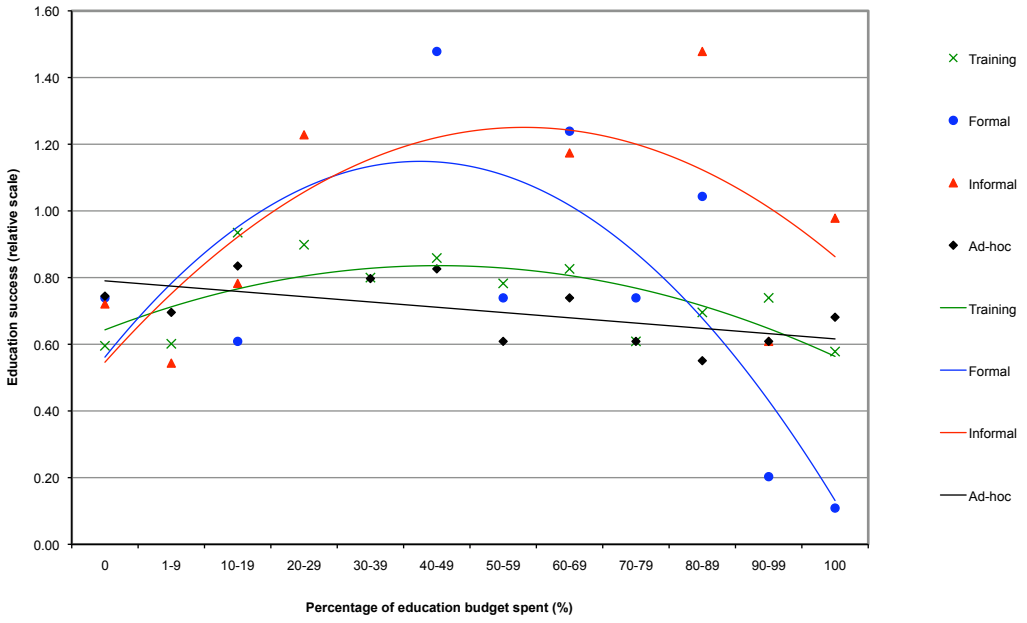

Figure 5.2: Return-on-investment (ROI) from different types of education.

analysed to explore their influence on ROI, based on the education-specific success of a project (ES). There was an exponential decrease in ROI with increasing amount of time spent by the UK PL in the host country. This suggests that after the initial few weeks, time spent in-country was better spent on other actions than education. A closer analysis of the type of education employed and interaction with time spent in the host country, illustrates that under informal education, ROI increased with increasing number of weeks spent in the country ($R2 = 0.558, n = 24, p = 0.005$). There was no relationship between ROI for between formal, training or ad-hoc educational types and time spent by the PL in the host country.

ROI in education was higher in countries with an HDI of 0.750 or greater. However, this larger ROI was accounted for by those projects that spent less than £5,000 on education. When more than £5,000 was spent, richer countries showed a sharp drop in ROI. This did not occur in low HDI countries (Figure 5.3). This would suggest that education is more costly in richer countries and therefore there is less *"bang-for-your-buck"*. There was no interaction between the proportion of the whole DI project budget spent on education and HDI.

Projects involving flagship species had a greater ROI from education than those with non-flagship species (ROI = 0.097 and 0.060 respectively). Educational success when flagship species were the conservation target was maximised by spending £10,000 - £14,999 on education whilst ROI was maximised for non-flagship species when spending £15,000 - £19,999 (Figure 5.4). There was no interaction between proportion of DI budget spent on education and flagship species. There was no variation in ROI in education when addressing different numbers of conservation threats, as defined by IUCN (IUCN-CMP, 2006a), targeting flora or fauna or dependent on the scale of the project.

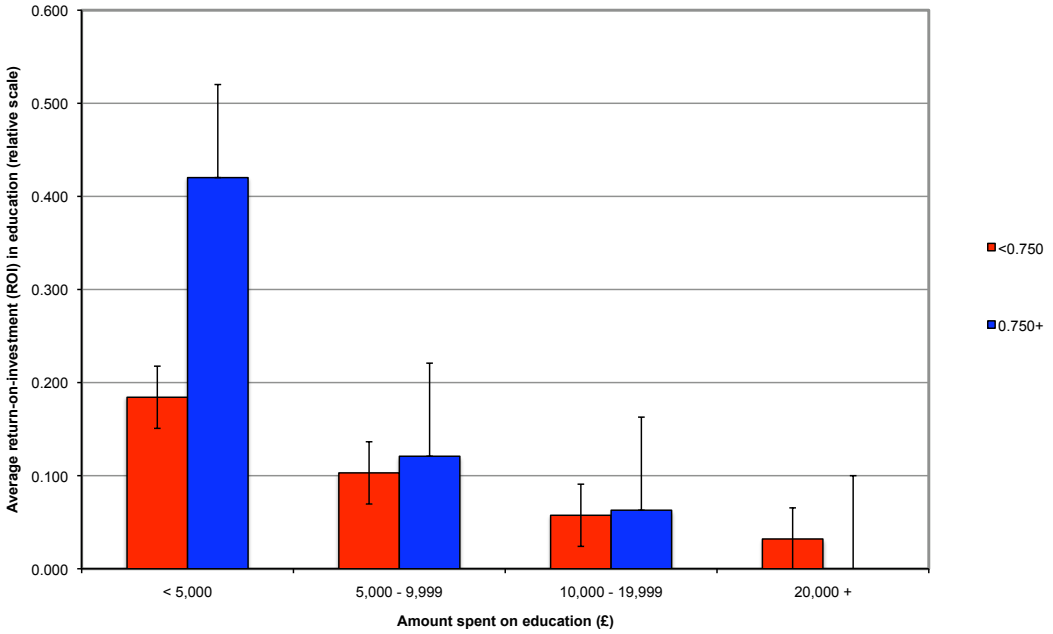

Figure 5.3: Variation in return-in-investment (ROI) as a function of amount spent on education per project (£) and Human Development Index (HDI) of host country ($HDI < 0.750, ROI = 0.091, n = 25; HDI = 0.750+, ROI = 0.101, n = 28$).

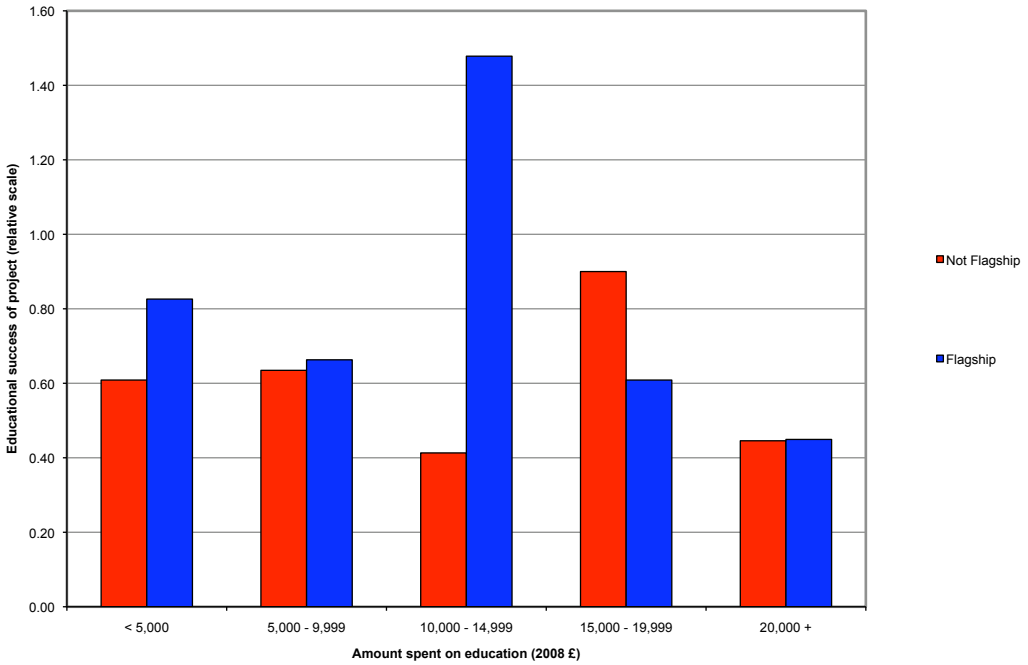

Figure 5.4: Variation in return-on-investment (ROI) between projects with flagship species and projects without.

5.4 Discussion

This study supports the findings of previous analyses that have illustrated the positive effect of education in the fields of agriculture, economic development, and conservation (Alix-Garcia, 2007, Asadullah & Rahman, 2009, Godoy & Contreas, 2001, Godoy *et al.*, 2000, Yunez-Naude & Taylor, 2001). However, the effect is non-linear, and the influence of education varies with the number of other conservation actions being implemented, the overall aim of the project and the amount spent on education. This non-linear effect of education has been shown in other studies where education has been shown to improve environmental behaviour up to a limited point, after which there is no further improvement or even a negative change observed (Godoy *et al.*, 1998, Van, 2003). This effect can be compared to the Environmental Kuznets Curve Hypothesis, which predicts that after a certain level of improvement in wealth, environmental quality will stop decreasing and may even increase (Grossman, 1995, Grossman & Krueger, 1995). However, in this particular study it may simply be due to the fact that, in those cases where education is either the primary aim, or one of the primary actions being implemented, less money needs to be spent on it to achieve maximum ROI and therefore it is a cost-effective method for achieving conservation success. However, in those cases where education is one of a number of conservation actions, more money is required to maximise the ROI from education. In these cases, education may not be the most cost-effective conservation intervention. *"Education is one of a portfolio of actions"* (Mr Barrie Cooper, RSPB) and therefore, not the sole solution to an environmental problem. Interestingly, it was the total amount spent on education and not the percentage of the overall budget that influenced the ROI from education. Consequently, even with a small budget, if education is the primary aim, significant return-on-investment can be achieved.

As further support for the above conclusion, it was shown that the ROI in education declines exponentially as the number of weeks spent by the project leader in the host country increases. Most project leaders are academics, or leading researchers in their field and therefore, the amount of time spent in the host country is more reflective

of the amount of research, infrastructure development and other conservation actions carried out, rather than education. On the whole, the success of the educational side of a project depends more on the strengths of the host country partner, and therefore the relationship between the UK partner and the host country institution is *"vital"* (Dr Paul Donald, RSPB). *"Interaction with local partners is absolutely key. If the project is not rooted in local people and local institutions, then we dont have a role"* (Dr Colin Clubbe, Kew Gardens).

As discussed in the introduction, many studies exploring the effect of education only consider formal education. In general, it is assumed that non-formal education is necessary in order to supplement formal environmental/conservation education (Haigh, 2006, Weladji *et al.*, 2003) and non-formal education initiatives are often employed and considered to be important policy strategies. Some attempts to measure the effect of non-formal initiatives have been made in the agricultural field, for example it has been shown that the variation between early and late adopters (of agricultural innovations) is explained by their access to non-formal information sources (Parra-Lopez *et al.*, 2007). In the area of poverty alleviation, it has been shown that the provision of skills training, as opposed to traditional formal education, is more effective in improving household income (Grootaert & Narayan, 2004, Palmer, 2007).

The HDI of the host country is, understandably, a key background factors affecting the influence of education on conservation. It was shown that the ROI in education is slightly greater for richer countries with a higher HDI, however other studies investigating the socio-economic influence on educational success are divided. An analysis of returns-to-schooling across different socio-economic backgrounds found that returns were higher in those from wealthier families (Neuman, 1991) whilst a study carried out the United States found no evidence of this relationship (Card & Krueger, 1992). In general, it has been shown that primary education provides the greatest rates of return in developing countries (Psacharopoulos, 1994), which would appear to disagree with this study. However, most of the education carried out in Darwin Initiative projects is aimed at adults, either formally or informally, which may account for this discrepancy. There have been a number of studies that show that returns to education

depend, not solely on level of economic development, but on whether a threshold level of socio-economic development has been passed, for example, how well developed local markets are (Bravoureta & Evensou, 1994, Laszio, 2008). Again, this may account for this finding. However, it was shown that there is an issue of value of amount spent on education in real terms. For higher amounts of spending on education, there was a significant decrease in ROI in wealthier countries, suggesting that higher HDI countries are more expensive and there is less *"bang-for-your-buck"*.

It was found that there were a number of background factors that influenced the ROI in education. Namely that funding investments in education vary over time, possibly as a result in changes in amount of funding available or the relative cost of education changing over time. It was also shown that it was cheaper to maximise ROI in education when working with flagship species suggesting that awareness may already have been heightened in these projects due to the iconic nature of the conservation target. Using background factors such as this as an advantage may therefore be a cost-effective way to increase conservation and educational success.

As discussed in the methods, there are a number of caveats and assumptions that have been made in this study. Carrying out a detailed ROI analysis of conservation education is a complex matter, and there are a number of issues such as opportunity costs (potential loss of income whilst not working), complementarity (overlap between different educational types and different conservation actions), investment risk (success is a snap shot in time and a project might not be successful in the long-term) and start-up costs (developing a project in a new country requires investment both in terms of time and money, different projects will have different start-up costs) that will influence the outcomes. However, a simple model will still be able to demonstrate the fundamental role of costs when planning conservation education programmes (Murdoch *et al.*, 2007). It was shown that investing in education is a cost-effective way of achieving conservation when education is the primary aim or one of a primary number of conservation actions. When education is one of a number of actions a ROI analysis should be undertaken in order to choose the most effective combination and quantity of education. There was no access to data on funding of different conservation actions, in order

to make a comparative analysis with education, however this would be a useful future study. There are a number of recent studies that have illustrated the significant benefits to be gained from including costs in evaluations of conservation outcomes (Joseph *et al.*, 2009, Underwood *et al.*, 2009, 2008). This study supports these findings and is an example of the benefits that can accrue from carrying out a ROI in conservation education and should be used as a springboard for further, more in-depth analysis. Although there are a number of studies that have explored the use of ROI in either conservation or education, this may be one of the few studies that seeks to explore the ROI in conservation education specifically.

"To kill an error is as good a service as, and sometimes even better than, the establishing of a new truth or fact"

Charles Darwin, The Descent of Man, 1871

6

Evaluating the Success of Alternative Conservation Interventions Using Willingness To Pay (WTP) as a Measure of Behavioural Intention

6.1 Introduction

Effective conservation requires us to measure the success of our interventions (Saterson *et al.*, 2004, Sutherland *et al.*, 2004). There are, however, few studies that attempt to quantify the relative success of different conservation interventions in a controlled manner (Ehrenfeld, 2000), and those that have attempted it, highlight the problem of the lack of systematic monitoring schemes (Brooks *et al.*, 2006a). The diversity of conservation actions that may be employed, from education and training to habitat restoration, means that it can often be difficult to define the meaning of *"success"*, as those undertaking conservation prioritise different outcomes (Brooks *et al.*, 2006a). There are a number of approaches to developing common measures of success that involve assessing impact according to the type of intervention employed (Jepson, 2004, Mace *et al.*, 2007, Salafsky & Margoluis, 1999).

Long-term saiga antelope (*Saiga tarctica*) conservation requires a combination of measures that include raising awareness and generating positive behavioural changes in

the local population. Although it is difficult to directly observe and relate actual behavioural changes to a particular intervention (Holmes, 2003), behavioural intention can be measured using willingness-to-pay (Mitchell & Carson, 1989), and used as a proxy or indicator of conservation success. This method is used to quantify the relative success of three different antecedent interventions for saiga antelope conservation, and to address the lack of quantitative comparative studies of conservation intervention effectiveness.

The attitude-behaviour relationship, established by Fishbein and Ajzen 1975, predicts that human behaviour is governed by a series of beliefs that a person learns or forms on the basis of observation and information received. A belief is a individual's opinion about an object, and in the case of possible behaviour, the consequences of that act on the object (Bateman & Willis, 2001). These beliefs then form the basis of a person's attitudes, which in turn are predicted to influence behavioural intentions: stated intentions to perform an act at a later date (Bateman & Willis, 2001). However, the relationship between behavioural intentions and behaviour is contextual and depends on intervening experiences and information obtained (Foxall, 1984).

Antecedent interventions, such as those employed in this study, target underlying behavioural determinants, for example knowledge, which in turn are hypothesised to influence behaviour (Luiselli, 2006). Studies of energy use show that the provision of information tends to result in higher knowledge of the subject (Abrahamse *et al.*, 2005). Other studies show a positive relationship between knowledge and attitudes to conservation; for example Aipanjiguly *et al.* 2002 showed that greater knowledge about manatees was positively correlated with support for manatee conservation. Formal education level, even when not specifically tailored to conservation, also correlates with positive attitudes (Caro *et al.*, 1994, Infield, 1988, Mehta & Heinen, 2001). Consequently, it can be hypothesised that there is a link between conservation interventions that raise awareness and the attitudes and behavioural intentions of the target population, which may occur through a change in knowledge levels.

The North-West Pre-Caspian region of the Russian Federation is one of the poorest

regions of Russia. The dissolution of the USSR in 1991 resulted in high levels of unemployment in the area (Grin, 2000). The consequent poverty and collapse in hunting controls are thought to be driving the illegal hunting of the saiga antelope, *Saiga tatarica* (Kuhl *et al.*, 2009). The saiga is a nomadic ungulate of the Central Eurasian rangelands hunted both for its horn, which is used in traditional Chinese medicines and for meat for local consumption (Milner-Gulland *et al.*, 2001). Post-Soviet over-hunting led to a dramatic population reduction from over a million to less than 50,000 individuals (Milner-Gulland *et al.*, 2001) and in 2002 the species was officially classified in the IUCN Red List as Critically Endangered (www.redlist.org).

Known as the *"friends of the steppe"* by the poet Alexander Pushkin, the Kalmyk people used to manage the saiga antelope populations that migrated through their territory, punishing those who broke hunting laws with severe fines (Kirikov, 1983, Lushchekina & Struchkov, 2001). Although this practice is no longer carried out, the saiga still plays a significant part of Kalmyk life as it is seen as a symbol of the steppe and is represented as a holy figure in statues in the Buddhist temples of the region. As previously mentioned, saigas are also consumed by the local population and therefore there is a high meat value from sustainable hunting (Sokolov & Zhirnov, 1998). The preservation of the saiga is therefore important, not only for the international organisations funding conservation, but also for the Kalmyk people, their culture and livelihoods.

The study area has a number of saiga conservation initiatives underway. In 1990 the Chernye Zemli Biosphere Reserve (CZBR) was established in the Autonomous Republic of Kalmykia, followed by the Stepnoi Reserve in the neighbouring Astrakhan Province in 2000. Both reserves undertake monitoring and protection of the species, with a particular emphasis on traditional *"fences-and-fines"* conservation in and around the Stepnoi Reserve. In 2003 the first major saiga conservation project began in Kalmykia, funded by the UK Darwin Initiative. This was followed, in 2006, by a DEFRA-funded Small Environmental Projects Scheme (SEPS) project to provide cows to two villages in Kalmykia. The aim of this project was to provide alternative livelihoods for the poorest members of society. Finally, the Darwin Initiative project was awarded post-project funding in 2006, specifically concerned with the examining the

effect of conservation interventions on attitudes and in extending public awareness of conservation. The Darwin and SEPS projects were focussed on two villages to the north and west of the CZBR. They also involved a general media campaign in local newspapers and TV that reached the rest of Kalmykia. The villages in neighbouring Astrakhan province, on the eastern side of the two protected areas, are geographically, administratively and ethnically separated from the Kalmykian villages, and were exposed only to the conservation activities of the Stepnoi Reserve. This lack of leakage means the region provides a unique opportunity to compare how different conservation interventions: traditional *"fortress"* conservation; social engagement; and media campaigns, influence behavioural intentions. Due to the geographically small area studied, cultural and demographic influences can be measured and controlled for as much as possible. The effect of blanket socio-political influences, such as the break-up of the Soviet Union in 1991, on attitudes towards saiga conservation in general can also be investigated.

Willingness-to-pay (WTP) towards saiga conservation has been well established as a measure of behavioural intention (Bateman *et al.*, 2002, Mitchell & Carson, 1989). Due to the cultural importance of the saiga antelope to the Kalmyk people, WTP was considered to be an appropriate method since the benefits of conservation accrue to the local people, as well as to the international community. WTP is a less direct form of questioning than asking straightforwardly about behavioural intention and enables the quantification of behavioural intention alongside protest-bidding behaviour, which may provide further understanding of underlying influences on attitudes. In this study the usefulness of WTP is evaluated as a measure of conservation success where the aim of the conservation intervention is to increase awareness and promote positive attitudes towards the conservation target.

It is hypothesised that the three conservation interventions had different effects both on the level of knowledge regarding saiga ecology and population fluctuations and saiga conservation as well as on the attitudes and behavioural intentions of the local population. In turn, knowledge may also be a predictor of behavioural intention in its own right, and therefore may be the mechanism by which interventions influence

behavioural intention. The specific research questions are:

1. Does the type of conservation intervention, taking into account confounding factors, have an effect on ecological knowledge?

2. Is behavioural intention (WTP bids) with regards to saiga conservation dependent on an individual's level of ecological and conservation knowledge?

3. What are the confounding effects of social, political and economic influences on individuals' knowledge and behavioural intention towards saigas and their conservation?

4. Does the type of conservation intervention employed have an effect on an individual's behavioural intention towards saigas and their conservation?

6.2 Methods

6.2.1 Study system

This study was conducted in eight villages in southern Russia. Four villages in the Autonomous Republic of Kalmykia (Utta, Erdnevskiy, Molodozhnye and Adyk) were exposed to a media campaign, through regional and local papers and local TV. Two villages in Kalmykia (Khulkhutta and Tavn-Gashun) were targets for social engagement and also exposed to the media campaign. By contrast, two villages in the Liman region of Astrakhan Province (Bacy and Zenzeli) were exposed only to the Stepnoi Reserve's traditional "fences-and-fines" conservation (Table 6.1). The villages ranged in size from 415 people (Municipal Administration of Tavn Gashun, 2007) to 3112 people (Municipal Administration of Zenzeli, 2007). All villages are located in steppe habitat, within the saiga range. None have running water, but all have electricity, a school to age 14 and mobile phone coverage. All but two (Bacy and Adyk) have medical facilities. Unemployment is generally high and employment is in the livestock sector,

or in unskilled and temporary work. As the largest village, Zenzeli has a greater range of employment opportunities. See Appendix B section B.1 for details on interventions employed and study location.

6.2.2 Field methods and data collection

The study was carried out over two months in September-October 2006. 250 respondents were chosen using systematic transects of each village. This methodology has potential bias issues if the houses are not representative of the village as a whole, however due to time constraints it was the best method to obtain as random a sample as possible. Depending on size, 5-35% of each village was interviewed (Table 6.1). This was the minimum sample size to ensure adequate power in subsequent analyses (Kirk, 1995). Interviewees completed questionnaires using a combination of structured and semi-structured questions to obtain breadth and depth of information (Bernard, 2002). The questions assessed their level of exposure to saigas, knowledge of population trends, knowledge of conservation projects locally and nationally and willingness-to-pay (WTP) for saiga conservation. Willingness-to-pay was used a measure of behavioural intention (Bateman *et al.*, 2002, Mitchell & Carson, 1989). A closed payment ladder, coupled with a voluntary payment scenario, was used to elicit WTP, in order to encourage participants to respond honestly (Bateman *et al.*, 2002, Mitchell & Carson, 1989). The WTP scenario was developed to take into consideration the means of payment, form of action to be undertaken and the organisation that would undertake the work (Fischhoff & Furby, 1988). Possible reasons for zero bids were provided to the respondents. Interviews were conducted in person by Caroline Howe (CH) and Ruslan Medzhidov (RM), together with a trained translator. See Appendix C detailing wording of the WTP question, alongside questions used to obtain the level of respondents' knowledge about saiga population trends and conservation.

Table 6.1: Sampling strategy indicating number of individuals interviewed by village and intervention strategy.

Intervention	Village	Area	Number Interviewed	% of Population
Media campaign	Utta	Kalmykia	30	11
	Molodozhnye	Kalmykia	27	20
	Erdnevskiy	Kalmykia	25	34
	Adyk	Kalmykia	36	10
Social engagement and media campaign	Khulkhutta	Kalmykia	49	5
	Tavn−Gashun	Kalmykia	25	21
Traditional conservation	Bacy	Astrakhan	30	15
	Zenzeli	Astrakhan	30	12

6.2.3 Model selection and data manipulation

People's knowledge about changes in saiga population status (*"population knowledge"*) and their WTP for saiga conservation were used as dependent variables, representing knowledge and behavioural intention respectively. The explanatory variables were intervention, nationality, wealth, village, area, formal education, exposure to saigas, residence time in the village and knowledge about conservation projects in the area (*"conservation knowledge"*). Several of these variables were scored subjectively (Appendix B section B.2). Three factors were spatially confounded: administrative area (i.e. Kalmykia and Astrakhan), village and the conservation intervention. Area did not provide any explanatory power over and above village and intervention, and was therefore not used in the final models. *A priori*, nationality may take into account possible area effects but is not so confounded with intervention. In order to tease apart the effect of intervention from village, linear mixed effects models (LMEs) were used. Intervention was treated as a fixed effect, and village as a random effect. The effects of intervention was always included in the saturated model as it was the primary variable of interest. In those cases where the random effect explained little or no variation, a generalised linear model (GLM) was tested using ANOVA against the LME and accepted as the minimum adequate model (MAM) if there was no significant difference

between the two models.

Error structure was defined by the distribution of the response variable. Explanatory variables were chosen using a tree model (Crawley, 2007). Two-way interactions between explanatory variables that *a priori* could be of interest, were added. Stepwise deletion was carried out based on non-significant p-values (5% and 10% significance), with largest p-values and two-way interactions removed first. Non-significant main effects were removed only if not involved in two-way interactions. After each variable removal, the model was checked with an ANOVA or F-test (where overdispersion occurred), to assess the significance of the subsequent increase in deviance (Crawley, 2007). Fixed effects were analysed using Maximum Likelihood (ML) and random effects using Restricted Maximum Likelihood (REML). Residuals versus fitted values plots were used for informal exploration and the Breusch-Pagan test used to test for heteroscedasticity. R.app GUI 1.19 (R Foundation for Statistical Computing, 2007) was used for all statistical analyses.

6.3 Results

There is a strong positive correlation between "population knowledge" and "conservation knowledge" indicating mutual reinforcement between the two forms of knowledge. Both formal education and length of time resident in village also have a positive relationship with population knowledge (Table 6.2). When asked whether they were willing to pay anything towards saiga conservation, 18% of the respondents gave zero bids. Of these, 98% were true protest bids (Table 6.3). Respondents were able to give more than one reason for not paying and if they mentioned any one of the protest reasons, they were counted as a protest bid. 48% of the protest bids occurred under traditional conservation, accounting for 26% of the total number of respondents exposed to this form of conservation. These values were 41% and 15% respectively for the media campaign and 11% and 10% respectively for social engagement.

Table 6.2: The minimum adequate model (MAM) for "population knowledge". Model is a generalised linear model (GLM) with Gaussian error structure. All variables are ordered factors. (Significance: $^{*} = 0.050 - 0.099$, $^{**} = 0.010 - 0.049$, $^{***} =< 0.010$, $n = 250$).

	95% Confidence Interval			
	Estimate	**Standard Error**	$t-$**value**	$p-$**value**
(intercept)	1.986	0.415	4.783	0.000 ***
Conservation knowledge	0.215	0.071	3.046	0.003 ***
Residence time in village	0.298	0.124	2.398	0.017 **
Formal education	0.229	0.107	2.141	0.033 **

Table 6.3: Respondents' reasons for not being willing-to-pay anything and the corresponding percentage responses. Respondents could answer yes to more than one statement.

Number of respondents	**% of protest bids**	**Statement**	**True protest or true zero?**
39	86	*"Our household cannot afford to pay"*	zero
4	9	*"I need more time/information to answer"*	zero
24	55	*"Not very interested and not a priority"*	zero
41	81	*"Government or international community should pay"*	protest
4	9	*"Don't believe a contribution scheme would work"*	protest

Considering WTP as a binomial variable, where 0=not willing-to-pay anything (true protest bid) and 1=willing to pay something, three variables were retained in the minimum adequate model (MAM); exposure level to saigas, formal education and conservation knowledge (Table 6.4). The random effect of village explained almost none of the variation. This was due to conservation knowledge being strongly influenced by village, as conservation interventions are village-specific. Conservation knowledge therefore, absorbed most of the variation explained by village in the MAM. All three explanatory variables had a positive influence on whether an individual is WTP something or not.

All true protest bids were removed and the model was re-run with WTP as a continuous variable (log-transformed in order to fit an LME with Gaussian errors), in order to determine which factors influenced the magnitude of WTP bids. The MAM contained five explanatory variables: wealth, age, residence time, conservation knowledge, and conservation intervention, with village as a random effect (Table 6.5). The magnitude of WTP increased with increased wealth, conservation knowledge and length of time resident in the village and decreased with increasing age. Those exposed to the media campaign were willing-to-pay the most for saiga conservation, followed by traditional conservation and social engagement (Figure 6.1).

Table 6.4: The minimum adequate model (MAM) for willingness-to-pay (WTP) something or nothing. Model was a generalised linear model (GLM) with a binomial error structure. All variables are ordered factors. (Significance: $^{*} = 0.050 - 0.099$, $^{**} = 0.010 - 0.049$, $^{***} =< 0.010$, $n = 250$).

	95% Confidence Interval			
	Value	**Standard Error**	$t-$**value**	$p-$**value**
(intercept)	-1.372	0.646	-2.132	0.034 ***
Exposure level	0.630	0.271	2.322	0.020 **
Conservation knowledge	0.316	0.138	2.301	0.021 **
Formal education	0.543	0.183	2.976	0.003 ***

Table 6.5: The minimum adequate model (MAM) for magnitude of WTP. The random effect of village explained 12.80% of the variation. Model was a linear mixed effects model (LME) with Gaussian error structure and the dependent variable was log-transformed. All factors except intervention, which is nominal, are ordered factors. 'Value' of nominal factor represents difference in effect on WTP between intervention types, where 'media campaign' = baseline for intervention. Protest votes are excluded. (Significance: $^{*} = 0.050 - 0.099$, $^{**} = 0.010 - 0.049$, $^{***} =< 0.010$, $n = 250$).

	95% Confidence Interval				
	Value	**Standard Error**	**df**	$t-$**value**	$p-$**value**
(intercept)	5.267	0.436	194	12.072	0.000 ***
Conservation knowledge	0.110	0.055	194	2.021	0.045 **
Age	-0.268	0.057	194	-4.672	0.000 ***
Wealth	0.214	0.067	194	3.188	0.002 ***
Residence time	0.279	0.095	194	2.924	0.004 ***
Intervention	-0.283	0.096	6	-2.949	0.026 **
Social engagement	-0.617	0.220	5	-2.802	0.038 **
Traditional conservation	-0.508	0.184	5	-2.753	0.040 **

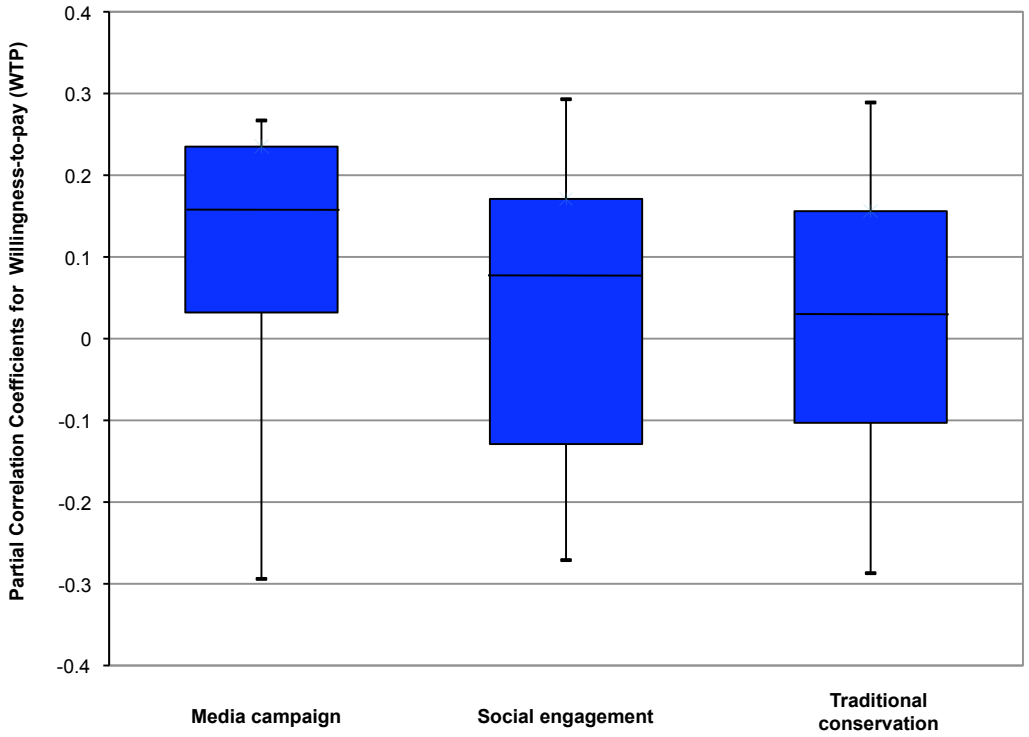

Figure 6.1: Differences in partial correlation coefficients against willingness-to-pay (WTP) under each conservation intervention strategy. Partial correlation coefficients are used to take into consideration all other background factors influencing WTP.

6.4 Discussion

Two indicators of conservation success were used: knowledge regarding saiga population changes over time and willingness-to-pay a voluntary contribution for saiga conservation, as a measure of behavioural intention. It was hypothesised that the type of conservation intervention employed would influence behavioural intention, potentially through an effect on knowledge regarding both saiga population changes and conservation. However, this study showed no direct effect of intervention on "population knowledge", and found instead that such knowledge was explained by background socio-cultural factors. For example, residence time in the village was a key factor. Information regarding population changes was often gained through personal observation or communication with older residents (CH pers. obs.). Consequently, the influence of local knowledge and inter-generational transfer of information should not be overlooked as a means for generating environmental knowledge. Knowledge about conservation interventions accounts for a significant amount of the variation in population knowledge. This is understandable; those who are aware of conservation interventions are more likely to understand the underlying factors driving the need for conservation, and hence have a greater knowledge regarding population changes.

The second link in the chain, an influence of knowledge on behavioural intention, was observed. The number of protest bids made decreased and the magnitude of WTP increased with increased conservation knowledge. It has been shown that direct knowledge of a good reduces the observed disparity between hypothetical and real WTP (Paradiso & Trisorio, 2001). In this case therefore, it can be suggested that conservation knowledge aids individuals to make a more informed WTP bid for conservation. The type of knowledge imparted is also important as it makes individuals differentially sympathetic to arguments used to promote conservation (Caro *et al.*, 2003). Consequently, in this study a knowledge of specific conservation actions rather than population knowledge was more effective at promoting positive behavioural intentions towards saiga conservation.

While intervention did not appear to influence behavioural intentions through an increase in knowledge, it did have a direct influence on WTP. It has been suggested that there are ecocentric, biocentric and altruistic motives for giving and that these should be considered when interpreting WTP (Spash, 2000). Analysis of the reasons for the protest bids indicated many people felt that the government or the international community should pay for conservation. It is possible that this feeling may be a relic from the Soviet period when government both provided for and controlled many aspects of daily life. Social engagement projects, provided by the international community, may sustain this feeling, resulting in people being WTP less for conservation than otherwise expected. Many studies have shown that past conservation actions, as well as historical practices and rights to land, have a long-term influence on attitudes towards conservation and even a high level of awareness may not increase local support for conservation (Ite, 1996, Newmark *et al.*, 1993). Taking account of historical influences is therefore vital when planning a conservation intervention in order not to weaken its potential success.

WTP a non-zero amount and magnitude of WTP were, like population knowledge, influenced by a number of socio-cultural and demographic factors. Understanding the background of the target group of a conservation intervention allows existing sensitivity towards the species or area being conserved to be heightened, increasing receptivity to a campaign, thus hopefully maximising success. For example, those with a high level of exposure to saigas were more likely to make a WTP bid. Consequently, it may be possible to build a media strategy based on reinforcing a visual awareness of saigas in order to increase the number of people with positive behavioural intentions towards saigas and saiga conservation. Wealth was not significant at this juncture, but as expected, did become relevant when assessing the magnitude of a WTP bid.

This study is a snapshot, and the effect of conservation interventions on knowledge and behavioural intention is likely to change over time as the reported intention maybe a function of the information presented to a respondent (Luzar & Cosse, 1998). Likewise, understanding the motivation behind the protest bids and in particular whether they are due to transient effects of the Soviet legacy or some other factor, is necessary in

order to design effective conservation strategies for this region. Most importantly however, determining whether the positive behavioural intentions observed are translated into actual behaviours would allow it to be possible to quantify the direct influence of conservation interventions, and ultimately their true success. It is difficult to link any changes in behaviour directly to conservation interventions, as it was impossible to obtain direct data on poaching behaviour during the timescale of this study, and the saiga population is shared between the 8 villages. Nowak and Korsching 1983, in a study of farmers' attitudes to environmental stewardship, found that although many farmers held positive attitudes, this did not translate into conservation behaviour. The significant effect of demographic factors such as residence time and age suggests that relating behavioural change directly to intervention requires understanding of the social context (Holmes, 2003). A recent study in the region found that poaching behaviour is driven by poverty (Kuhl *et al.*, 2009). This would suggest therefore, that although media campaigns and, to some extent, social engagement, have had a positive influence on attitudes, it is quite possible that no actual behaviour change, in terms of poaching reduction, may have occurred.

This paper establishes WTP as a practical indicator of conservation success, where the intervention concerned is focussed on developing awareness and positive behavioural intentions towards the conservation target. The results of this study illustrate a measurable effect of conservation intervention on behavioural intention, with WTP showing significant variation between strategies. The need for a combination of success measures and an understanding of demographic factors in order to unearth the underlying reasons for observed differences in behavioural intention was also demonstrated. This agrees with Brooks *et al.* 2006a, in their study testing hypotheses for the success of different conservation strategies, in which they emphasise the importance of including multiple measures of success. Quantifying the relative success of conservation interventions is vital to ensure that the most effective conservation strategy is implemented. This is one of the few studies in which the effectiveness of a set of conservation interventions, implemented in one-region with regards to conserving a particular species, has been properly quantified and robustly compared. Such studies

often compare biologically-based interventions using methods from adaptive management (**?**), rather than social interventions such as those considered in this study. The next step is to quantify the cost-effectiveness of interventions (Hughey *et al.*, 2003, Underwood *et al.*, 2009). In this case study, the relatively cheap media campaign had the strongest effect on behavioural intention; however, the attitudes-behaviour linkage remains unquantified.

". . . it is always advisable to perceive clearly our ignorance"

Charles Darwin, The Expressions of the Emotions in Man and Animals, 1872

7

Evaluating the effectiveness of a public awareness campaign as a conservation intervention

7.1 Introduction

Education, both formal and informal, is widely used as a conservation intervention in order to develop positive attitudes, and it is often assumed that effective education will automatically lead to environmentally responsible behaviour (Dobson, 2007). There have been a few studies that attempt to quantify the effect of education on conservation behaviour and on the whole, they agree that the effect is beneficial (Alix-Garcia, 2007, Carr, 2005). One study estimated that between 4% and 21.5% less old-growth forest was cut annually per household for each additional year of formal education that the household head had received (Godoy & Contreas, 2001, Godoy *et al.*, 1998). However, despite conservation education having a high profile within conservation for over 30 years, the number of quantitative studies measuring its effect is limited. Evidence can be found in other fields such as agriculture and energy policy, where it is often easier to quantify the output. For example, in developing countries, studies have shown an improvement in awareness of energy-efficient technologies with increasing environmental education (Kumar *et al.*, 2003) whilst in developed countries analyses have demonstrated a positive correlation between formal education and willingness-to-pay

(WTP) for utility investments in energy efficiency (Zarnikau, 2003).

In general non-formal environmental or conservation education campaigns fall into the category of antecedent interventions, that is interventions that are aimed at influencing underlying behavioural determinants such as knowledge (Abrahamse *et al.*, 2005). A number of studies looking at mass media campaigns have shown that such interventions do result in an increase in knowledge and positive attitudes, for example, a study on the effect of a media campaign run by the Dutch government regarding global warming (Staats *et al.*, 1996). However, Staats *et al.* 1996 suggest that it is difficult to change inherent cognitions and behaviour and that even a heightened awareness of environmental issues may not be instrumental in promoting behavioural change.

Public awareness campaigns may be seen as a marketing of conservation to the wider public. Social marketing campaigns rely on an understanding of the audiences motivations and perceptions so that carefully crafted messages can be communicated (Jacobson *et al.*, 2006). Such strategies often also rely on the provision of supplementary resources to allow changes to take place, such as waste recycling bins (Linden & Carlsson-Kanyama, 2003). The effectiveness of these campaigns can be seen in the UK with the dramatic increase of organic and fairtrade food now available in the supermarkets. At an international level the growth of WWF, who now run global campaigns on climate change and sustainability, is a prime example of what such campaigns can achieve (WWF, n.d.).

The North-West Pre-Caspian region of the Russian Federation is one of the poorest regions of Russia. The dissolution of the USSR in 1991 resulted in high levels of unemployment in the area (Grin, 2000). The consequent poverty and collapse in hunting controls are thought to be driving the illegal hunting of the saiga antelope, *Saiga tatarica* (Kuhl *et al.*, 2009). The saiga is a nomadic ungulate of the Central Eurasian rangelands hunted both for its horn which used in traditional Chinese medicines and for meat for local consumption (Milner-Gulland *et al.*, 2001). Post-Soviet over-hunting led to a dramatic population reduction from over a million to less than 50,000 individuals (Milner-Gulland *et al.*, 2001) and in 2002 the species was officially classified in

the IUCN Red List as Critically Endangered (www.redlist.org).

The study area has a number of saiga conservation initiatives underway. In 1990 the Chernye Zemli Biosphere Reserve (CZBR) was established in the Autonomous Republic of Kalmykia, followed by the Stepnoi Reserve in the neighbouring Astrakhan Province in 2000. Both reserves undertake monitoring and protection of the species, with a particular emphasis on traditional "fences-and fines" conservation in and around the Stepnoi Reserve. In 2003 the first major saiga conservation project began in Kalmykia, funded by the UK Darwin Initiative. This was followed in 2006, by a DEFRA-funded Small Environmental Projects Scheme (SEPS) project to provide cows to two villages in Kalmykia. The aim of this project was to provide alternative livelihoods for the poorest members of society.

Finally, the Darwin Initiative project was awarded post-project funding in 2006, specifically concerned with examining the effect of conservation interventions on attitudes and in extending public awareness of conservation. The Darwin and SEPS projects were focussed on two villages to the north and west of the CZBR. They also involved a general media campaign in local newspapers and TV that reached the rest of Kalmykia. The villages in neighbouring Astrakhan province, on the eastern side of the two protected areas, are geographically, administratively and ethnically separated from the Kalmykian villages, and were exposed only to the conservation activities of the Stepnoi Reserve. This lack of leakage means the region provides a unique opportunity to test the hypothesis that such media campaigns are an effective tool for producing positive, long-term attitudinal changes and behavioural intentions towards conservation.

This study analyses the effectiveness of public awareness campaigns carried out in this region over the period 2003-2007. The aim was to understand how such interventions work in practice and to provide useful guidelines for the effective use of public awareness campaigns for environmental conservation in the future. The specific research questions addressed were:

1. What is the public perception of saigas and saiga conservation in Kalmykia and

Astrakhan?

2. Has the media campaign been noticed by the population of the target villages? What media formats and subject matters has the campaign utilised?

3. What elements, such as subject matter and media format, of a public awareness campaign are most effective at gaining public interest and changing attitudes positively? And how do these elements interact with socio-cultural and demographic differences within the population?

7.2 Methods

Methods are as described in Chapter 6 Section 6.2, with the addition of:

7.2.1 Model selection and data manipulation

People's knowledge about saiga conservation projects in the area (*"conservation knowledge"*) and whether they remembered receiving public awareness materials were used as dependent variables to explore how knowledge was acquired and retained. Their change in opinion towards saigas and saiga conservation over the last three years (*"opinion change over time"*) and their WTP for saiga conservation were used to represent attitudes and behavioural intention respectively. Those who had not been resident in the village for more than two years were excluded in order to determine the established general feeling towards saigas and saiga conservation. The explanatory variables were intervention (media campaign, social engagement, and traditional conservation), nationality, wealth, village, geographical area (Kalmykia or Astrakhan), level of formal education, exposure to saigas, residence time in the village and knowledge about saiga population status (*"population knowledge"*). Those who remembered receiving public awareness materials were also asked open ended questions on: when they remembered receiving the materials (*"date"*), what media format (*"media"*) they came

in (e.g. newspaper or television), subject matter (*"subject"*), for example ecology or conservation, and whether the materials had had an *"immediate effect"* (did the respondent recall undergoing a change in awareness upon receiving the materials). Several of these variables were scored subjectively (see Appendix B Section B.2). Three factors were spatially confounded: administrative area (i.e. Kalmykia and Astrakhan), village and the conservation intervention. Area did not provide any explanatory power over and above village and intervention, and was therefore not used in the final models. *A priori*, nationality may take into account possible area effects but is not so confounded with intervention. In order to tease apart the effect of conservation intervention and village, linear mixed effects models (LMEs) were used. Intervention and village were treated as random effects. Due to the interest in the recalled effects of public awareness materials, whether people remembered receiving materials, or aspects of this variable such as date or subject, were always included in the saturated model. In those cases where the random effect explained little or no variation, a generalised linear model (GLM) was tested, using ANOVA, against the LME and accepted as the minimum adequate model (MAM) if there was no significant difference between the two models.

Error structure was defined by the distribution of the response variable. Explanatory variables were chosen using a tree model (Crawley, 2007). Two-way interactions between explanatory variables, which *a priori* could be of interest, were added. Stepwise deletion was carried out based on non-significant p-values (5% and 10% significance), with largest p-values and two-way interactions removed first. Non-significant main effects were removed only if not involved in two-way interactions. After each variable removal, the model was checked with an ANOVA or F-test (where overdispersion occurred), to assess the significance of the subsequent increase in deviance (Crawley, 2007). Fixed effects were analysed using Maximum Likelihood (ML) and random effects using Restricted Maximum Likelihood (REML). Residuals versus fitted values plots were used for informal exploration and the Breusch-Pagan test used to test for heteroscedasticity. R.app GUI 1.19 (R Foundation for Statistical Computing, 2007) was used for all statistical analyses.

7.3 Results

7.3.1 Public attitudes towards saigas and saiga conservation

Respondents were asked to reply to three statements regarding saigas and saiga protection. Two thirds of respondents agreed that they had more important things than saigas to think about, although they were more likely to simply agree rather than strongly agreeing with this statement. However, 89% said they would mind if saigas were lost from Russia and 94% strongly agreed that saigas should be protected now, for future generations. This suggests a generally positive opinion towards saiga and their protection, although, understandably tempered by more important, everyday requirements (Table 7.1).

Interviewees were asked about their general feeling towards saigas and saiga conservation and how it had changed over the last three years (*"opinion change over time"*). 42% had always had a positive opinion and had retained this over time. 47% had changed from being either negative or indifferent towards saiga to positive, whilst only 12% remained indifferent or negative over the same period of time.

When asked to make a willingness-to-pay (WTP) bid based on a voluntary payment ladder, only 18% of respondents bid a zero value. Of those who made a bid, WTP averaged between 141 roubles and 630 roubles ($5.26 and $23.52 at 2006 rates), depending

Table 7.1: Interviewees responses to a series of statements regarding saiga and saiga conservation.

Statement	Strongly Agree	Agree	Disagree	Strongly Disagree	Don't Know
"I have more important things to think about than the future of the saiga antelope"	2	57	32	0	8
"If the saiga were lost from Russia I would not mind"	0	5	62	25	7
"Saiga should be protected for future generations even if that means making sacrifices now"	72	22	0	3	3

on wealth.

7.3.2 Who is receiving public awareness materials?

Individuals were asked to state whether they recalled receiving public awareness materials or not, and 76% of those interviewed remembered receiving some form of public awareness. Of those exposed to the media campaign, 83% had received some form of media material. This figure was 93% and 53% for those exposed to the media campaign/social engagement projects and traditional conservation respectively.

The minimum adequate model (MAM) for whether people remembered receiving public awareness materials or not was fitted using an LMER with binomial errors. As expected, a key explanatory variable was intervention. Exposure level to saiga antelopes also explained a large proportion of the variation (Table 7.2).

Those exposed to social engagement were more likely to remember receiving public awareness materials, followed closely by those receiving the media campaign. In the case of exposure to saiga, the probability of remembering receiving public awareness increased with increasing exposure. In fact, 98% of those with the highest exposure remembered receiving public awareness materials compared to 65% of those with the lowest exposure.

In order to ascertain whether information from public awareness materials was retained, individuals were asked about what they knew regarding saiga conservation projects, and were marked as either having some knowledge or having no knowledge. An LMER model with binomial errors was developed. The MAM is given in Table 7.3 and, as expected, both intervention and remembering having received public awareness were significant explanatory variables, alongside knowledge about the saiga population. The random effect of village explained 67.95% of the variation in this model suggesting that knowledge of conservation was strongly dependent on village. This is understandable as the geographical location of conservation in the region

Table 7.2: The minimum adequate model (MAM) for "remembering having received public awareness materials", showing intervention and exposure level to saiga as significant variables explaining the variation. Exposure is an ordered factor and intervention is nominal. "Estimate" of nominal factor represents difference in effect on "remembering having received public awareness materials" between intervention types, where media campaign = baseline for intervention. (GLM = generalised linear model with nlme package of R; significance: $^{*} = 0.050 - 0.099$, $^{**} = 0.010 - 0.049$, $^{***} =< 0.010$, $n = 250$).

	95% Confidence Interval			
	Estimate	**Standard Error**	$z-$**value**	$p-$**value**
(intercept)	0.737	0.603	1.223	0.221
Intervention	-0.522	0.180	-2.910	0.004 ***
Social engagement	0.563	0.594	0.949	0.343
Traditional conservation	-1.047	0.347	-3.016	0.003 ***
Exposure	0.911	0.251	3.630	0.000 ***

means that several projects are situated closer to some villages than others. In the case of intervention, those exposed to the media campaign were more likely to know about conservation if they had a high level of knowledge about population status. Under traditional conservation, conservation knowledge remained constant regardless of the level of population knowledge. In the case of social engagement, all those exposed to it knew something about conservation and therefore population knowledge was not a significant covariate (Figure 7.1).

The results indicate that those exposed to either, media campaign or social engagement, had received public awareness materials. This is the predicted and hoped-for result. However, reinforcement does appear to have occurred with those with high levels of exposure and population knowledge being more likely to have remembered receiving public awareness materials. Likewise, although those exposed to social engagement were not specifically targeted with a media campaign, they reported receiving more information materials than those exposed to either of the other conservation interven-

Table 7.3: The minimum adequate model (MAM) for whether a respondent has some or no knowledge of conservation projects. Significant explanatory variables are knowledge of saiga population status ("population knowledge") and remembering having received public awareness, alongside an interaction between population knowledge and conservation intervention. Village was fitted as a random effect, explaining 67.96% of variation. Model fit by LMER with binomial errors. (LMER = linear mixed effects model with lme4 package of R; significance: $^{*} = 0.050 - 0.099$, $^{**} = 0.010 - 0.049$, $^{***} =< 0.010$, $n = 250$).

	95% Confidence Interval			
	Estimate	**Standard Error**	$z-$**value**	$p-$**value**
(intercept)	-1.938	1.523	-1.272	0.203
Population knowledge	0.798	0.284	2.812	0.005 ***
Public awareness recalled being received	0.940	0.367	2.561	0.010 **
Intervention	0.845	0.691	1.223	0.221
Population knowledge:Intervention	-0.238	0.111	-2.138	0.033 **

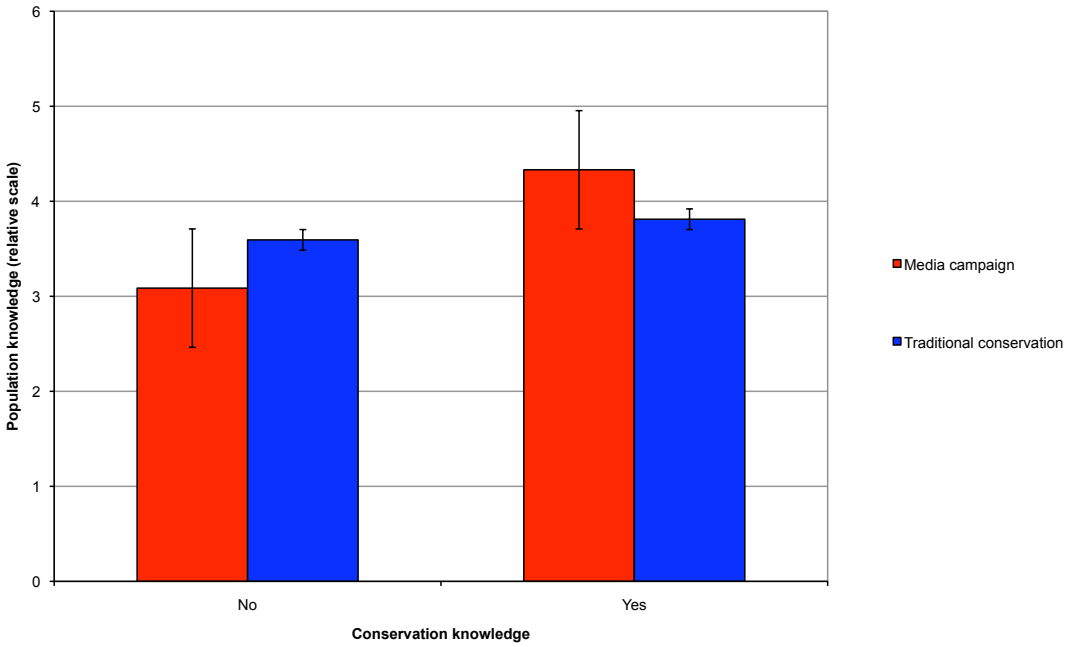

Figure 7.1: Relationship between knowledge of population status (*"population knowledge"*) and knowledge of conservation interventions (*"conservation knowledge"*) under different conservation interventions.

tions. These results suggest that a prior awareness of saigas or saiga-related conservation heightened awareness and increased the likelihood that an individual read, saw or responded to the public awareness campaign.

7.3.3 What type of information is received?

Those who received public awareness materials were asked using open questions to state when they had received them, what media form the information had taken and the subject matter of the information (Table 7.4).

The results indicate that those who had not been targeted by a specific campaign, i.e. those exposed to traditional conservation, tended to have received their information earlier than 2006 and normally via the medium of television. In most cases, most of the information was about the ecology and life-history of the saiga and not about its current threatened status or conservation. Those exposed to the media campaign received an even coverage in both the newspapers and the television. However, interestingly, those exposed to the social engagement (rotating cows) project received their information most recently, despite interventions starting in 2003. Also, those exposed to the media campaign alone did not generally recall receiving their information during the height of this campaign, August October 2006, but earlier.

The results also indicate that women tended to read less about conservation than men ($\chi^2 = 8.986, p = 0.029, df = 3$). Ethnic Russians and other nationalities (i.e. not Kalmyks) tended to receive their information via television and learnt more about ecology, than other subjects ($\chi^2 = 9.856, p = 0.043, df = 4; \chi^2 = 17.535, p = 0.008, df = 6$, respectively). However, 73% of ethnic Russians interviewed lived in villages exposed to traditional conservation, and therefore were *a priori* more likely to have received their information through the medium of television and on the subject of ecology.

Table 7.4: Chi-squared tests of conservation intervention against media, subject and recalled date of receiving public awareness. For each intervention the most common outcomes are shown with a tick. $n = 91$.

	Media campaign	**Social engagement and media campaign**	**Traditional conservation**
Media: $\chi^2 = 31.642; p = 2.26e-06, df = 4$			
Newspaper	✓	✓	
Television	✓		✓
Subject: $\chi^2 = 45.190; p = 4.29e-08, df = 6$			
Ecology	✓	✓	✓
Conservation	✓	✓	
Poaching	✓	✓	
Date: $\chi^2 = 42.844; p = 1.12e-08, df = 4$			
Aug−Oct 2006		✓	
Jan−July 2006	✓		
2005 and earlier			✓

7.3.4 How does public awareness work?

Those who recalled receiving public awareness materials were asked if they felt that the information had contributed to influencing their opinion towards saigas and saiga conservation in a positive way. It was found that the *"immediate effect"* of information (whether respondents recalled undergoing a change in awareness on receiving the information) was influenced by the sex of the individual and the medium of the information ($\chi^2 = 4.066, p = 0.044, df = 1; \chi^2 = 5.914, p = 0.049, df = 2$, respectively). Television was a more effective medium than reading materials and men were more responsive to this medium than women. Hence, there is a general trend that men responded more to public awareness materials than women. Although not significant, there was a slight effect of subject matter on the direct effect of information, with ecology and conservation materials producing a more positive response than information about poaching.

In order to determine whether the public awareness campaign had had a more sustained effect (over a period of at least three years), willingness-to-pay (WTP), as a measure of behavioural intention, and *"opinion change"* (over the last three years), were modelled against whether people remembered receiving public awareness materials. The model was then re-run with only those who had remembered receiving information in order to investigate the influence of subject matter, date of receiving public awareness materials, and medium on opinion change and WTP.

Opinion change over time was coded as +1 for those who had changed from a negative or indifferent position to a positive one and as 0 for those who had remained indifferent. Those remaining positive throughout were excluded. A GLM with binomial errors was used, as the random effects were not significant (Table 7.5). For WTP a LME with Gaussian errors was used, using logged WTP. The random effect variables, intervention and village, explained 5.03% and 2.76% of the variation respectively (Table 7.6).

A change in opinion change over the last three years was highly influenced by remembering having received public awareness materials, with those receiving information

Table 7.5: The minimum adequate model (MAM) for opinion change over the last three years. Model fit by GLM with binomial errors. Positive conservation knowledge and exposure are ordered factors; remembering receiving information and *"immediate effect"* of information received (if respondents recall undergoing a change in awareness on receiving the information) are binomial factors. (GLM = generalised linear model; significance: $^{*} = 0.050 - 0.099$, $^{**} = 0.010 - 0.049$, $^{***} =< 0.010$).

	95% Confidence Interval			
	Estimate	**Standard Error**	$z-$**value**	$p-$**value**
(a) GLM for positive opinion change with remembering receiving information as explanatory variable ($n = 133$)				
(intercept)	-0.210	0.391	-0.539	0.590
Conservation knowledge	0.568	0.196	2.893	0.004 ***
Information remembered being received	1.043	0.470	2.219	0.026 **
(b) Model for opinion change for those who remembered having received information ($n = 97$)				
(intercept)	-0.882	0.796	-1.109	0.274
Exposure level	1.130	0.450	2.512	0.012 **
Recalled *"Immediate effect"* of information received	1.766	0.712	2.481	0.013 **

Table 7.6: The minimum adequate model (MAM) for willingness-to-pay (WTP). Model fit by LME with Gaussian errors. Wealth is continuous; length of time resident in the village (residencetime), age, conservation knowledge and date information received are ordered factors; information remembered being received is binomial. Random effects of intervention and village explained 5.03% and 2.76% of the variation respectively. (LME = linear mixed effects model; significance: $^{*} = 0.050 - 0.099$, $^{**} = 0.010 - 0.049$, $^{***} =< 0.010$).

	95% Confidence Interval			
	Estimate	**Standard Error**	$z-$**value**	$p-$**value**
(a) Model for WTP with remembering receiving information as an explanatory variable ($n = 206$)				
(intercept)	3.917	0.478	8.199	0.000 ***
Wealth	0.238	0.066	3.584	0.000 ***
Age	−0.232	0.058	−3.984	0.000 ***
Residence time	0.290	0.095	3.044	0.003 ***
Information remembered being received	0.786	0.286	2.744	0.007 ***
Conservation knowledge : Information remembered being received	−0.358	0.153	−2.338	0.020 **
(b) Model for WTP for those who remembered receiving information ($n = 163$)				
(intercept)	5.777	0.714	8.089	0.000 ***
Wealth	0.249	0.070	3.573	0.001 ***
Age	−0.927	0.175	−3.592	0.000 ***
Residence time	0.252	0.100	2.516	0.013 **
Recalled date information received	−0.439	0.292	−1.508	0.134
Age : Recalled date information received	0.186	0.079	2.367	0.019 **

being much more likely to become positive about saigas and saiga conservation. Opinion change was more likely if an individual recalled receiving a piece of information and if it had an *"immediate effect"* when it was received. Once again the occurrence of reinforcement is observed, with opinion change also being strongly influenced by an individuals exposure level to saigas.

In the case of WTP, both wealth and length of time the respondent had been living in the village (residence time) had a positive linear effect on WTP, when controlling for village and intervention, whilst age had a negative influence. Higher levels of conservation knowledge strongly increased WTP when no public awareness materials had been received, while remembering having received information led to consistent levels of WTP (Figure 7.2).

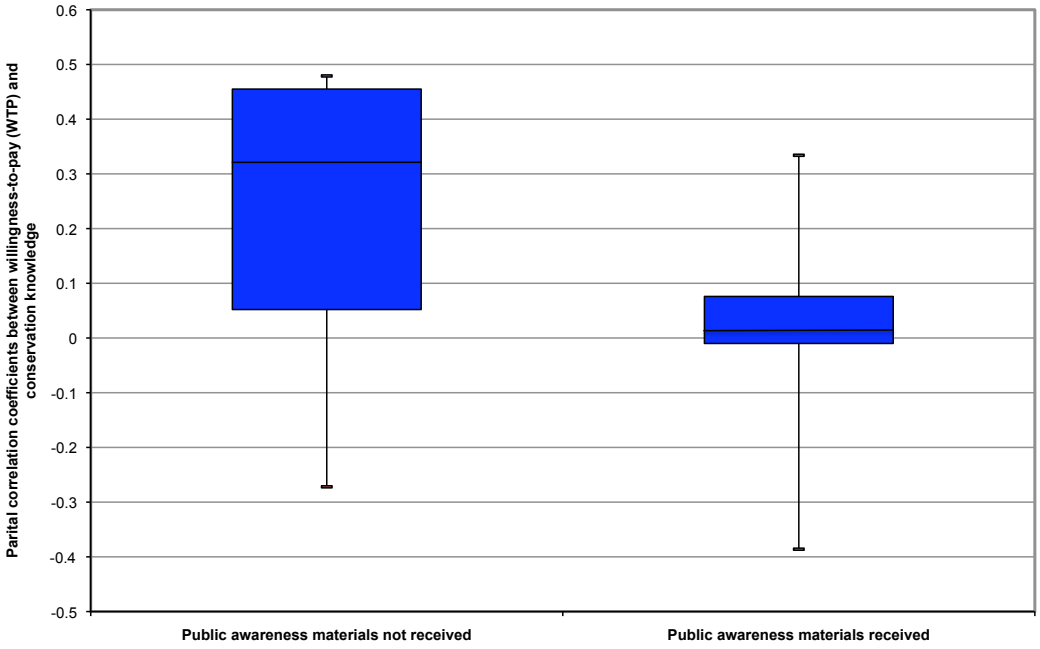

Figure 7.2: Interaction between knowledge of conservation interventions (*"conservation knowledge"*), information remembered being received and willingness-to-pay (WTP). Partial correlation coefficients are used to take into consideration all other background factors influencing WTP.

When respondents recalled receiving information, WTP was dependent on an interaction between the date the materials were received and age. For information received between January and October 2006, WTP was greatest for those between the ages of 26

and 46. However, if the materials were received in 2005 or earlier, WTP was greatest for those aged between 18-25 and declined with age (Figure 7.3).

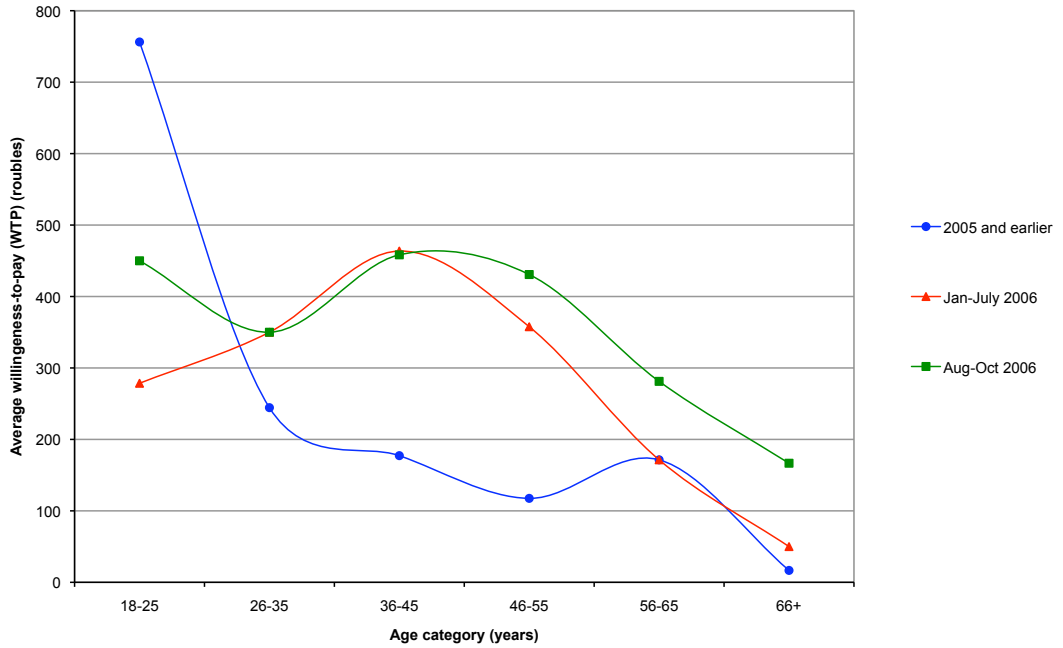

Figure 7.3: Interaction between age and recalled date of receiving public awareness materials on willingness-to-pay (WTP).

7.4 Discussion

The results of this study indicate that the population of the North-west Pre-Caspian is in general, very positive about saigas and saiga conservation. There is a long history existing between the saiga antelope and the Kalmyk people and throughout the field-work period saigas were said to be: *"a symbol of the steppe"*, *"a beautiful animal"* and *"godly creatures"* and that killing one is punishable by God, as decreed by their ancestors. Consequently, this attitude provided a positive background for the media campaign, with people already predisposed to be interested in, and respond to, the material provided.

Analysis of the pubic awareness campaign illustrates that, in this region, public media such as newspapers and television are readily available to most of the population

and are also interested in publishing stories about conservation issues. Subject matter was evenly spread across ecology, conservation and poaching and the media campaign utilised both written and visual media, illustrating that it had been a broad and evenly-based campaign. This highlights the importance of using established information delivery systems in order to provide an effective media campaign.

Studies have shown that as much as 50% of the variation in people's attitudes towards conservation can be explained by having received conservation education (Kideghesho *et al.*, 2007). This finding is corroborated by the results of this study which show that remembering having received public awareness materials is a significant variable explaining variation in opinion changes over the last three years and behavioural intention (WTP). This suggests that public awareness campaigns can have a positive influence on attitudes towards conservation.

Although it has been suggested that attitudes can be a useful surrogate for behaviour, in those situations where assessing behaviour is difficult (Infield & Namara, 2001), most studies are non-committal about the link between the conservation programme being analysed, resulting attitudes and any reported behavioural changes (Abbot *et al.*, 2001, Adams & Infield, 2001). WTP was highly influenced by an interaction between the recalled date of receiving public awareness materials and age of respondent. Many studies have found a negative influence of age on attitudes towards and participation in, environmental conservation (Roskaft *et al.*, 2007, Winter *et al.*, 2007). However, one study on energy conservation patterns in Greece found that energy-conserving actions were not simply related to age, but also interacted with environmental feedback and consciousness of energy problems (Sardianou, 2007). Consequently, although attitudinal studies are useful for determining relative success of a conservation intervention, it is not advisable in this case, to relate this to observed or predicted behavioural change (Holmes, 2003). Particularly, as in this region poachers are young men (A. Kuhl, pers. comm.).

A key finding of this study is the importance of the influence of reinforcement. In theories on how brain-based learning takes place, it is believed that the more frequently

a memory is activated, the more quickly it can be recalled (Jacobson *et al.*, 2006). The results of this study suggest that there is mutual reinforcement between an individual's knowledge of saiga conservation and their level of ecological knowledge about saigas. They also show that an individual was more likely to remember receiving awareness materials if they had a high level of exposure to saigas or if they were exposed to another related conservation strategy such as the social engagement project. For those individuals who had not received any information in the media, behavioural intention (WTP) changed as a function of conservation knowledge. This implies that direct exposure to saigas, different forms of knowledge and having more than one type of conservation intervention serve to reinforce one another, making a change in opinion or behavioural intention more likely to occur. Research on health campaigns has revealed that success is often dependent on whether an issue has been a previous or current concern of the target audience, and in the case of tobacco, whether they have smoked or not (Glascoe *et al.*, 1998, Pinkleton *et al.*, 2007). Consequently, it may be possible to heighten awareness in a population in order to use reinforcement to effect positive changes in behavioural intention.

This case study provides a detailed and quantitative analysis of a campaign, aimed at raising awareness of both the ecology and conservation of the saiga antelope. The results indicate that such strategies are effective and can lead to declared positive attitudinal changes and behavioural intention. However, when planning an educational strategy, it is important to understand the demographics and socio-cultural aspects of the focal audience in order to target the programme most effectively. Taking advantage of factors that may already have, or may be able to, raise the receptiveness of the target group is also an effective approach, for example in this case an individual's exposure level to saigas. There are few studies investigating the use of different approaches to public awareness on different target groups in relation to conservation, however much can be learnt from research done in the fields of medicine, communication and advertising (Glascoe *et al.*, 1998, Pinkleton *et al.*, 2007).

Overall, this study supports the call for effective evaluation of conservation interventions (Salafsky *et al.*, 2002, Sutherland *et al.*, 2004). This is case-specific example, but

it demonstrates how adaptive management could be applied to increase the effectiveness of the media campaign in this region, to take full advantage of the socio-economic and experiential factors that make people more or less responsive to a particular public awareness programme. Evaluating the outcomes of a project is a key requirement of the Darwin Initiative and therefore it is recommended that more projects should undertake this kind of study. Without effective evaluation at both the case study and global levels, conservation will continue to fail to achieve maximum return-on-investment (Brooks *et al.*, 2006a, Joseph *et al.*, 2009, Underwood *et al.*, 2009).

"It is not the strongest of the species that survives, nor the most intelligent that survives. It is the one that is most adaptable to change"

Charles Darwin, The Origin of Species, 1859

8

Discussion and Conclusions

8.1 Discussion

8.1.1 Conservation education

Communication, Education and Public Awareness (CEPA) is recognised as an essential part of achieving the objectives of the Convention on Biological Diversity (CBD, 1992), and consequently its use is strongly emphasised in Darwin Initiative (DI) projects (ECTF *et al.*, 2007a). This is one of the few studies that attempts to quantify the effect of conservation education on conservation success. It demonstrates that education has an effect both at the individual level, by having a positive influence on behavioural intention and at the project level, on overall project success. It is possible that these two findings are linked and the reason for the positive effect of education on overall project success maybe due to a change in behavioural intention at the individual level. However, as relating behavioural changes to a particular intervention requires understanding of the social context, this assumption cannot be made without further testing (Holmes 2003). This finding of a positive influence agrees with other studies exploring the effect of education on conservation, agricultural productivity and renewable energy uptake (Asadullah & Rahman, 2009, Dias *et al.*, 2004, Godoy & Contreas, 2001).

This is also one of the first studies to carry out a return-on-investment (ROI) analysis of conservation education. Studies that use ROI have shown it to be an important tool because without consideration of costs, it is hard to make wise investment choices or to undertake effective evaluation for adaptive management (Joseph *et al.*, 2009, Murdoch *et al.*, 2007, Underwood *et al.*, 2009, 2008). The results of this study indicate that education may be a cost-effective intervention, when education is the primary aim of a project or one the primary conservation actions being carried out. However, without quantifying the relative value of different interventions it is not possible to confirm this. The results also indicate that ROI from education is strongly dependent on the relative costs of education within the host country, and that greater spending on education in wealthier countries provides less conservation benefit per dollar spent These findings may provide an explanation for the findings by a number of studies that have shown education to have a non-linear effect on conservation success (Godoy *et al.*, 1998, Van, 2003).

At the case-study level, once again this is one of the few studies to compare an educational intervention (public-awareness) with alternative interventions, such as traditional protected areas or alternative livelihoods. Evaluation of the success of different conservation interventions is still in its infancy and although there have been a few recent attempts using both socio-economic and biological indicators (Brooks *et al.*, 2006a), most studies often compare biological indictors alone (Innes *et al.*, 1999, Salafsky & Margoluis, 1998). The results of this study show public awareness-raising to compare favourably with other interventions and to be an effective measure for changing behavioural intentions.

Educational achievement is not simply measured in terms of quantity, and type of education is also important. Most studies that have explored the effectiveness of education in conservation, agriculture or energy have only considered formal education, with non-formal education considered to be an addition or supplement (Weladji *et al.*, 2003). However, informal education is thought to be a very important tool for conservation (UNESCO, 1992) and also highly effective (Parra-Lopez *et al.*, 2007). My meta-analysis demonstrated that formal education alone is not the most effective form

of education, whilst the case study clearly highlighted the benefits of applying a relatively cheap informal environmental awareness-raising programme. Therefore, when planning an education campaign, the best type of programme should consider both educational type as well as quantity of education.

The ultimate aim of education, and therefore the fundamental definition of the success of an educational campaign, is whether positive behavioural intentions observed are translated into actual behaviour (Nowak & Korsching, 1983). The attitude-behaviour framework, established by Fishbein and Azjen 1975 predicts how human behaviour is governed. The results of the case-study in Russia provide evidence of a link between conservation intervention and behavioural intention. However, a recent study in the region showed that poaching behaviour is primarily driven by poverty (Kuhl *et al.*, 2009) and therefore it is possible that no actual behavioural change may have occurred in the region. Providing evidence that education does have a direct effect on environmental behaviours and therefore on conservation success, requires controlling not only for demographic factors (Holmes, 2003), but also the belief systems of those being studied (Bateman & Willis, 2001, Foxall, 1984).

There were a number of compromises that had to be made when carrying out this study, and ultimately they will influence the outcome of the results. Both the meta-analysis and the case-study are based on data collected at a single time-point for a given project. The effect of education is likely to change over time; the reported intention or observed behavioural changes are likely to be a function of both experience and the cumulative effect of the information provided (Foxall, 1984, Luzar & Cosse, 1998). Likewise, demographic and socio-economic factors have a very strong influence on behavioural intention or ultimate conservation or educational success (Holmes, 2003). These may include local knowledge or inter-generational transfer of knowledge. Due to the difficulties of controlling for every possible factor, as well as time limits involved in data collection, it was not possible to control for all of these. Consequently, the assumption was made, in both the meta-analysis and case study, that no other forms of education were provided, and that the measured quantity and type of education were the sole inputs.

There are a number of future studies that would add greatly to this research and that would provide more in-depth insights into the quantitative effect of education on conservation success and the cost-effective implementation of education as a tool for conservation. At the local, small-scale level, a study such as the one carried out on the public-awareness campaign, but for different educational types, would provide project-level guidance for implementation. Likewise, an analysis of the ROI for education at the project level would provide more robust results, as the inputs could be varied and measured more easily than at the meta-analysis level. At the larger scale, more research is needed on the ROI from different types of education, as well as a cross-comparison of education compared with other interventions. Finally, in order to start to gather information on whether education has a long-term effect on conservation, i.e. a demonstrated behavioural change over time, long-term studies are required. Most conservation projects do not gather baseline data on attitudes and behaviour, and do not also return to gather data at specific times after a project has finished. This type of study would provide very beneficial results as to the fundamental influence of education on conservation.

8.1.2 Conservation success

Evaluations of the success of different conservation strategies are still in their infancy (Brooks *et al.*, 2006a). This study has shown that it is possible to develop consistent indicators of success at both the project level and global (meta-analysis) level that consider socio-economic, as well as biological aspects. The study also provides support for indicators previously developed such as the Threat-Reduction Assessment (Salafsky & Margoluis, 1999) and the measures of success of projects run by zoos (Mace *et al.*, 2007). As resources available for conservation will continue to be limited, the need to carry out comparative evaluations of conservation success is paramount (Salafsky *et al.*, 2002).

Unfortunately, given these funding limitations, this study highlights the importance of funding and economic wealth as fundamental predictors of conservation success. At

the global level, funding is positively correlated with conservation success, although return-on-investment in conservation interventions, in this case education, do not vary linearly with the amount of money spent. The Human Development Index of the host country is also important, and has a strong effect on both the overall effect of education and the ROI from education. At the local level, I find that individual household wealth is a significant predictor of the indicator of behavioural intention, willingness-to-pay (WTP). Although it is to be expected that WTP will be correlated with wealth, the fact that this measure of behavioural intention is affected by socio-economic status highlights the importance of including the local population in conservation planning in order to obtain their support for any conservation interventions implemented (Brandon, 1997, Fiallo & Jacobsen, 1995). The fact that both funding and wealth are important further supports the need to include costs when planning or evaluating conservation measures (Naidoo *et al.*, 2006).

The results of this study illustrate that reinforcement measures can be used to improve the success of a conservation project. I found that a high level of knowledge about the conservation of saigas led to a more informed WTP bid, whilst the level of exposure to saigas had a positive effect on whether people remembered undergoing a positive change in opinion on receiving public awareness materials or not. At the meta-analysis level, ROI from education were much higher when a project focused on flagship species, probably because such species already have high public exposure. These are all examples of positive reinforcement, however the study in Russia demonstrated that past conservation actions have the potential to have a long-term, and sometimes negative, influence on attitudes towards conservation and that, in these cases, even a high level of awareness may not increase support for conservation (Ite, 1996, Newmark *et al.*, 1993). Consequently, preliminary studies carried out before establishing a conservation programme, may provide key socio-economic or life-history details of the local population that can be used to either reinforce the impact of conservation or alert one to possible pitfalls, and hence increase the likelihood of success.

Most importantly however, in terms of a discussion on success, I found that there are fundamental differences between conservationists and non-conservationist and within

conservationists, as to what constitutes *"success"*. A recent study attempted to define what constitutes success in Pacific Island community conservation areas and found a huge difference in opinion between those who considered the broader picture of success, such as sustainability of conservation areas, and those who were more focused on the practical workings and needs of the areas (Axford *et al.*, 2008). This difference in opinion is important as it may either cause difficulties for environmentalists seeking to gain funding from external bodies or when defining whether a project has been successful or not. Measuring conservation success is necessary but needs to be approached with caution.

As with the discussion on education, this study has made a number of assumptions when attempting to define and measure success. Once again, the data are a snap shot and therefore do not consider long-term impacts of conservation. During the development and testing of the indicators of success, due to the time it required to complete the exercises, it was not possible to test the measures on a larger group of people which would have strengthened the conclusions. The type of methodology that was used; an independent evaluation of self-reports, coupled with a case-study evaluation, meant that the positives of both methodologies could be combined. It was possible to study a huge variation in project type using the meta-analysis, and by using independent evaluations as opposed to simply relying on the final reports, potential bias from human reporting could be counteracted. However, there was still an issue of relying on reported data, in which quantitative monitoring had not always been carried out. The case-study allowed for the comparison of three different conservation interventions, however due to lack of resources both in terms of time and money, it was only possible to carry out a socio-economic study of success and not a biological study too. There were also logistical difficulties, for example it was hard to get to the truth about actual poaching behaviour, as such studies require the investigator to spend long periods with the local community to obtain their trust. Even then, it may be impossible to unearth the truth.

As future work, it would be useful to continue to develop the Ranked Outcomes indicator of success, as it attempts to consider all aspects of success simultaneously. At a

local level, it would be useful to explore the element of reinforcement in greater detail, in order to obtain an understanding as to the level to which it influences conservation success. The study in Russia could be expanded to compare the results of ecological data collection on the saiga antelope and condition of the Steppe with data on changes in behavioural intention over a longer time period, to obtain a more fundamental comparison of the success of the alternative interventions. Finally, the Darwin Initiative database contains a wealth of information. Due to the difficulties in obtaining the data and creating the database it was not possible to compare more than 100 projects. However, now this database is in place, it would be worthwhile to expand on this research with a greater number of projects, in order to draw stronger conclusions.

8.2 Conclusions

This thesis demonstrates that it is possible to develop useful, practical indicators of conservation success that can be used to guide conservation implementation to ensure that it is both effective and successful. However, it is necessary to understand how an indicator has been developed and the background of those carrying out the evaluation, as the choice of a particular measure and the interpretation of the meaning of "success" by the evaluator can have a very strong effect on the conclusions drawn. As different indicators highlight different factors contributing to success, it is not possible to produce a single measure of success, but rather a set of indicators that can be used in tandem. It is also not practical to develop blanket solutions to conservation in general, and what is required instead, are guidelines that can be adapted to the specific natural and socio-economic environment being considered.

In an age of accountability, it is necessary for conservation to be able to show a return from investment. The results of this study show that there are differing patterns of return-on-investment (ROI) from different conservation interventions. Consequently, it is vital that we continue to develop ways to measure the impact and outcomes of our conservation programmes and to include accounts of the costs and benefits involved,

to ensure that future conservation makes the best use of, what will be, increasingly limited resources, in order to achieve maximum success.

The findings of this study have shown that conservation education (both formal and informal) as a specific example of a conservation tool, is a practical and cost-effective conservation intervention. However, its effect on conservation outcomes is not linear and therefore, a ROI analysis should be carried out during and after any education programme, to ensure that the type and quantity of education employed provides the most cost-effective results for conservation. Although education is a highly cost-effective measure when it is the primary aim of a project, overall conservation success depends on both socio-economic and ecological aspects, and therefore education should be used as one of a number of tools in the conservation tool box.

With specific reference to the Darwin Initiative (DI), drawing from both the findings of this study and personal experience in collating the data, I have the following recommendations:

1. Reporting of additional factors (these are factors that I would have liked to have included in my analysis, but was unable to do so due to lack of information) such as: the length of time the project had been running (previous to the Darwin Initiative), the specific habitat of the area (surprisingly this was often unclear), religion of the local people, the background level of awareness/knowledge (and if possible the change in awareness/knowledge) for education specific projects, the development level of the specific area, and the level of urban development in the project area.

2. Reporting of the actions and threats inline with the IUCN guidelines (IUCN-CMP, 2006a,b).

3. A reporting framework that includes the variables included in my analysis. This would allow for rapid analyses and summaries to be carried out on a regular basis, to explore the funding patterns of the Darwin Initiative and also to monitor overall success of the Initiative.

4. More rigorous and structured reporting to prevent project leaders from providing vast quantities of data, of little or no practical value to either conservation or the Darwin Initiative.

5. Removal of the final question: "Do you think this project has been a success". All Darwin project leaders responded yes to this question. If not removed, the question could be supplemented by: "If yes, how do you define success, and how has your project been successful?"

6. Leading on from the previous point, such a question would allow for project leaders to define their outcomes rather than their outputs. This could be a specific question in its own right.

7. During the application procedure, there should be better measures to ensure that project leaders really do have established links with host-country participants. This was often lacking in those projects that were not successful.

The above suggestions are recommendations only, and are provided in order to offer guidance as to how the reporting of Darwin Initiative projects could be improved, to ensure that the Initiative continues to monitor and report the outcomes of its projects, to guarantee its place at the forefront of international conservation efforts.

Success *n. a favourable outcome; doing what was desired or attempted; . . .(OED, 1990)*

By the above definition, a conservation project that has delivered on its objectives can be considered a success. However the findings of this thesis show that that there are a myriad of opinions as to what constitutes success in conservation and a kaleidoscope of factors; demographic, socio-economic, cultural and biological, which contribute to delivering positive conservation outcomes. Hence, my belief that the dictionary definition of success may be too simplistic with regard to conservation. The literature reviewed in this study demonstrates the range of prioritising and evaluative tools currently available for conservation. Although those that seek to compare conservation

initiatives using both biological and socio-economic indicators, include estimates of costs, or to evaluate conservation education as a tool for conservation, may still be in their infancy, they illustrate the effectiveness of these tools for conservation and highlight the need for their usage to be more widespread. As the global biodiversity crisis continues to worsen, due to an ever-increasing human population and the intensifying threat of climate change, it may be wisest to act on, and learn from, the lessons of these studies and to perhaps focus less on the philosophical discussion as to what constitutes *"conservation success"*.

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Appendices

A

Chapters 4 & 5

A.1 Scoring of Darwin Initiative Outputs (DO)

The Darwin Initiative requests that final reports include a standard table of outputs (Defra, 1996). Tables A.1, A.2 and A.3 detail these outputs and explain how they were used to develop the Darwin Outputs (DO) success indicator. Weighting was based upon the distribution of values in the database as a whole. Where an output has been marked as an input, it was used as an explanatory variable rather than an output.

A.2 Distributions of indicators of conservation success

Distributions of the three indicators of success used are illustrated in Figures A.1, A.2, and A.3.

Table A.1: Scoring of Darwin Initiative Outputs (DO)

Output Type	Description	Mark Scheme		Comments
		Value	Mark	
Training	Number of people to submit PhD	INPUT	0	These were considered to be educational inputs and therefore were not included in the calculation of Darwin Outputs (DO) to avoid pseudo−replication.
	Number of people to submit masters	INPUT	0	
	Number of people with other qualifications	INPUT	0	
	Number of students (postgraduates and undergraduates)	INPUT	0	
	Number of training weeks	INPUT	0	
	Number of long term trainees	INPUT	0	
	Number of short term trainees and weeks spent	INPUT	0	
	Number of materials produced	INPUT	0	
	Trainees still employed in the field post project	No	0	
		Yes	2	

Table A.2: Scoring of Darwin Initiative Outputs (DO)

Output Type	Description	Mark Scheme		Comments
		Value	Mark	
Research	Number of weeks spent by UK staff in country	INPUT	0	These were considered to be inputs and therefore were not included in the calculation of Darwin Outputs (DO) to avoid pseudo−replication.
	Number of management plans	0	0	
		1−2	1	
		3+	2	
	Number of guides/manuals	0	0	
		1−2	1	
		3+	2	
	Number of papers for peer review	0	0	
		1−5	1	
		6+	2	
	Number of other papers	0−5	0	Half marking to reflect the assumption of greater difficulty and better science in being in the peer reviewed literature.
		6+	1	
	Number of computer databases established	0	0	
		1	1	
		2+	2	
	Number of computer databases enhanced	0	0	Half marking to reflect the assumption of greater difficulty in establishing something rather than enhancing it.
		1+	1	
	Number of collections established	0	0	
		1	1	
		2+	2	
	Number of collections enhanced	0	0	Half marking to reflect the assumption of greater difficulty in establishing something rather than enhancing it.
		1+	1	

Table A.3: Scoring of Darwin Initiative Outputs (DO)

Output Type	Description	Mark Scheme		Comments
		Value	Mark	
Dissemination	Number of conferences and workshops attended and organised	0	0	
		1−5	1	
		6−10	2	
		11+	3	
	Number of press releases and newsletters in host country and UK	INPUT	0	
	Number of networks	0	0	
		1	1	
		2+	2	
	Number of TV programmes in host country and UK	INPUT	0	
	Number of radio programmes in host country and UK	INPUT	0	
	Estimated value (£) handed over to host country	0	0	
		£200−£5000	1	
		£5001−£10,000	2	
		£10,001−£20,000	3	
		£20,001+	4	
	Number of permanent education/ research facilities	0	0	
		1	1	
		2+	2	
	Number of permanent sites	0	0	
		1−10	1	
		11+	2	

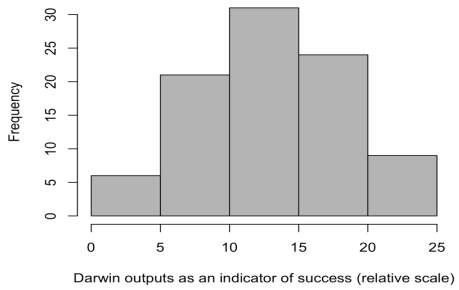

Figure A.1: Distribution of Darwin Outputs (DO).

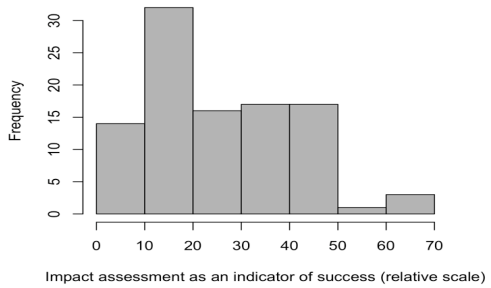

Figure A.2: Distribution of Impact Assessment (IA).

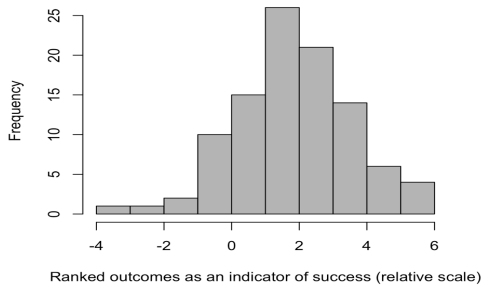

Figure A.3: Distribution of Ranked Outcomes (RO).

A.3 Calculation of Explanatory Variables

A.3.1 Variables

Tables A.4, B.3, A.6 provide a list of the explanatory variables used in the analysis. The units, range and method of calculation are also given.

A.3.2 Calculation of quantity of education

Weighting was based on a combination of using the distribution of values in the database, coupled with weightings based on opinion of importance from project leader interviews.

Quantity of education $=$ *capacity* $+$ *schooling* $+$ *media score* $+$ *public awareness campaign*

Capacity $=$ PhD score $+$ MSc score $+$ number qualified and/or number of long term trainees $+$ number of students and/or number of short term trainees score

- PhD: score 3 per PhD student
- MSc: score 2 per MSc student
- Oualification/long-term trainee: score 1 per trainee
- Students/short-term trainee $=$ *number of people x number of weeks*
  Score as follows: $1-50=1$; $51-150=2$; $151-350=3$; $351-750=4$; $751-1550=5$; $1551-2750=6$; $2751-5150=7$; $5151-9950=8$; $9951-19550=9$; $19551-38750=10$; $38751-77350=11$; $77351+=12$;

Public awareness campaign (e.g. posters and leaflets) $=$ 2 points if carried out
Schooling $=$2 points for informal visits, 5 points for formal programme
Media score $=$ how many radio/television and newspaper releases in host country

Table A.4: Details of explanatory variables. Age and sex were also included. N = nominal; O = ordinal.

Variable Type	Variable	Units	Range	Calculation	Type
Background	Human Development Index (HDI) (UN, 2008)	NA	NA	NA	O
	Geographical location	**1** = island **2** = coastal **3** = continental	NA	NA	N
	Date	NA	1997 – 2004	NA	O
	Organisation of UK Project leader/Organisation of host country project leader	**1** = government **2** = NGO **3** = research institute (eg. university) **4** = educational institute (eg. museum) **5** = Multiple	NA	NA	N

Table A.5: Details of explanatory variables. N = nominal; O = ordinal.

Variable Type	Variable	Units	Range	Calculation	Type
Conservation Target	Flora or Fauna	**1** = Flora **2** = Fauna **3** = Both	NA	NA	N
	Flagship species (Roberge & Angelstam, 2004)	**0** = no **1** = yes	NA	NA	N
	Species	**1** = mammal **2** = bird **3** = amphibian/reptiel/fish **4** = plant **5** = multiple	NA	NA	N
	Threat type	**1** = lack of infrastructure **2** = lack of knowledge and infrastructure **3** = lack of knowledge **4** = loss of habitat or species and lack of knowledge **5** = disturbance and lack of knowledge **6** = disturbance **7** = loss of habitat or species **8** = loss of habitat or species and disturbance **9** = multiple	NA	Based on IUCN categorisation (IUCN-CMP, 2006b)	N
Project resources	Number of weeks spent by UK project leader in host country	NA	NA	NA	O
	Number of conservation actions implemented	NA	NA	Based on IUCN -CMP categorisation (IUCN-CMP, 2006a)	O

Table A.6: Details of explanatory variables. N = nominal; O = ordinal.

Variable Type	Variable	Units	Range	Calculation	Type
Project type	Project scale	**1** = local **2** = regional **3** = national **4** = international (based on DI final reports)	NA	NA	O
	Project aim or target	**1** = education or training **2** = infrastructure or research **3** = species **4** = habitat	NA	Based on Mace et al. (2007)	N
Education	Quantity of education	NA	NA	See Section A.3.2 for calculation	O
	Type of education	1 = formal 2 = training 3 = public awareness 4 = formal & training 5 = all of the above	NA	After quantity of education was calculated, projects were grouped according to the quantity of different types of education carried out	N

A.4 Ranked Outcomes

Below is a list of the outcomes that were ranked according to importance in contributing to conservation success:

Education and Training

1. Increased motivation/involvement/ability of: People directly involved in project (e.g. NGO staff, teachers)
2. Increased motivation/involvement/ability of: Local community
3. Increased motivation/involvement/ability of: Local government
4. Increased motivation/involvement/ability of: National government
5. Increased awareness of conservation (of the particular species/habitat) at: Community level
6. Increased awareness of conservation (of the particular species/habitat) at: Local government level
7. Increased awareness of conservation (of the particular species/habitat) at: National government level
8. Increased knowledge of conservation (particular species/habitat) in non-specialists (e.g. community, government officials)
9. Awareness raised as to the need for environmental education
10. Establishment of: Community conservation centre (actual building at local level)
11. Establishment of: Community education network of local people and organisations
12. Establishment of: Community outreach programme (e.g. provision of local environmental education officer or children's programme)
13. Establishment of: Innovative conservation programmes (e.g. theatre groups)
14. Establishment of: University course/module

15. Establishment of: Environmental institute (e.g. within host country university)
16. Sustainable capacity e.g. trainees of project become trainers or further PhD and MSc places secured
17. Voluntary actions: Incorporation of EE at individual level (e.g. individual teachers)
18. Voluntary actions: Continued use of manuals/books produced
19. Voluntary actions: Continued awareness raising by local community
20. Voluntary actions: Conservation clubs established in school and/or university
21. Strengthening of/ support for: Schools and wildlife clubs to teach environmental education
22. Strengthening of/ support for: Current courses run by host country university
23. Strengthening of/ support for: Establishment of environmental education within national curriculum

Research and Infrastructure

1. Establishment of: Herbal farm/medicinal garden at village level
2. Establishment of: University or national botanic garden / national research lab (legally recognised within host country and internationally)
3. Establishment of: Field station established
4. Establishment of: Operational NGO
5. Establishment of: National advisory committee
6. Establishment of: Local conservation committee
7. Establishment of: Community department of forestry department
8. Establishment of: Research journal within host country
9. Improvement of National Museum or Botanic Garden
10. Methodology developed, tested and established

11. Research: Baseline data obtained
12. Research: New species discovered / bioactive extracts discovered / key species identified
13. Research: Pioneering study
14. Research: Promotion of future research into same or related areas
15. Research: Contribution to red data lists/IUCN categories
16. Research: Data used for sustainable use programmes
17. Strategic management plan: Influence of results on exisitng management plans (e.g. conservation strategies changed accordingly)
18. Strategic management plan: Successfully implemented (not just drawn up)
19. Advanced identification system developed (e.g. for insect identification)
20. Provision of resources e.g. hardware/software/plants and seedlings etc
21. Jobs created around project e.g. builders, social benefits of trainees of project
22. Infrastructure provided for sustainable livelihoods: Training and resources
23. Infrastructure provided for sustainable livelihoods: Legal concessions and certification systems
24. Increase in quality and quantity of exisitng livelihood options/ecotourism
25. Alternative livelihoods established e.g. markets underway, income security

Species and Habitat

1. Nature reserve: Gazetted
2. Nature reserve: Expanded
3. Nature reserve: Revised interest in area that has been forgotten/overlooked
4. Nature reserve: Proposed for upgrade to National Park status
5. Nature reserve: International designation e.g Ramsar or UNESCO

6. Monitoring: Established or improved locally in the long-term
7. Monitoring: National systems established
8. Monitoring: Initiated but not completed within project lifetime
9. Legislation: Legal protection at national level for habitat or species e.g. hunting ban, reduced quotas, control measures for illegal trade
10. Legislation: Regional legislation
11. Legislation: Village level laws
12. Construction of ex-situ conservation/research/veterinary centres (e.g. hatcheries or breeding centres)
13. Prevention of damaging conservation strategies (e.g. unsanctioned captive bredding, poorly focused conservation plans)
14. Local improvments in environment (e.g. reforestation, rubbish collection, moratorium on driving behind nesting beaches)
15. Evidence of species improvement: Anecdotal (e.g. animals no longer running from vehicles)
16. Evidence of species improvement: Scientific (population surveys, species downgraded in IUCN categories)
17. Evidence of species improvement: Number of infractions decreased
18. Species established as flagship species
19. Discussions for establishment of future conservation areas/management plans underway

Legacy

1. Future projects: Initiated by Darwin Initiative project leaders (e.g. money found for post-project work)
2. Future projects: Inspired other organisations to established related projects
3. Future projects: Inspired local community projects and initatives

4. Collaboration: Network of conservationists/scientists established within country
5. Collaboration: International cooperation
6. Collaboration: Cooperation with other fields e.g. veterinary field or religious organisations
7. Recognition of work at international level and collections/data/methodology used by other researchers and conservation practitioners
8. Project members or trainees: Permanent positions in conservation within host country
9. Project members or trainees: High profile positions within host country
10. Project members or trainees: Hold positions on national advisory committees
11. Impact on society e.g. jobs, improvements in health or schools etc.
12. Additonal countries or regions joined project (over and above those planned for)

Negatives

1. Reduced number of outputs: Workshops/dissemination
2. Reduced number of outputs: Training and materials
3. Bureaucratic/logistical: In-country corruption
4. Bureaucratic/logistical: Difficulty obtaining permits
5. Bureaucratic/logistical: Loss of funding from other bodies/ other monetary and budgetary problems
6. Bureaucratic/logistical: Changes in resources available
7. Bureaucratic/logistical: Politically senstive issues being dealt with
8. Bureaucratic/logistical: Political instability
9. Bureaucratic/logistical: Logistical delays
10. Bureaucratic/logistical: Project fell behind schedule

11. Design flaws: Research/methodology/fieldwork not well designed
12. Design flaws: Project goals too unrealistic
13. Design flaws: Misguided conservation strategy
14. Design flaws: Training not targetted effectively
15. Institutional: Lack of interest in-country
16. Institutional: High staff turnover/lack of staff
17. Institutional: Unable to employ highly qualified local staff as not enough money or no-one avaliable
18. Institutional: Difficult to target women
19. Communication: UK facilitators not spend enough time in-country
20. Communication: Language barriers
21. Communication: High staff turnover therefore difficult to communication with host institute
22. Communication: No government support
23. Communication: Limited exchange between biological and social scientists
24. Communication: Cultural differences
25. Communication: Not enough stakeholder meetings
26. Project results: Conservation threats still a problem
27. Project results: Database still has holes/baseline data not collected
28. Project results: Not enough trainees to institutionalise benefits
29. Project results: Monitoring not yet secure
30. Project results: Institution not developed due to lack of resources and interest
31. Project results: No influence on policy / management and action plans not implemented
32. Project results: Results very local with no benefit to wider community

33. Project results: No jobs for trainees
34. Project results: Sustainablity of alternative livelihoods not achieved
35. Project results: Negative economic impacts
36. Project results: Negative ecological impacts
37. Project results: Not enough access to data and resources provided
38. Project results: Project not effectively assessed as to impact
39. Project results: Project too ephemeral
40. Project results: Lack of secure exit strategy

A.5 Project leader interview

1. Why did you first decide to become involved in conservation? What was your motivation? How long? Where else have you worked?
2. Please can you give me a general description of your projects (ask about each project specifically in turn)? For example: overall aim; what did you do; why did you decide on this project; how much importance was given to the educational aspect, and why?
3. What do you understand by education for environmental conservation and sustainable development? What are your definitions of different forms of education? E.g. media campaign, training, capacity building, formal.
4. What types of education have you used in your projects? Do you prefer any particular form or method of education for your projects and why? And do you prefer working with a certain age group? And if so, why? (direct questions to specific projects)
5. How did the educational aspect interact with/influence the other parts of the project?
6. Please can you tell me how you feel the following variables influenced the project as a whole, and in particular the educational side: interaction with local partner and residents; your personal expertise/background; the ethos of your organisation; the particular

country e.g. religion/culture/poverty; the conservation target e.g. flora/fauna/flagship species.

7. Amount spent on education. Do you think you spent too much/too little/enough? And why? In retrospect would you have changed anything about the allocation of your project budget to education, either overall, or within the education project allocation?

8. Please can you tell me how you feel about the success of your projects? For example: project success overall; how did you measure/monitor success; specific aspects of the project which you feel contributed to its success; how much did the education aspect contribute to success?

9. In general what is your feeling about education as a tool for conservation and sustainable development: can it be used to link them or used separately; overall effect on a projects success; lessons learnt about implementation; what would you do again; what would you do differently and why; setting up permanent educational facilities.

10. In research terms, how do you feel the issue of environmental education has been tackled so far? Do you perceive it as being under-researched?

B

Chapters 6 & 7

B.1 Data Collection

Information regarding data collection is provided in Table B.1 and Figure B.1.

B.2 Calculation of Variables

B.2.1 Variables

Tables B.2 and B.3 provides a list of the variables used in the analysis. The units, range and method of calculation are also given.

Table B.1: Conservation interventions for saiga antelope carried out between 1990 and 2006 in Kalmykia and Astrakhan.

Conservation programme	**Dates**	**Location**	**Main funding body**
Using saiga antelope to improve rural livelihoods	2003 – 2006	Kulkhutta, Tavn–Gashun	Darwin Initiative (Defra)
Rotating cows project	2006 onwards	Kulkhutta, Tavn–Gashun	Small Environmental Projects (Defra)
Evaluating approaches to public engagement in	2006 – 2007	Utta, Erdnevskiy, Molodozhyne, Adyk	Darwin Initiative (Defra)
Chernye Zemlie Reserve. – support and capacity building	1990 onwards	Kalmykia	Russian Federation UNESCO
Stepnoi Sanctuary – anti poaching and population monitoring	2000 onwards	Astrakhan	Astrakhan Province INTAS

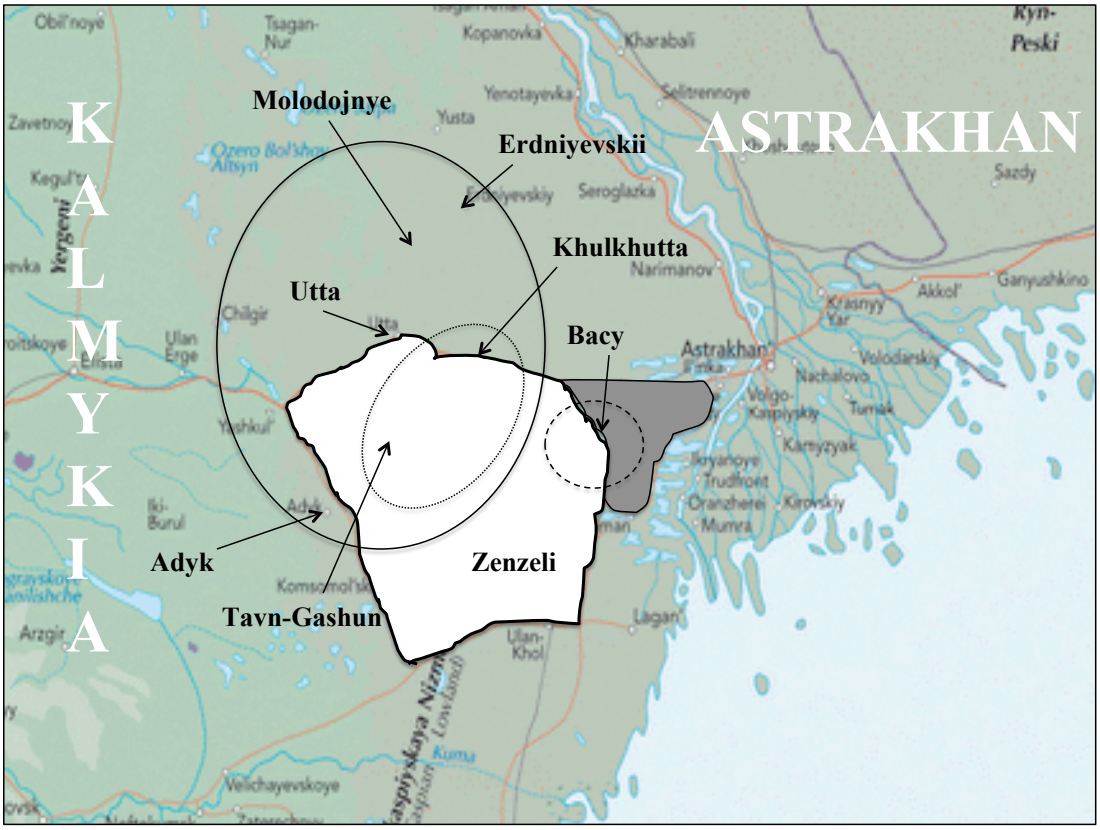

Figure B.1: Map illustrating the location of Kalmykia and Astrakhan within the Russian Federation. The eight study villages are shown with arrows. The white shaded area indicates the location of the Chernye Zemli Reserve in Kalmykia and the grey shaded area the boundary of the Stepnoi Sanctuary. The bold oval indicates the region exposed to the media campaign, the dotted circle highlights the villages under the social engagement project and the dashed circle encloses the area under the traditional conservation intervention (Map adapted from Multimap 2007).

Table B.2: Details of explanatory variables. Age and sex were also included. N = nominal; O = ordinal.

Variable Type	Units	Range	Calculation	Type
Village	**1** = Utta **2** = Khulkutta **3** = Tavn−Gashun **4** = Bacy **5** = Zenzeli **6** = Molodozhyne **7** = Erdnevskiy **8** = Adyk	NA	NA	N
Intervention	**1** = media campaign **2** = social intervention and media campaign **3** = Traditional conservation	NA	Media campaign = coverage in local and national media. Social intervention = Rotating cows under Defra's Small Environmental Projects Scheme + detailed socio−economic survey in 2003 + media coverage. Traditional conservation = anti−poaching activities. No major media campaign.	N
Wealth	Scale 1−5: **1** = low **5** = high	1−5	See Section B.2.2	O
Formal education	**1** = none/primary **2** = full secondary **3** = technical secondary **4** = higher education	1−4	NA	O
Nationality	**1** = Kalmyk **2** = Russian **3** = Other	NA	NA	N
Residence time	**1** = up to half their life **2** = over half their life **3** = all their life	1−3	Length of time resident in the village as a proportion of lifespan.	O
Exposure level to saiga	**1** = low **2** = high	1−3	See Section B.2.3	O
Conservation knowledge	Scale 0−5 **0** = none **5** = high	0−5	See Section B.2.4	O

Table B.3: Details of explanatory variables. Age and sex were also included. N = nominal; O = ordinal.

Variable Type	Variable	Units	Range	Calculation
Public awareness materials remembered being received	0 = no 1 = yes	NA	NA	N
Positive opinion change in last 3 years	0 = no 1 = yes	NA	NA	N
Media format of public awareness material	1 = newspaper 2 = television	NA	NA	N
Date materials being remembered being received	1 = 2005 or earlier 2 =Jan−July 2006 3 = Aug−Oct 2006	NA	NA	N
Recalled subject of material remembered received	1 = ecology 2 = conservation 3 = poaching	NA	NA	N
Recalled immediate effect of material remembered being received	0 = no 1 = yes	NA	NA	N

B.2.2 Wealth

Wealth was calculated taking into account employment ratio, farm ownership, large livestock and poultry ownership, pensions/allowances received and vehicle ownership (Kuhl, 2008). Each sub-category was scored as in Table B.4 and then the total score was added together. Wealth was then ranked according to the following 5-point scale: $1 = 1 - 4$ points; $2 = 5 - 8$ points; $3 = 9 - 12$ points; $4 = 13 - 16$ points; $5 = 17$ or more points.

B.2.3 Exposure level to saigas

Exposure level was defined as the level of exposure that individuals had had to saigas. Exposure level was calculated based on the date and location of last sighting, the number of animals seen and the total number of sightings. Each sub-category was scored as in Table B.5 and the total was summed together. Exposure was then ranked on a 3-point scale: $1 = 0 - 10$ points; $2 = 11 - 14$ points; $3 = 15 - 18$ points.

Table B.4: Summary of variables contributing to wealth calculation.

Variable	Scoring	Calculation
Employment Ratio	**1** =< 1; **2** = 1.1−2; **3** = 2.1−3; **4** = 3.1−4 **5** = 4.1−5; **6** = 5.1−6; **7** => 6	The number of people, per household, earning a wage, was divided by the number of dependents in that household.
Farm Ownership	0 = no farm; 1 = farm	Farm ownership was a significant indicator of wealth (personal observation) and therefore the scoring system was weighted to reflect this
Large Livestock Ownership	**0** = 0; **1** =< 50; **2** = 50−100; **3** = 101 − 200; **4** = 201−500; **5** => 500	Respondents were asked to provide the number of animals animals they owned and the income received directly from animal ownership
Poultry Ownership	**0** = no animals; **1** = subsistence number; **2** = income earned (generally > 50 animals)	Respondents were asked to provide the number of animals they owned and the income received directly from animal ownership. Poultry ownership was not scored as highly as large livestock ownership to reflect the greater wealth earned by large livestock farming.
Pensions or Allowances	**0** = no vehicles; **1** = one> 20yrs; **2** = one 10−20 yrs, two > 20yrs; **3** = one 5−10 yrs, two 10−20 yrs, three > 20yrs; **4** = one < 5yrs, two 5−10 yrs; **5** = one foreign 5−10 yrs; three 5−10 yrs; four > 10yrs; **6** = one or two foreign > 10 yrs, three < 5yrs; **7** = two to four foreign < 5yrs	Vehicle ownership was a significant indicator of wealth (personal observation). Scoring was calculated based on the number of vehicles owned, the age of the vehicles, and whether they were foreign or imported (which cost significantly more than Russian vehicles).

Table B.5: Summary of variables contributing to the calculation of exposure level to saigas.

Variable	Scoring	Calculation
Date of last exposure (years)	**0** = never; **1** => 20.01; **2** = 10.01−20.00; **3** = 5.01−10.00; **4** = 2.01−5.00; **5** = 1.01−2.00; **6** = 0.51−1.00; **7** = 0.11−0.50; **8** = 0.00−0.01	Respondents were asked to recall the data when they last saw saigas. More recent dates were given a higher rating in terms of exposure. This was done as it was assumed that the more recent the sighting the greater the effect of the sighting on the respondent in terms of exposure
Location of last sighting	**0** = no sightings; **1** = outside the republic; **2** = raion/republic; **3** = village	Interviewees stated where their last sighting was. Higher scores were given to those who had sighted saigas most locally. It was assumed that seeing animals close to home would have a greater influence as it was have a more immediate effect.
Number of animals in last sighting	**0** = no animals; **1** = 0−10; **2** = 11−50; **3** = 51−100; **4** = 100s; **5** = 1000s; **6** =100,000s	Respondents were asked to recall roughly how many animals they had seen at the last sighting. Greater numbers were awarded higher scores as it was assumed that seeing many animals would have a more dramatic effect on those observing it.
Number of sightings	**0** = no sightings **1** = 1; **2** = 2; **3** = 3	Interviewees were scored on whether they had see saigas in all three locations: village, raion/republic and outside the republic. Larger numbers of sightings were not used as it was not felt that recall was accurate enough.

B.2.4 Conservation knowledge

This was considered to be the level of knowledge regarding the number of conservation projects at the regional, republic and national scales. Respondents were scored on how many conservation interventions they knew about. The total score was summed together.

1. 1 mark for each intervention mentioned
2. 0.5 mark if they thought they had heard about a specific intervention but were not 100% sure (this was only awarded if they were in fact correct)
3. 1 extra mark was given for mentioning an intervention not in the local vicinity or district, but either elsewhere in the republic or Russia as a whole

B.2.5 Population knowledge

Population knowledge was an individual's level of knowledge regarding the direction, timing and reasons for population fluctuations. The table below was constructed based on population data gathered since 1978. Reasons for decline and increase were assessed against information from an in-country expert (A. Lushchekina, pers comm)

1. Direction of change: 1 mark was given for stating a decline or increase over a correct time period
2. Timing of change: Marks for accuracy in timing of commencement of trends were awarded according to Table B.6
3. Reasons for decline: 1 mark was given per correct reason for decline (see below for reasons; reasons provided by in-country expert [A.A. Lushchekina, pers comm])
4. No marks were awarded to those who stated that nothing had happened to the population over time, or those who did not have any knowledge regarding population trends

Anthropogenic reasons for decline

1. Overhunting and poaching
2. Government, lack of state protection (more detail required)
3. Rangers: do not have necessary funding to do their job; dishonest, failing to do their job
4. Poverty, lack of alternative livelihoods
5. Extensive irrigation channel network (Volga water channel (more detail required))
6. Uncontrolled increase of livestock and overgrazing of pastures

Ecological reasons for decline

1. Changing natural conditions due to: desertification, cold winters and summer drought fires decreasing capacity of grasslands

2. Wolves

3. Migrational changes

Anthropogenic reasons for increase

1. Chernye Zemli Biosphere Reserve and other protected areas to cover the migration routes and rutting/lambing areas

2. Social improvements

3. Total control of poachers and ban of hunting up to restoration of saiga numbers

Ecological reasons for increase

1. Improving habitats by restoration measures

Table B.6: Scoring sheet for accuracy in knowledge regarding saiga population trends over time. Based on data (Milner-Gulland *et al.*, 2001)

Year	Decline	Increase
1978	0.5	0
1979	1	0
1980	2	0
1981	2	0
1982	2	0
1983	1	0
1984	0.5	0
1985	0	0.5
1986	0	1
1987	0	1
1988	0	1
1989	0.5	0.5
1990	1	0
1991	1	0.5
1992	1	1
1993	0.5	2
1994	0.5	2
1995	1	2
1996	2	1
1997	2	0.5
1998	2	0
1999	1	0
2000	0.5	0
2001	0	0
2002	0	0.5
2003	0	1
2004	0	1
2005	0	1
2006	0	0.5
1980s	1	0.5
1990s	1	1
2000s	0	0.5

B.3 Distribution of dependent variables

Distributions of the three dependent variables used are illustrated in Figures B.2, B.3, and A.3.

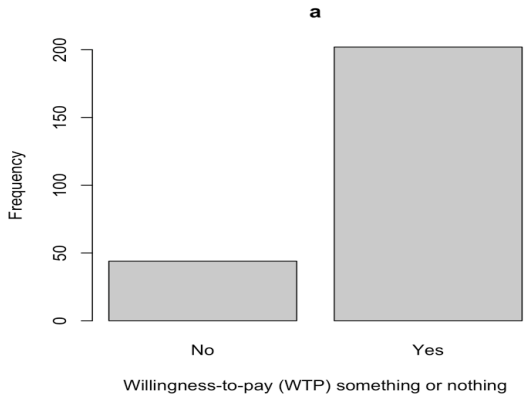

Figure B.2: Distribution of willingness-to-pay (WTP) something or nothing for saiga conservation.

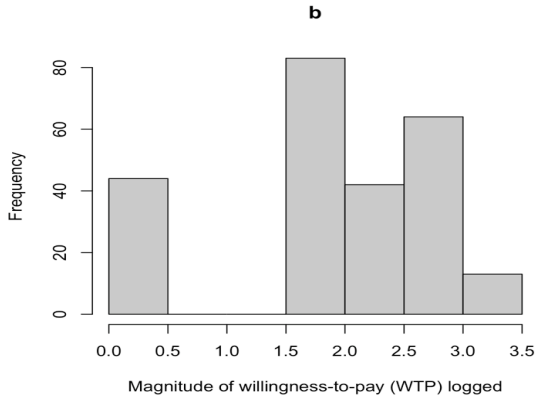

Figure B.3: Distribution of willingness-to-pay (WTP) for saiga conservation.

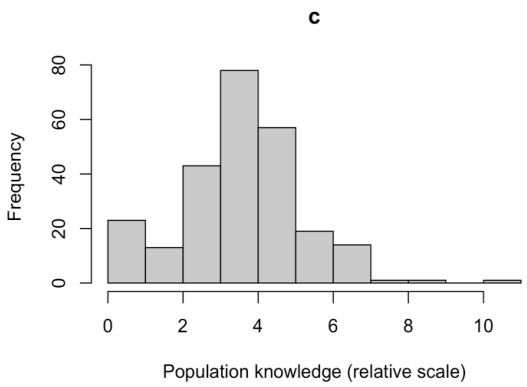

Figure B.4: Distribution of *"population knowledge"*: a respondent's knowledge regarding saiga population fluctuations.

C

Questionnaires

Attitudes and Perceptions Questionnaire

Age: Sex: Occupation(s): Education Level:

[*Using the map provided explain the following regions before commencing the questionnaire*]

Throughout this questionnaire we will refer to different geographical areas. These are:

a) 5km radius of your village
b) Your raion
c) Kalmykia/Astrakhan [*depends on location of village*]
d) Russia

1. Exposure and knowledge of status of saiga antelope

a. When did you last see saiga in:

i. A 5km radius of this village?

ii. This Raion?

iii. Kalmykia/Astrakhan oblast?

b. On this last occasion, what were the most saigas that you saw at one time?

Numbers	**Location**		
	5km radius	**Raion**	**Kalmykia/Astrakhan**
a. One hundred thousand			
b. Thousands			
c. Hundreds			
d. 100-50			
e. 50-10			
f. 10-0 [***ask them to be precise where possible***]			

c. Do you think there have been changes in saigas (e.g. numbers, behaviour, migratory routes, sex ratio etc.) in:
   i. A 5km radius of this village?
   ii. Raion?
   iii. Kalmykia/Astrakhan?

Area	Change	When did the changes start?	How has the change progressed over time?	Reason
5km radius of village				
Raion				
Kalmykia/Astrakhan				

1. **General perception and attitudes towards saiga antelope**

    a. Using the scale below, please tell me whether you agree or disagree with the following statements:

    1. Strongly agree
    2. Agree
    3. Neither agree nor disagree
    4. Disagree
    5. Strongly disagree
    6. Don't know

1. "I have more important things to think about than the future of the saiga antelope"

2. " If the saiga was lost from Russia I would not mind"

3. "Saiga should be protected for future generations even if than means making sacrifices now"

    b. Has your attitude towards/opinion of saiga changed over time? If YES, how has it changed?

Before		After		Why
Time	Opinion	Time	Opinion	

a. Willingness to pay

The current saiga population is considerably smaller than historic levels and is also no longer reproducing healthily. If current levels of hunting pressure are maintained or increased in this region the saiga will be lost from Russia.

An annual household voluntary contribution has been considered as a means of raising money to support the conservation and protection of the saiga antelope.

Which of the amounts below best describes your household's maximum willingness to pay, every year, through a voluntary contribution, to prevent the loss of saiga from Russia? Please think carefully about how much you can really afford and where the additional money would come from and try to be as realistic as possible.

Place a tick (**√**) next to the amount your household would be willing to pay. When you reach an amount that you are not sure of paying then leave it BLANK. When you reach an amount that you are almost certain you would not pay, then place a cross (**x**)

Roubles/Year	Willingness to pay
0	
50	
100	
200	
400	
800	
1,600	
3,200	
6,400	
12,800	
25,600	
50,000	
>50,000	

b. Follow up questions

i. Possible reasons why interviewee is NOT willing to pay (True **√**; False **x**)

- Our household cannot afford to pay
- I am not very interested in saiga antelope and feel that their conservation is not a priority

- I don't believe a contribution scheme is workable
- The government or international community should pay for this
- I need more information/time to answer the question

i. Possible reasons why interviewee is willing to pay (True ✓; False **x**)

- I am interested in the saiga antelope and feel that it is important to conserve them
- I get satisfaction from giving to a good cause
- We should protect the saiga for future generations
- I feel we should protect our wildlife and environment in general

2. Knowledge and opinion of conservation

a. Do you know of any saiga conservation taking place at this moment in:
   i. This raion?
   ii. Kalmykia/Astrakhan?
   iii. Russia?

Area	Where	Who	When	What/how	Opinion
Raion					
Kalmykia/Astrakhan					
Russia					

b. Any suggestions for how to improve the conservation of saigas in:

i. This raion?

ii. Kalmykia/Astrkhan?

iii. Russia?

1. Knowledge and opinion of public awareness

a. When was the last time that you or any family members received any information about anything to do with saiga antelopes?

b. What was the medium through which you gained this information (e.g. t.v., radio, friends etc)?

c. What was that information about? (e.g. ecology, poaching, culture etc?)

d. In the last year, about how many times have you received information of any sort about saigas, from where and what was it?

Who received information	**Last time received**	**Medium (From whom/where from)**	**What (ecology, poaching, culture etc.)**	**Frequency**	**Opinion**

i. Do you feel that this information has altered your attitude/behaviour towards saiga and their management?

YES/NO

ii. If YES, how?

a. Have you or someone you know received any benefits related to saiga conservation?

Who received benefits	What	From whom/where from	When	Opinion

i. Do you feel that these benefits have altered your attitude/behaviour towards saiga and their management?

YES/NO

ii. If YES, how

2. Opinion on costs of conservation

a. Have you or someone you know suffered any costs related to saiga conservation?

Who suffered costs	What	From whom/where from	When	How did they affect you

i. Do you feel that these costs have altered your attitude/behaviour towards saiga and their management?

YES/NO

ii. If YES, how?

b. What suggestions would you make to help to lessen these costs?

Basic Household Questionnaire

Date: Village: Household no.:

1. Demographics

How many years have your family lived in the village?

Where did your family live before?

Why did your family move here?

Household structure [circle respondent]

Relation to head	Sex	Age	Social status	Education

2. Household income

What are the dominant livelihood activities of your household in each season of the year?

What income is derived from each of the activities in the different seasons?

Livelihood activity	Income

Does this household receive any additional income (e.g. from family members in town, pensions)? If YES, where from?

Do you own any animals? If YES, how many and what kind?

Type of animal	**Income from other animal products/year (wool, milk, eggs etc)**

Does your household own any vehicles? If YES, what and how many?

Type of vehicle	**Number**	**Year of purchase**
Motorbike		
Non off-road car		
Off-road car		
Bus, Minibus		
Tractor/Machinery		