1. Darwin Project Information

Project Reference No.	162-12-022
Project title	Genetic diversity and management implications for high Andean guanaco populations in Peru.
Country	Peru
UK Contractor	Cardiff University
Partner Organisation (s)	CONOPA
Darwin Grant Value	£201,015
Start/End date	1st July 2003 – 30th June 2006
Project website	www.conopa.org www.cf.ac.uk/biosi/research/biodiversity/staff/dodd.html
Author(s), date	Ciara S Dodd, Jane C Wheeler, Michael W Bruford. 30th June 2006

2. Project Background/Rationale

This was a collaborative project between Cardiff University and the Peruvian NGO CONOPA, Coodinadora de Investigación y Desarrollo de Camélidos Sudamericanos. In the host country the project was known as Guanaco 1 and represented by a project logo (Appendix A).

Both partners have shared responsibility for this project in terms of organisation and decision making. Project meetings have been held throughout the course of the project and regular contact has been maintained between all parties via email. The Darwin Trainees Jorge Rodriguez (JR) and Katherine Yaya (KY) spent a total of 20 months in the UK and the UK post-doc Ciara Dodd (CD) worked in Peru for a total of nine months.

Fieldwork was organised and conducted by members of the CONOPA team in six localities where guanaco exist in the most substantial numbers in the Peruvian Andes. The principal laboratory work and training of JR and KY was undertaken in Cardiff. Two one-month conservation biology courses were held in Peru and involved the whole project team.

CONOPA was actively involved in all stages of this project, from initial discussions, through proposal writing, execution in the field, laboratory and organization of the training courses, as well as taking a lead in the development of the final management plan and liaison work with the Peruvian government.

Under Peruvian legislation the guanaco is classified as endangered, but receives no protection from CITES because the Patagonian subspecies is abundant. The 2001 Peruvian census reported just 3,500 guanacos, which survive in isolated, fragmented populations, a number of which will not survive in the long-term because no specific measures have been taken for conservation of this species. Therefore, the principal aim of this project was to determine the genetic diversity of the poorly known high Andean guanaco populations in Peru. This information will serve as the basis for developing a management plan and this information has been adopted by the Peruvian authorities who joined CONOPA to carry out the conservation assessment of the guanaco, arrive at the Guanaco Declaration (Appendix B), form a working group to draw up the management plan and carryout a publicity campaign to save the guanaco, insuring its survival. The project also aimed to increase capacity in conservation genetics and conservation biology in Peru through the training of JR and KY in the laboratory and a cohort of Peruvian scientists on two one-month long conservation biology courses.

This project arose from a pervious Darwin grant (5/6126, Genetic Diversity and Management Implications for Vicuña Populations in Peru). The vicuña project was initially intended to

include guanaco, but as the capture of sufficient numbers of guanaco to obtain blood for DNA testing proved impossible and as a result of a severe El Niño event and its aftermath, the project was forced to focus on vicuña. Furthermore, at that time the technology for extraction of DNA from faecal material was not sufficiently developed for faeces to represent an alternative source of DNA.

CONOPA's coordinator, Jane Wheeler (JW), co-authored and managed the vicuña grant for Peru, and CONOPA evolved into its present NGO status largely as a result of this work, in order to continue research in conservation genetics of wild camelids and to extend these techniques to the preservation of endangered domestic camelid breeds. The vicuña project resulted in management recommendations that have been adopted in Peru for its vicuña populations, as well as in the official policy of the Andean Vicuña Convention and as a requisite for opening the US market to the sale of vicuña fibre. An evaluation of the important role that CONOPA has played in this process can be found in the March 2005 document by Anna Karp, "Darwin Initiative: Evaluation of Closed Projects in Peru (ECTF)".

CONOPA now serves as an advisor to various commissions of the Peruvian congress in regard to drafting new legislation concerning vicuña conservation and management (a direct outcome of research conducted under the previous Darwin grant) (Appendix C). CONOPA is in constant consultation and collaboration with CONACS (National Council for South American Camelids) and INRENA (National Institute of Natural Resources), the two government organizations with legal responsibility for the vicuña and guanaco, and has been named Scientific Authority for CITES-Peru. CONOPA's reputation for producing high quality scientific research and their independence from political affiliation means that they hold a key position for the dissemination of future results and recommendations that result from the guanaco project.

3. Project Summary

There were four main objectives for this project. These are referred to in the logical framework in Appendix D and discussed below with reference to it.

1) Conservation management of the guanaco

Six Peruvian populations of the Andean guanaco were surveyed and faecal samples collected (Appendix E) so that direct estimation of population numbers and genetic analysis could be conducted. Additionally, all available information on the Peruvian guanaco, including both published articles and unpublished internal government reports, was collected and evaluated. This approach allowed the demographic and genetic characteristics and viability of these fragmented populations to be ascertained and the data has provided the basis for establishment of a management plan based on ground-truthed data. Recommendations have been developed with and handed over to CONACS, with whom CONOPA co-organised the Workshop. The Guanaco Declaration, signed by all interested players attending the workshop (Appendix B) analyzes the situation and contains clear recommendations which will be carried into direct conservation action by the management plan work group formed during the meeting.

Three hundred and twenty-eight base pairs (bp) of mitochondrial DNA (mtDNA) Control Region was sequenced for 10 individuals per population where possible and 16 polymorphic microsatellite loci were genotyped for 15-20 individuals per population (Appendix F). These data provided sufficient resolution to achieve the outcomes detailed in the logical framework. It is widely accepted that for population genetic analysis 15 unrelated individuals per population is sufficient for studies using microsatellites (see Beaumont and Nichols, 1996) and 10 per population is considerably more than is usually analysed for phylogeographic studies. We are therefore confident that our data are adequate for such analyses and as an internationally recognised laboratory in conservation genetics, we have considerable experience in such analysis. However CONOPA will continue to sample guanaco in the future to fill in population gaps and will seek funding for the analysis of these samples

through grants from the Interamerican Development Bank tied to Peru's National Plan for Science, Technology and Innovation in South American Camelids. CONOPA is ranked as the lead Peruvian institution in the fields of genetics and wild South American Camelids under this plan.

2) Build capacity in conservation genetics in Peru

Expertise in animal conservation genetics was lacking in Peru. Two CONOPA scientists were trained in non-invasive sampling, DNA sequencing, genotyping and data analysis of wild guanaco populations in the UK and Peru. Both trainees also attended MWB's final year Cardiff University undergraduate module in conservation biology and were enrolled onto the one-month long conservation biology course that was run as part of this project in Peru.

Both trainees are now able to produce high quality genetic data, and have indeed produced a large proportion of the data for this project. They are able to write papers (e.g. JR presented a poster and wrote a paper for a conference in Göttingen (Appendices G & H respectively) and JR and KY are co-authors on all the project papers. They have demonstrated their increased knowledge and hands-on capacity by training others within the laboratories in Cardiff and Lima (Appendix I). JR has also taught molecular courses in Facultad de Medicina Veterinaria, Universidad de San Marcos. KY presented an excellent report (Appendix Tb) at the Dissemination Conference in Lima on 6th April 2006, proving to Peru that the project has produced a fully capable Peruvian scientist in the area. This result is invaluable and probably the one of the most important outcomes of the project in the long term.

JR and KY's work has been evaluated on an ongoing basis in the laboratory by CD and through discussion at laboratory and project meetings with the whole team. Throughout the project JR and KY have gained competence and knowledge and are on their way to becoming independent scientists. They are now beginning to establish their own active research programmes and have each applied for funding to continue their research. KY won funding from CONCYTEC to research the molecular etiopathogenesis of enterotoxemia in alpacas as part of a Master's degree programme at San Marcos, applying the skills she learned under the Darwin Project to help resolve a major health problem in Peru's alpaca population.

In 2006 KY applied for a Darwin Fellowship and Royal Society grant to investigate the phylogeography of camelid parasites in Peru (*unfortunately, both were unsuccessful*). This work has arisen as a direct consequence of KY's involvement with the Guanaco 1 project and alternative sources of funding is being sought to enable her to return to Cardiff and register for a PhD. JR has enrolled on a Master's programme at Cayetano Heredia University, Lima (Peru's premier research-led university).

Additional research conducted by JR during the Guanaco 1 project continues to benefit CONOPA and increase their capacity for research. Building on JR's work on parentage testing in alpacas, which he conducted in Cardiff in 2003-4 for his veterinary thesis (Appendices G, H & J), a new collaborative project, funded by IAEA, between Cayetano, CONOPA and IPEN has been established to initiate parentage testing for the government run alpaca registry.

JR also developed camelid specific sexing primers that will provide additional important information for camelid samples that come from individuals for which the sex is unknown. These primers work in guanaco, vicuña, alpaca and llama and will be of great use for the work of CONOPA (Appendix AT).

KY is taking on an important new role in fulfilling the long-term vision of CONOPA, both on an internal level and in the complex world of Peruvian politics, as well as in the planning of future research projects. Her new awareness and increased capability in these areas is largely the result of her time at Cardiff.

These activities demonstrate that KY and JR have acquired the necessary research skills to enable them to develop and establish active research and training programmes and to work as independent scientists, fulfilling one of the key objectives within the logical framework.

Additional general points that are worthy of note are that within CONOPA, the other laboratory members, have benefited directly from the training given to JR and KY who have, in turn, instructed them in molecular ecology techniques. There has also been an increase in the willingness and ability of CONOPA scientists to learn English and several members of the lab enrolled in English classes in 2004 and more have been added to the list in each subsequent year. This has meant that they are more able to access scientific literature in English language journals and textbooks which has increased their scientific knowledge base. Access to the Web of Knowledge, through Cardiff University, and other search engines such as Hinari which are now available through Peru's National Science Foundation CONCYTEC, has also been crucial.

Further capacity has been built in CONOPA through the acquisition of a number of conservation biology and genetics text books, which were purchased by CONOPA or privately by JR, for use in CONOPA, during his visit to the UK. These are listed in Appendix K.

3) Train Peruvian scientists in conservation biology and population viability analysis

This capacity was not present in Peru before the project. Two one-month long courses were devised and run in Lima in 2004 and 2005 (Appendices L & N) some sessions of which were open to the public (Appendix M). Full details of course content are given in the Training section. The courses were attended by Peruvian scientists from government departments, universities and NGOs (Appendix O). In total 34 individuals were trained and demonstrated their increased knowledge through assessment at the end of the course (Appendices P & Q), fulfilling this requirement of the logical framework.

The course participants demonstrated that they understood the course aims and concepts through active discussion and assessments. Thirty-one out of 34 students gained a certificate of completion at the end of the courses and three a certificate of attendance. Examples of course certificates are included in Appendix R.

All the course materials (Appendix BI, discs 1 & 2) have been transferred to CONOPA, which now has the capacity to deliver such courses in the future should they wish to do so, again fulfilling one of the key objectives of the logical framework. Indeed, one CONOPA scientist, Susy Nuñez (SN), has already delivered one course to scientists in northern Peru at a conference in Trujillo (Appendix BI, disc 3). Host-coordinator JW maintains contact with the course participants and a number of collaborative projects have arisen since the courses finished. The powerpoint presentations of the course lectures are posted on the CONOPA website (www.conopa.org). One of the course students for 2005, Maribell Milla from CONACS, played a crucial role in organizing the Guanaco workshop.

Another outcome has been the establishment of a postgraduate masters level second specialization course in Wildlife Management and Medicine at the Faculty of Veterinary Medicine, San Marcos University (Appendix AB). One of the teachers on this course, Jannet Cisneros, not only completed the conservation biology course but is also carrying out research on pecary population genetics utilizing the CONOPA laboratory.

The capacity for conservation biology and genetics has therefore increased within Peru as a direct result of the training given in the project and will continue to benefit the country in the future as well as increase the capacity of CONOPA for involvement in this type of research. Indeed as a result of contacts made through the conservation biology courses, a number of research proposals have been prepared (including a collaborative proposal from students of the first one month course, on Andean bear conservation), in which CONOPA has been involved.

4) Conduct a Conservation Assessment Workshop for the Andean guanaco in Peru

The Workshop was held from 16th-17th May 2006 and a one-day conference took place of 6th April 2006 at which the results of the guanaco genetic analysis and the Vortex population viability modelling were disseminated. The programmes for both events are included in Appendix S. The Workshop was originally planned for 5th-7th April 2006, however, since the Peruvian presidential election was held on 9th April the organisers, CONACS and CONOPA, felt it appropriate to postpone the event until after the election, in order to avoid any problems associated with political demonstrations or unrest, and to maximise media interest and reporting of the workshop.

The conference on the 6th April 2006 was supported by British Embassy, Lima, CONAM, INRENA and CONCYTEC, representatives from which gave short presentations indicating their support for the project. The genetic and Vortex modelling results were presented by JCW, KY, CD and MWB (Appendix Ta-d respectively). The event was filmed and the main results re-played at the Workshop in May as it was not possible, due to budgetary and time constraints, for CD and MWB to return to Peru. The DVD of the conference on the 6th April is included in Appendix BI (disc 4) at the end of this report. The Workshop from 16th-17th May 2006 was likewise filmed and a DVD of the meeting was given to all participants. This disc is freely available from CONOPA.

The Workshop was held from 16th-17th May 2006 in the auditorium of CONCYTEC (Peru's National Science Foundation) in Lima. Organization of the event was a joint undertaking between CONOPA and CONACS. A total of 96 personal invitations were sent to the key players, including national, regional and local authorities, representatives of local communities, not for profit organizations, educators, legislators, police and armed forces among others. A publicity campaign was also mounted utilizing posters and flyers, as well as press releases, postings on relevant web sites and specialist lists. The programme was arrived at in committee. Day 1 included presentations by Benito Gonzalez (Universidad de Chile), Julieta von Thungen (INIA Bariloche, Argentina) and Domingo Hoces (CONOPA, Peru) on the situation of the guanaco in Chile, Argentina and Peru. Subsequently, specialists in the field presented background information for four topics of basic importance: international conventions and national conservation strategies; experiences, threats and future possibilities for guanaco conservation; research and conservation of the guanaco; and Identification of the problem, immediate action measures and implementation of guanaco conservation projects. Subsequently, four work groups were formed to address the following topics: poaching and sport hunting; legal, institutional and political framework; conservation priorities and community participation to insure survival of the species; and research priorities for the development of a conservation plan for the guanaco. The outcome of the event was signing of the Guanaco Declaration, a document which critically analyzes the current situation of the guanaco in Peru, makes specific recommendations as to what measures should be taken to save the guanaco from extinction, and sets up a working group charged with preparing the actual management plan.

The original objectives have not been altered, but the operational plan was modified at the beginning of the project in agreement with Darwin and described in the first annual report. The modifications from the initial schedule are as follows:

The start date was delayed by two months until 01/07/03 as requested by DEFRA due to DEFRA's own budgetary constraints. Consequently, the dates for some key milestones were put back by two months especially during the first year of the project. All other changes have been minor and relate back to this initial delay. All modifications were described in the annual reports. These are as follows:

In year 1, JR arrived in Cardiff three months later than scheduled due to the prohibitively high airfare from Peru to UK before 12th September 2003 (due to the ongoing effects related to 9/11). CD and JR travelled to Peru in March 2004 rather than in January. Sampling delayed until April 2004 because significant difficulties were encountered with obtaining permits from INRENA to allow fieldwork to commence. Despite initial delays, the fieldwork was completed in December 2004.

In year 2, the first conservation biology course was held from 14th June – 9th July 2004 two weeks later than initially scheduled. CD returned to the UK in September 2004 rather than in

July as originally planned. JR delayed his return to Cardiff until early October 2004 to accommodate a field expedition in September to Arequipa, so that he could bring the maximum number of guanaco samples with him to Cardiff for analysis. JR travelled back to Lima on 1st April 2005.

In year 3, CD travelled to Lima on 1st June 2005 rather than in April as originally scheduled. This was to allow the maximum possible period of time in the laboratory in Cardiff, since the samples proved much more difficult to analyse than anticipated. This did not effect the organisation of the course, arrangements for which were primarily made by JW and CONOPA staff. KY worked in Cardiff between 14th July 2005 and 15th March 2006. This training period was for eight rather than six months as originally scheduled, partly due to the availability of affordable airfares and to enable KY to receive adequate training in data analysis after the completion of the laboratory work. However, laboratory work remained problematic and continued up until KY's departure, and training in analysis continued up until the end of the project. CD and MWB returned to Lima for the final project meeting on 29th March 2006 for two weeks. It was originally intended to hold the Workshop during this visit, from 5th-7th April 2006. However, presidential elections were held on the 9th April and therefore the organisers of the workshop (CONACS and CONOPA) were of the opinion that it would be better to postpone this meeting until 16th-17th May, since violence was threatened by the party of one of the presidential candidates. Instead, a one day conference was held on 6th April, at which the results of the genetic analysis and the population modelling were disseminated by CD, MWB, KY and JCW and the stakeholder's workshop was held from16th-17th May. Unfortunately, due to the close temporal proximity of the election, there was virtually no press coverage of this event.

This project is particularly relevant to the following articles under the Convention on Biological Diversity (CBD):

Article 7, Identification and monitoring, especially - "Identify and monitor components of biological diversity, particularly those requiring urgent conservation." We identified the most vulnerable populations of guanaco in Peru through genetic analysis and population viability modelling. The outcome of the stake-holder's workshop has been the setting up of a standing committee to develop a guanaco management plan for Peru. This will entail ongoing evaluation of the guanaco population.

Article 8, *In-situ* conservation, especially – "Regulate biological resources; promote protection of habitats; and recovery of threatened species; ensure compatibility between sustainable use of resources and their conservation". The Guanaco Declaration (Appendix B) produced during the Workshop from 16th-17th May outlines the dire situation of the Peruvian guanaco and details the steps which need to be taken to protect the species. A working group formed at the workshop will produce the final, detailed management plan.

Article 10 – "Integrate conservation and sustainable use in national decisions; support local populations to implement remedial actions". One of the problems in conserving the guanaco is the vicuña model. The successful rescue of the vicuña from pending extinction through implementation of live shearing and subsequent CITES approved sale of its fibre has produced significant income for many campesino communities and it is natural that similar expectations should exist in regard to the other wild camelid the guanaco. Government regulations and plans concerning this animal have been formulated by simply adding "and guanaco" to the vicuña legislation without any consideration of the situation of the guanaco. One of the most important results of the Darwin Guanaco 1 project has been to demonstrate just how different the guanaco is from the vicuña, to convince the authorities at CONACS that the guanaco cannot be grouped with the vicuña and that separate legislation and treatment is required if this animal is to be saved from extinction. Their strong support of the Darwin Guanaco 1 project results and participation in the management plan workgroup bodes well for a change in policy.

During the stakeholders workshop (PHVA) 16th-17th May, special emphasis was placed on community participation in guanaco conservation through the formation of privately owned conservation areas. Under Peruvian legislation, it is possible for campesino communities to convert their lands into private nature reserves, and the first of these, the Area de

Conservacion Privada Chaparri of the Santa Catalina de Chongoyape community has been very successful in protecting the Peruvian dry coastal forest and producing important income for the community. They are working on recovery of the pava aliblanca (*Penelope albipennis*), an endangered craccid, and have recently brought a small group of guanacos from the Community of Huallhua to Chaparri. Because so much expectation that conserving the guanaco will generate important income following the vicuña live searing model has arisen it was very important to find another model for guanaco conservation capable of generating income for the communities involved. For this reason representatives of the Chaparri reserve and lawyers from the Sociedad Peruana de Derecho Ambiental – SPDA, participated in the PHVA, and the outcome has been that the community of Huallhua is seeking to establish a Area de Conservacion Privada to formalize their efforts to protect their guanaco population, the third largest in Peru and presently headed to extinction due to hunting.

Article 12 Research and Training. These were two of the main components of the project. We researched the population genetics of Peruvian guanaco populations, trained two Peruvian scientists in molecular ecology techniques in Cardiff University and CONOPA and carried out two training courses in Lima on conservation biology, during which 34 students were trained.

Article 15, Access to Genetic Resources – "Scientific research based on a country's genetic resources should ensure sharing in a fair and equitable way of results and benefits". A computer database of genetic data on the guanaco population in Peru will be handed over to CONOPA at the end of the project. CONOPA established a collection of non-invasive genetic samples of guanaco, supplementing their existing archive of camelid samples. The results produced by the project have been translated into the Guanaco Declaration and are central to the development of the final management plan.

Articles 16 and 17, Access to and Transfer of Technology and Exchange of Information. Scientists in CONOPA were trained in high-technology molecular genetics techniques and during the training course, students learned how to use modern stochastic population modelling software and apply it to Peruvian endangered species.

All the objectives for this project were met. These are discussed below.

The fieldwork was completed in December 2004. There were initial delays due to problems obtaining permits from INRENA to allow the collection of samples, but these did not seriously delay the progression of the lab work.

The molecular lab work was completed in March 2006 for six Peruvian populations of guanaco as well as for animals from Chile, Argentina and Bolivia which were provided through collaboration with Juan Carlos Marin (JCM) from Universidad de Chile. Up to 10 individuals per population have been sequenced for mtDNA control region and 15-20 per population at 16 microsatellite loci, where these numbers of samples were available (Appendix F).

Two papers are in preparation, one focusing on the fieldwork (Appendix U) and the other on the genetic analysis (Appendix V). These will be submitted to *Oryx* and *Conservation Genetics* respectively, within the next three months. The project implementation timetable states that two genetic papers will be produced; however, it was felt by the project leaders MWB and JW that a single paper incorporating the two data sets would have a higher impact. In addition, there is an increasing trend for phylogeography papers to include both mtDNA and nuclear DNA data. Difficulties producing the data (see section 3-research for details) meant that the genetic work was not completed until the end of March 2006, therefore the anticipated submission date for the paper has been delayed. The data from the fieldwork and genetic analysis will be used in the production of the management plan.

The Darwin trainees completed at total of 20 months laboratory training in Cardiff and generated the majority of the data for this project. They have therefore demonstrated their increased knowledge, technical expertise and ability to produce high quality genetic data. Both trainees were involved in the production of the project papers and JR wrote a short communication (Appendix H) for the proceedings of a camelid conference in Göttingen at

which he presented a poster (Appendix G). JR also delivered an oral presentation (Appendix W) on behalf of CD who was unable to attend due to ill health. Both trainees have given a number of informal presentations about their work to the research group in Cardiff. KY presented the methods of the guanaco study at the event on April 6 in Lima (Appendix Tb).

As a result of this project, JR and KY are able to work independently and are establishing their own areas of research. They have both been accepted onto Masters Degree programmes which incorporate a research element. KY applied for funding to conduct research on camelid parasites in collaboration with Cardiff University where she intends to register for a PhD. JR used his own initiative to develop a set of primers to identify the of sex camelid sampled for which the origin was unknown and has been working on developing markers for identifying alpacas with high quality fibre. JR has also been involved in the production of research proposals on tapir and taruca. These activities fulfil one of the main objectives of the project.

Eric Chavez (EC), a student at the Faculty of Veterinary Medicine, San Marcos University, collaborated with the project from the beginning. Initially he spent more than a month at Calipuy Reserve making observations of guanaco behaviour and taking photographs, and his veterinary thesis (defended in 2006) involved compilation of all the available information on the Peruvian guanaco. He is currently working on his M.Sc. thesis for the Universidad Nacional de Andalucia, Spain, evaluating public knowledge about the guanaco in Peru in order to design an education programme. EC attended parts of both conservation biology courses, but was unable to complete either because he travelled to Spain for his M.Sc. courses. He is one of the most enthusiastic supporters of the project and his research interest in the human aspects of conservation has added an important, unanticipated, dimension to the project.

Thirty-four students enrolled on the conservation biology courses, 14 more than anticipated at the beginning of the project. All but three demonstrated their increased knowledge through assessment and were awarded a certificate of completion at the end of the course. After both courses, the students set up a web user group through which they keep in contact and in which CONOPA is involved. Through this group, several project proposals have arisen (including a collaborative proposal from the first month long course, on Andean bear conservation).

The true impact of these courses will be seen in the long term, since the students were young professionals recently embarked on their careers and already in positions of importance within key government agencies and private organizations related to conservation. None the less, some outcomes are already obvious, such as the key, knowledgeable contribution to the population assessment workshop process given by Maribel Milla of CONACS. Another important outcome has come through Cecilia Turin, a young professor at La Molina University, who has completely changed the organization of the courses she teaches in South American Camelids to incorporate the conservation biology concepts learned during the course. Other ex-students have gone on to further postgraduate training and one, a lawyer, has taken a post at INRENA.

CONOPA now has the capacity to deliver such courses in the future again fulfilling one of the principal objectives by increasing capacity in CONOPA and in Peru. APECO, an NGO of 26 year's standing and principally dedicated to conservation education, has identified CONOPA as the only organization in Peru offering courses in conservation genetics. They have also offered to work with CONOPA developing the public education campaign on guanaco conservation.

The Workshop was held from 16th-17th May and was attended by key stakeholders. The resultant Guanaco Declaration represents a consensus of all interested parties and establishes the basis for development of an effective, science based, conservation programme.

Additional accomplishments

During the first two weeks of the project (July 2003), MB and CD travelled to Lima for a series of events to launch the project in the host country. From 1st-7th July and exhibition entitled "The applications of DNA in Peru: South American Camelids", was organised at the Peruvian Congress (Appendix Y). As part of this event, an evening conference was arranged at the Congress, at which, MB and JW introduced the concept of conservation genetics and discussed the importance of the Guanaco 1 and previous Darwin Vicuña projects in ensuring the conservation and survival of these species. This conference was introduced by Congressman Adolfo Latorre López and Gustavo Pacheco Villar (Fifth Vice-President of the Congress). The conference was attended by an invited audience comprising parties and organisations with an interest in camelid research. This event gave the project an ideal launch, increased the visibility of the project and led directly to a meeting where the stakeholders all signed up to assist the project and give it their backing and support.

The stakeholders' meeting was held at INRENA drawing together representatives from organisations whose support was necessary for the successful outcome of the Workshop at the end of the project, principally CONACS (National Council for South American Camelids) and INRENA, the two government organisations with legal responsibility for the guanaco, CONAM (National Council of the Environment) and SNVG (National Society of Vicuña and Guanaco).

MB was invited to speak about biotechnology and conservation of animals in danger of extinction at the 57th Anniversary conference of the Faculty of Veterinary Medicine of San Marcos University, Lima on 7th July (Appendix Z)

An evening reception was held on 8th July at the home of Mr Ian Davies, the Deputy Head of the British Embassy Lima, to which representatives of organisations with an interest in camelid research were invited.

An evening seminar was organised at INRENA (National Institute of National Resources) on the 'Applications of biotechnology for conservation of endangered species in Peru' (Appendix AA) at which presentations were given by MB and JW.

Additionally, in collaboration with the British Embassy in Lima, CONOPA helped to organize a special exhibition celebrating 50 years of the discovery of DNA. The event included a series lectures at the embassy, schools and universities in Lima and a poster exhibition highlighting CONOPA's work in population genetics and especially the connection with the Darwin Initiative in relation to the present guanaco and past vicuña projects. The posters were exhibited at different institutions across Peru, having been loaned to the National Museum, Ricardo Palma University and several schools. A letter of thanks from the British Ambassador for CONOPA's contribution to the event is given in Appendix AC.

In September 2004 CONOPA and the III Peru Foundation organized a course on camelid genetics (Appendix AD) which was held at Peru's National Science Foundation, CONCYTEC, and attended by university professors from all over Peru. MB attended as special guest speaker and gave four talks (Appendix AE). The work of the Darwin Guanaco 1 project and the previous Darwin Vicuña project were discussed in detail.

In 2005, the DI carried out a 'Closed Projects Review' of projects based in Peru which have now ended. This included our previous collaborative camelid project (5/6126) Vicuña and Guanaco Conservation and Genetic Resource Management in Peru, which was evaluated by Anna Karp of LTS International Ltd and which included a visit to CONOPA from 24th-26th October 2005. Our project was extremely positively evaluated and partly as a result of this, MWB was invited to present an evaluation of the lessons learned from this project in the context of how DI project results can influence CBD-related activities and legislation in-country at the recent Darwin Initiative workshop in London, 22nd February 2006 (Appendix AF).

During 2005 and 2006 CONOPA consolidated its position as a lobbying force in the area of scientific research on South American Camelids. CONOPA is now considered a strategic partner by CONACS and the two institutions are working hand-in-hand in the area of

conservation of both the wild and domestic camelids. CONACS has embraced the efforts of CONOPA, Cardiff and the DI through the Guanaco I project in co-organizing the workshop and subsequently taking up responsibility to see the results through to the establishment of a formal management plan, complete with changes in the law and financial responsibility to insure its implementation. Nonetheless, the CONACS authorities are aware of their limited term with the upcoming change of government, and they have often expressed their view that CONOPA will remain as the one point of continuity in conservation of the wild camelids. Therefore CONOPA and the project have fulfilled one of the key objectives of the logical framework by ensuring that the outcome of the DI guanaco project will play an important role in planning for future conservation activities.

4. Scientific, Training, and Technical Assessment

The principal scientific goals of the Guanaco 1 project were: to characterise genetically the populations of guanaco living Peru using mtDNA control region sequences and 16 polymorphic microsatellite loci; to gather population demographic and behavioural data through direct observation of the animals in the field; and to use these data to develop a management plan for the species within Peru. In conducting these activities, we intensively trained two Peruvian scientists in laboratory genetic analysis as well as a cohort of CONOPA staff in fieldwork. In addition, two groups of Peruvian scientists were trained in conservation biology through the delivery of two one-month long courses in conservation biology. Details of these activities will be discussed below.

Research

The staff which have been involved in this project and their respective roles are: Professor Michael W. Bruford (MWB) (Cardiff University, Project Leader); Dr Jane Wheeler (JW) (CONOPA, Host-country Coordinator); Dr Ciara Dodd (CD) (Cardiff University, Post-doctoral Research Associate); Mr Jorge Rodriguez (JR) (CONOPA, Darwin Trainee); Miss Katherine Yaya (KY) (CONOPA, Darwin Trainee); Mr Domingo Hoces (DH) (CONOPA, Fieldwork Leader); Mr Hugo Castillo (HC) (CONOPA, thesis student and fieldwork assistant); Miss Rocio Quispe (RQ) (CONOPA, fieldwork assistant); Miss Karina Cabello (KC) (fieldwork assistant); Mr Alvaro Veliz (AV) (Fieldwork assistant); Mr Juan Olazabal (JO) (CONOPA, fieldwork assistant); Mr Eric Chavez (EC), (CONOPA, thesis student, San Marcos University and Universidad Nacional de Andalucia, Spain). Additional research collaborators played a role in this and other projects: Ms. Sara Gomez-Ibanez (SGI) (veterinary student at Cornell University), Dr Stephen Casey (SC) (colleague from Cardiff who volunteered on the project between July and September 2004, currently a lecturer at Lincoln University), Dr Juan Carlos Marin (JCM) (collaborator, Universidad de Chile), Dr. Benito Gonzalez (Universidad Catolica de Chile), Dr. Julieta von Thungen (INTA Bariloche, Argentina).

Fieldwork

In June 2002, 12 blood samples were collected from guanaco captured in a chaccu in Huallhua (Appendix AG, Figure 1). Subsequent field expeditions were planned for 2003 to collect faecal samples non-invasively from six guanaco populations across Peru. However, unforeseen problems were encountered in obtaining the necessary permits from INRENA, which delayed the sampling until April 2004. A map of the sampling sites and details of the samples collected is shown in Appendix E)

The logistics of collecting samples from guanaco, which are found at elevations from sea level to above 4,000 meters in the high Andean puna and are spread across areas of remote, often precipitous and inhospitable terrain where there is little or no human presence, meant that a large team was required for each field expedition. Photos of the fieldwork are shown in Appendix AG (Figure 2). Typically, four to six people were involved in each expedition working in teams of two or three and maintaining contact by walkie-talkie. Animals were observed using a high resolution spotting scope, which was purchased for the project, and

binoculars. A record was made of the animal's behaviour, family grouping and position using a GPS data logger. When an animal was observed to defecate, one member of the team was guided to it by the other who was observing through the binoculars and maintained contact via walkie talkie. In this way, every attempt could be made to relate the sample to the animal from which it came. Every attempt was made to reach the sample quickly and to only collect faeces that still appeared moist and fresh. On collection, the faecal pellets were preserved in 100% ethanol in individually marked plastic (Falcon) tubes.

In practical terms, this method of sample collection was very labour intensive. It can take days to find and observe the animals, and getting to the point where the sample has been deposited can be very difficult and time consuming since observations were often made over relatively long distances in difficult terrain. However, given the virtual impossibility of collecting a sufficient number of blood samples or other types of material from live animals, the procedure described above was the best solution available for obtaining DNA samples.

In addition to collecting faecal material, the field team conducted interviews with members of the local communities using a standard questionnaire that was developed for this purpose (Appendix AH) to obtain data about the guanaco population in the community's area. Information about the project and the remit of CONOPA was also disseminated within the communities where sampling took place (Appendix AI).

A paper is in preparation for *Oryx* detailing the results for the fieldwork and behavioural observations of the guanaco in Peru (Appendix U).

Although not listed within the objectives or outputs of this project, CONOPA continues to conduct research on vicuña, a legacy from a previous Darwin grant (5/6126). As part of this work, several members of the research team (JW, DH, CD, SC, JR, HC, JO) attended a vicuña chaccu in Catac (Ancash) on 3rd September 2004 that was organised by CONOPA and CONACS (Appendix AG, Figure 3). Prior to the chaccu JW and DH presented lectures to the Catac community on CONOPA's work on camelids, the utility of genetics in vicuña population biology and management as well as the aims and objectives of the guanaco DI project Guanaco 1. The vicuña samples collected in the chaccu were analysed with mtDNA and microsatellite markers by CD and JR in Cardiff.

Two papers are currently in preparation on mtDNA phylogeography and demographic history of vicuña for *Heredity* (Appendix AJ) and population genetics and conservation management for *Conservation Genetics* (Appendix AK).

Laboratory work

The principal objective between September 2004 and March 2006 was to obtain mtDNA control region sequence for 10 guanaco individuals per population and 16 multilocus microsatellite genotypes for 15-20 individuals per population where available. This included the Peruvian samples collected for the Guanaco 1 project and also an additional 64 samples from Chilean, Argentinean and Bolivian guanacos that were provided through collaboration with JCM. This work was conducted by CD, JR and KY in the laboratory in Cardiff. All samples were imported with CITES permission under import permit numbers 269658/01, 262547/02 and export permit numbers 0007, 0005176. Details of JR's and KY's contributions to the work are discussed below.

Many difficulties were encountered with the faecal samples at all stages of the laboratory work. These are discussed below.

The laboratory in Lima had already established blood extraction protocols that are used in their other areas of work. However, since the majority of guanaco samples being used in this project were of faecal origin, stool extraction protocols needed to be established and refined. CONOPA had previously successfully extracted DNA from faeces using the Qiagen DNA Stool Mini Kit, but extracts had only proved successful for the amplification of mtDNA. Modifications were made to the manufacture's protocol by both JR and KY to enable the subsequent successful amplification of microsatellites from genomic DNA. Only by using the outer surface of the faecal pellet for extraction, increasing the length of some protocol

steps and reducing reagent volumes to increase DNA concentration in the final extract, was it possible to obtain DNA suitable for all analyses. The optimal protocol is listed in Appendix AL.

However, DNA extracted from the guanaco samples collected in Calipuy consistently failed to amplify in PCR reactions both for mtDNA and microsatellites in Lima and in Cardiff. KY was finally able to successfully extract DNA using the optimal Qiagen protocol, but in parallel, she also spent several weeks optimising a CTAB extraction protocol (Appendix AM), which is normally used for extracting DNA from plant material and has been shown by a laboratory colleague to be the method of choice for extracting DNA from insect gut samples.

For mtDNA PCR, we attempted initially to amplify long fragments (c. 650 bp) of the left domain of the control region from faecal DNA extracts, using primers that had been developed by JCM for camelids. This fragment was difficult to amplify (due to its size) from most of the faecal samples, although using the Qiagen Multiplex PCR Kit with manufacturers standard conditions overcame the problem for some samples, but the resultant sequences were not of good quality. Two shorter overlapping fragments were amplified, using additional primers from JCM, both of which worked well and produced good quality sequences. However, some samples continued to be problematic, especially those from Calipuy, so new primers were designed to address this problem and sequencing was finally completed in March 2006. Details of primers and PCR conditions are listed in Appendix AN (Figure 1; Tables 1-3).

The problem with fragment length has not been as apparent with the microsatellite genotyping, since the maximum allele size being amplified was approximately 260 bp. All microsatellite PCRs were conducted using the Qiagen Multiplex Kit following manufacturer's instructions. Details of microsatellites and multiplexes are listed in Appendix AN (Table 4 & Figure 2). However, difficulties arose with the microsatellite analysis.

DNA obtained from faecal samples is by its very nature degraded and therefore one would expect amplifiable fragments of DNA to be shorter than those obtained from DNA extracted from blood or tissue. In addition, genomic DNA, in which the microsatellites are located, is contained in the nucleus and therefore there is in only one copy per cell compared to several hundreds of copies for mitochondrial DNA. When amplifying microsatellites from faeces it is necessary to amplify the same sample a minimum of three times to ensure that the result is reproducible. Common amplification errors that occur are allelic dropout where one or other allele fails to amplify giving a false homozygote; and false alleles, where an erroneous allele may amplify and give an incorrect genotype. Both of these errors occurred for the microsatellite genotypes being generated in this project. Therefore, it was necessary to repeat the PCRs for some samples up to seven times to ensure that a reliable genotype was obtained. Allelic dropout was more apparent in the loci with larger amplicons and these larger fragments were also more likely to fail completely compared with ones which were smaller. Despite these problems, both in terms of time and expense (finance needed to be vired from other budget headings) the genotyping was completed in March 2006.

Sequence data was analysed using DNASP and Arlequin to determine the relationship among haplotypes and genetic structure within and among Peruvian guanaco populations (Appendix AO, Figures 1-3). We identified 16 haplotypes within Peru out of a total of 30 haplotypes across the animals' South American range. Weakly defined population structure is evident among the haplotypes, which show a distribution pattern that is consistent with a species that diverged since the last glaciation. When an analysis of molecular variance (AMOVA) was performed, the large majority (72.6%) of the variance was observed within the populations rather than between groups based on country (9.11%) or among populations within groups (18.3%).

Genetic diversity was measured as the mean number of alleles per locus, observed and expected heterozygosities and Fst (genetic variance among populations with respect to the entire sample) using Genetix (Belkhir *et al* 2004). Patterns of genetic differentiation were further examined in Structure and Genetix using 2-dimensional factorial correspondence analysis (2D-FCA) (Appendix AO, Figures 4 & 5; Tables 1 & 2). In general there was little evidence of inbreeding because heterozygosity values were high and observed

heterozygosity values and those expected under Hardy-Weinberg equilibrium (random mating) were similar. Only one population showed evidence of an excess of homozygotes, but this was likely to be due to combining genotypes across a subdivided population. In general, the populations were not highly genetically differentiated with relatively low average Fst values. Analysis using the Bayesian clustering approach implemented in the software STRUCTURE (Prichard *et al* 2001) showed that there was only one genetic group within the guanaco in Peru, although from the results of the 2D-FCA analysis, it was evident that a cline of genotypic variation exists within the Peruvian guanaco from north to south, and which is apparent across the whole of the South American range (Appendix AO, Figures 4 & 5).

These results led us to make the following management recommendations. Guanaco in Peru comprise a single management unit and no distinct boundaries between populations. However, since a north-south cline in genetic variation exists, if animals are required to be translocated, a prudent approach would be to do this, where possible, only between adjacent populations. A paper is currently in preparation detailing the results of the genetic analysis which will be submitted to *Conservation Genetics* (Appendix V).

An additional goal of the laboratory work was to establish the ability to multiplex microsatellites visualised on silver-stained gels in CONOPA. JR and KY worked to optimise a system of multiplexed microsatellites in the lab in Lima under the supervision of CD. Initially multiplexes that had been used in Cardiff with a fluorolabelled system were tested, but it was clear that the multiplexes needed redesigning to allow for differences in the techniques used in the two laboratories (Appendix AP, Figures 1 & 2). Multiplexes were restructured so that co-amplified loci were within a smaller size range and loci were chosen that did not have overlapping allele size ranges. Two duplexes (two primer pairs amplified in the same PCR reaction) were optimised (Appendix AP, Figures 3 & 4).

JR also worked on developing a SSCP methodology for separating sequence haplotypes. Samples were run to test this method for which we already had sequences and knew the sequence polymorphisms between the haplotypes. Although progress was made with this technique up until December 2005, it was not possible to achieve the required level of resolution to separate haplotypes that differ by only a few mutations (Appendix AQ). This is most likely to be because of the lack of temperature controlled electrophoresis equipment in the lab in Lima. Another technique which may be suitable for this purpose (Denaturing Gradient Gel Electrophoresis - DGGE) was attempted in Cardiff, but again requires the use of specialised equipment which is not available in the lab in Lima. However, the need for separating mtDNA haplotypes in this manner is no longer an issue in CONOPA since future work requiring sequencing will be outsourced to a company (such as Macrogen) which offers sequencing at a very competitive price and produces high quality results.

Further, JR developed camelid specific sexing primers. To do this, he amplified sex chromosome fragments using general bovid primers, sequenced the fragments and then identified sex specific sequence polymorphisms. Specific PCR primers were then designed to amplify these fragments, showing one band for female and two bands for male when visualised on agarose gels (Appendix AR). These primers work in guanaco, vicuña, alpaca and llama and will be of great use for the work of CONOPA. However, as some of the amplicons were too large to work well with faecal samples, KY is developing a new set of primers targeting shorter DNA fragments.

Additional research outputs of the project include analysis of the guanaco faeces for parasites. A thesis student in CONOPA, Hugo Castillo (HC), identified endoparasites in the faeces of the guanaco populations surveyed for Guanaco 1. This research found significant parasitism with more than 50% of the guanacos sampled being positive for gastrointestinal nematode and coccidial infestation. A paper is currently in preparation for a parasitological journal.

Training

Darwin Trainees

JR and KY received a total of 20 months intensive training in laboratory techniques and analysis in Cardiff during the Guanaco 1 project. JR spent two six-month periods in Cardiff (September 2003 – March 2004 and October 2004 – April 2005). KY spent eight months in Cardiff (July 2005 – March 2006). Both JR and KY gained competence through working on a day to day basis with the guanaco samples collected for this project and worked with CD in the laboratory, extracting DNA from faecal samples, amplifying mtDNA and nuclear markers for sequencing and genotyping. The specific techniques and protocols which they learned are discussed above. JR also worked with alpaca samples for his thesis on parentage testing.

At all stages of the training process the techniques have been demonstrated to JR and KY and until reaching proficiency, they conducted these activities under the supervision of CD. CD provided advice, guidance and troubleshooting throughout the process.

As a result of the problems encountered with using faecal samples, KY particularly has become extremely proficient at extracting and amplifying DNA from difficult material. These skills will prove to be invaluable for ongoing and future work within CONOPA and KY will use her knowledge to train other members of the CONOPA laboratory.

Both KY and JR received extensive training in mtDNA sequence editing using the software Sequencher and microsatellite analysis using the programmes Genescan and Genotyper. The trainees were provided with a step-by-step sequence analysis protocol, written by CD, which included information on conducting subsequent preliminary analysis such as identifying haplotypes, and creating phylogenetic trees in PAUP (Appendix AS). A guide to scoring microsatellite gels was also provided but was not developed specifically for the project (Appendix AT). These protocols have been transferred to CONOPA for future work.

These analytical skills will be invaluable to the work in CONOPA particularly for future projects if they outsource sequencing and genotyping to companies (such as Macrogen in South Korea, who carry out such analysis more cheaply than is feasible in many developing countries). This company returns sequence and genotype files in a format for analysis with the above programmes. Currently KY and JR are the only members of CONOPA with the appropriate skills to conduct this analysis but are in the process of transferring their knowledge to other lab members.

Both Trainees attended MWB's undergraduate Conservation Biology module in Cardiff and the International Course in Conservation Biology in Lima, increasing their theoretical knowledge of the concepts of conservation biology and molecular ecology.

An undergraduate veterinary student from Cornell University, Sara Gomez-Ibañez (SGI) arrived at CONOPA in June for a 2 month placement to gain experience in many aspects of camelid medicine and research. She chose CONOPA as her training placement as a direct result of the Darwin Initiative project, information about which she obtained from the project website (http://www.cardiff.ac.uk/biosi/research/biodiversity/staff/dodd.html). As part of her placement she was trained in the laboratory by JR in PCR, SSCP and gel electrophoresis, using techniques that he learned from the Darwin project training (Appendix I).

Conservation Biology courses

Applicants for the conservation biology courses were invited from Peruvian NGOs, international conservation organisations and government departments such as INRENA, CONACS and CONAM. Applications for the courses were evaluated by JCW, DH and CD and candidates were chosen according to their experience and knowledge of English. In total 34 students enrolled on the courses from the following organisations: INRENA (6), CONAM (4), CONOPA (4), Faculdad de Medicina Veterinaria San Marcos (3), Universidad Alas Peruanas (3),CONACS (2), Museo de Historia Natural de Lima (2), APECO (1), Animal Management (1), Asociación Civil Salvemos al Guanaco (1), Associación Craccidae (1), Conservation International (1), Universidad Nacional Agraria La Molina (UNALM) (2), and Museo de Historia Natural de Lambayeque (1). Full details of course participants is listed in Appendix O.

The first course was held from 14th June to 9th July 2004 and hosted by Universidad Cayetano Heredia in Miraflores, Lima. The second conservation biology course was held between 13th June and 7th July 2005 and hosted by Facultad de Medicina Veterinaria, Universidad Nacional Mayor de San Marcos, Lima. The structure of these courses was similar, but some modifications were made to the second course based on experience in the first year. The courses were based on and extended from the framework of previous successful courses run as part of DI projects in Gabon (08/044) and Malaysia (09/016). Whilst overall course structure and core lecture topics were maintained for the Guanaco 1 project, specific examples and activities were tailored to the issues relevant to conservation within the different habitat zones of Peru. The programmes for the two courses are listed in Appendices L-N.

The core course material was delivered by CD and MWB in an intensive first two weeks, consisting of lectures, practical exercises and discussion. The lectures covered topics ranging from an introduction to conservation biology, threats to biodiversity, small population biology and extinction, to the application of genetics to conservation and population and habitat viability assessment. Students were required to gather information about an endangered species of their choice which they would then use in a practical exercise on PHVA using the programme VORTEX at the end of the second week. This modelling exercise was assessed by MWB. All the core lectures were delivered by CD and MWB in English, but the students were provided with a Spanish translation of most presentations, however the students felt that they did not require all the lectures to be translated. The Spanish versions of the lectures are included on the course CD and DVD (Appendix BI, discs 1 and 2 respectively).

The second two weeks of the course consisted of talks by invited speakers covering all aspects of conservation projects in practice in Peru. Speakers were invited from governmental, university, conservation organisations, eco-tourism companies and a variety of NGOs within Peru. Many speakers who gave presentations on the first course also lectured on the second course. Three special topic days were organised in 2004 which were open to members of the public. The topics of these were: 1. Legal Framework and Politics of Conservation; 2. Conservation in Practice in Peru; 3. Vicuña and guanaco Conservation. Two open sessions were organised in 2005; 1) Conservation in Peru and 2) Conservation of Species of Economic Interest. The programmes for these events are in Appendix M. Notable speakers who gave presentations at these sessions were invited from CONAM, IUCN, INRENA, Peruvian Congress, Conservation International and WWF amongst others.

Both the course and the open days were advertised by letters posted to all relevant institutions throughout the country containing posters and flyers, in local newspapers, at the host universities and on the CONOPA website and were well attended by both students and professionals from Lima and the provinces. The posters and leaflets produced for advertising the courses all of which featured the Darwin and project logos (Appendix AU).

Each course featured a daylong visit to the CGIAR International Potato Centre (CIP) which was made in the third week of the course. Here, the students learned about gene banks, conservation and sustainable utilisation of genetic resources (see Appendix N) for the programmes). This excursion provided the opportunity for the students to visit high-tech and high throughput laboratories and to observe the application of genetics to conservation from an agricultural perspective, providing a good contrast to the emphasis of the rest of the course.

In 2004, a three day field course was organised to Reserve Nacional de Paracas in collaboration with INRENA. During the field course, the students were given lectures by INRENA staff working in the national park, had the opportunity for discussions with them about conservation issues in the park and were given guided educational tours around the park. In particular, the difficulties of integrating effective conservation management in the reserve with the needs of local people using and/or living within the reserve were highlighted. In addition, a special presentation was given to the students by the members of the CAMISEA project in Pisco. This team is responsible for monitoring the impact of a large cross country gas pipeline which ends at a location situated just outside of the Paracas Reserve. This visit prompted intense discussion between the students and the CAMISEA

project representatives. This element of the course was not run in 2005 due to time and economic constraints.

At the end of each course the students were each given a CD (2004) or DVD (2005) of all the course materials and lectures. These are included in Appendix BI, discs 1 and 2 respectively at the end of the report). The DVD of the 2005 course is available to all on the CONOPA web site. Photographs of the students visit to CIP and the field course are detailed in Appendix AV.

On the first day of the course, the students were provided with written details of the assessment procedure (Appendix P) and shown examples of assessments from the course run in Malaysia (09/016). Assessed exercises consisted of; i) individual presentation about an endangered species, ii) group presentation about a protected area, and iii) an individual presentation of a scientific paper. Coursework exercises were assessed by CD and JCW and the PVA modelling was assessed by MWB. The student's assessments are included on the course discs (Appendix BI disc 1 and 2).

These assessments took place on the last 3 days of each course (Appendix Q) which the students needed to pass to gain a Certificate of Completion (representative certificates are shown in Appendix R). The students were also required to attend a minimum of 70% of the first three weeks lectures, and participate in course activities and discussion (e.g. see Appendix AW), which were monitored by CD. Through the discussion and assessment process delivered on this course, the students were able to demonstrate increased learning and show that they had digested and understood the messages and information given to them throughout the course. This meets one of the key objectives detailed in the logical framework. Students that did not satisfactorily complete the assessments were awarded a Certificate of Attendance. Photos of some of the students delivering their presentations are shown in Appendix AX.

The students were also required to participate in discussions and workshop exercises throughout the first two weeks of the courses. These consisted of a workshop session on conserving biodiversity on Peru (Appendix AW), a management plan for some endangered species and a PVA modelling practical class.

Capacity building

Two objectives of the project were to increase the capacity in CONOPA for molecular genetics techniques and to increase capacity in Peru for conservation biology. Both these objectives were successfully completed.

JR and KY learned many new molecular techniques, particularly in relation to using non-invasively collected material, a capacity that was lacking in CONOPA before the project. They have used their knowledge to train other scientists and students in the CONOPA laboratory in these technologies.

Capacity for conservation biology in Peru has been increased through the conservation biology courses that were run in 2004 and 2005. More scientists were trained than initially anticipated. This has fostered links between key organisations and individuals and led to the creation of a network of individuals with a commitment and enthusiasm for conservation within country. Through this network, number of new project proposals have arisen and will continue to yield similar activities in the future. It was clear that the positive impact of the first year's course influenced and increased the number of students from appropriate institutions applying for the second year's course.

Additional capacity has been built in CONOPA through the acquisition of a number of conservation biology and genetics textbooks (Appendix K).

5. Project Impacts

The project fulfilled the purpose of sampling six guanaco populations in Peru and through the behavioural data and laboratory analysis of these populations has determined the genetic structure of guanaco in Peru. These data have been used to model the viability of the populations and together have accomplished the main purpose of the project; to enable the development of a management plan for the species in Peru.

The International Workshop on the situation of guanaco in Peru resulted in a resolution to develop a strategy for the conservation of guanaco in Peru (Appendix B). The declaration, agreed by consensus to:

a) Firstly the necessity to implement conservation measures that prioritise the recovery of the populations.

b) Develop a national plan for conservation of the guanaco on the basis of the consensus reached during this meeting

c) Recognise and publicize information about the grave situation of the guanaco in Peru

d) Update laws for the protection of the guanaco

e) Promote environmental education and strengthen the teaching of guanaco related subjects in institutions

f) Create mechanisms and instruments to finance guanaco conservation

g) Generation and validation of knowledge and its transfer

h) Develop lines of scientific research directly related to conservation of the guanaco

i) Support the development of a guanaco management plan to be drawn up by representatives from CONAM, INRENA, the Peruvian National Police and INTERPOL, APECO, CONATURA, the Capesino Community of Huallhua, Proyecto San Cristobal, ILLACATA, Area de Conservacion Privada Chaparri and Centro Awanakancha, under the leadership of CONOPA, Sociedad Peruana de Derecho Ambiental – SPDA, CONCYTEC and CONACAS as a permanent secretariat.

This plan will become part of the National Plan for Conservation of Wild South American Camelids and will be translated into specific conservation action by the Peruvian authorities as soon as possible and the Workshop has contributed towards Peru's obligations under CBD.

Appendix I has been completed to indicate the contribution made by different components of the project to the measures for biodiversity conservation defined in the CBD Articles.

The capacity building aspects of the project have been extremely successful. Specifically, these were to increase capacity in conservation genetics research (by training CONOPA scientists in the laboratory) and to train a cohort of Peruvian scientists in conservation biology. JR and KY have established new protocols within the laboratory in CONOPA and are using their knowledge to train their colleagues. They are both actively involved in their own research projects and continue to apply for new grants

The conservation biology courses which we ran in 2004 and 2005 provided comprehensive training for 34 Peruvian scientists, many more than we anticipated initially. The enthusiasm of the students and the positive feedback received by them coupled with the development of several research proposals by the students demonstrates the increased capacity for local scientists to advance conservation work within Peru. Furthermore, several students have continued their training in conservation biology which will continue to increase Peru's capacity in conservation biology.

An unexpected impact of the courses was a spin-off course at Facultad de Ciencias Biologicas, Universidad Nacional de Trujillo, in northern Peru from 10th-12th March 2006, organised by a student from the 2005 course, SN. The course, "Tecnicas Moleculares Aplicadas a la Biologia de la Conservacion" was attended by young professionals, university professors and students and attracted more than 90 attendees from Trujillo and throughout northern Peru. A CD of the course is included in Appendix BI (disc 3).

Jessica Amanzo,(2004) a research assistant at the Museo de Historia Natural of San Marcos University during the course has gone on to join the Biology Department at Cayetano Herredia University where she is actively involved in research on the endangered pecari, woolly tapir (*Tapirus pinchaque)* and Spectacled Bear (*Tremarctos ornatus*). Both JR (2004) and Susy Nunez are involved in genetic research in collaboration with Amanzo. Susy Nunez (2004) received a two fellowship from CONCYTEC for completion of her masters degree. Pavel Cartagena (2004) moved from a position at INRENA to become Biodiversity Coordinator at Conservation International in Lima.

Jannet Cisneros (2005) professor at the Faculty of Veterinary Medicine, San Marcos University, has won a two year fellowship from CONCYTEC to carry out research on genetic variability of the peccary for her master's thesis. Sandy Tassi (2005) has taken leave from CONACS to complete her Biology degree. Cecilia Turin (2005), professor at Universidad Nacional Agraria La Molina, UNALM, continues to take a very active role in teaching conservation genetics concepts in regard to the South American camelids and is having a positive influence on a new generation. Carmen Guerrero (2005) has taken up a position in the legal department at INRENA.

The impact of the project in terms of collaboration between UK and local partners in discussed throughout this report. Collaboration between the partners will continue in the future during the preparation of publications and writing of new proposals building up on the Darwin legacy. One proposal has been submitted to the Royal Society to conduct research into camelid parasites.

One unanticipated outcome of the PHVA meeting was an agreement between the Comunidad Campesina de Huallhua, CONOPA and the Sociedad Peruana de Derecho Ambiental, to work together to establish a Private Conservation Area at Huallhua as a measure to protect the guanaco population and other endangered species which inhabit the area. A formal proposal is currently in preparation to be submitted to the Fondo de las Americas.

Exit strategies

Suitable exit strategies are in place.

In order to ensure the ongoing capacity within CONOPA for addressing conservation and scientific issues of camelid conservation in Peru, it is anticipated that CONOPA will be able to achieve the following functions by the end of the project.

a. JR and KY are able to produce high quality reproducible genetic data for population, phylogeographic and phylogenetic analysis from good quality and challenging DNA samples. The methodologies have been established in the laboratory in CONOPA. Microsatellite multiplex genotypes can be produced using silver staining and fluorescent methods (by outsourcing PCR products to e.g. Macrogen). MtDNA sequences can be produced again by cost-effectively outsourcing to e.g. Macrogen. JR and KY are able to analyse these data using the appropriate methods and can apply their knowledge to use new types of analysis and know where to find information and programs to enable them to do this.

b. JR and KY are able to work independently and train others in laboratory methods. JR and KY have supervised and trained thesis students in Lima and trained other scientists in the CONOPA laboratory. Both trainees have demonstrated that they are able to transfer the skills that they have learned in this Darwin project to other students and colleagues in the laboratory (Appendix I).

c. JR and KY have gained sufficient experience during the project to be able to apply their knowledge to new projects. KY is already working on molecular etiopathogenesis of enterotoxaemia in alpacas for which she obtained funding from CONCYTEC. KY applied for funding to investigate the genetics of camelid parasites. JR has been involved in the development of projects on woolly tapir and taruca.

d. The CD and DVD of the conservation biology course materials have been disseminated to CONPA for them to use for subsequent courses. One course using these materials was run in Trujillo in March 2006. (Appendix BI discs 1, 2 & 3)

e. A declaration on guanaco conservation in Peru was drafted and adopted by consensus by key stakeholders at the Workshop in May 2006. This is being translated into specific conservation action (Appendix B).

f. Four publications are in preparation for peer reviewed journals and one has been submitted to *Heredity* (Appendix AJ).

g. Initation of the process of converting the Community of Huallhua into an Area de Conservacion Privada in order to protect the local guanaco population is a direct result of the stakeholders workshop.

h. CONOPA has been named Scientific Authority for CITES by CONACS.

6. Project Outputs

The project outputs have been quantified in Appendix II and full details of publications and material that can be publicly accessed are given in Appendix III. All the outputs in the agreed schedule were successfully achieved (except for those highlighted below) and additional outputs were also produced (marked with * in Appendix II). These are discussed below.

Additional outputs:

(3) Fifteen Peruvian students were enrolled on the course in 2004 and 19 in 2005. In total 14 more than the anticipated 20 scientists were trained in conservation biology. Thirty-one out of 34 students passed the assessments and were awarded a Certificate of Completion. The other three received a Certificate of Attendance.

(4a, 4b) An undergraduate veterinary student SGI obtained funding to conduct an undergraduate placement on the project based at CONOPA. SGI was trained for eight weeks in laboratory skills by CD and JR. She travelled to the field to sample and examine alpacas to learn more about camelid medicine. She also attended the conservation biology course although did not sit the assessments.

(6b) KY received training in the laboratory in Cardiff for eight rather than six months from July 2005 to March 2006.

(7) In collaboration with the British Embassy in Lima, CONOPA helped to organize a special exhibition celebrating 50 years of the discovery of DNA. The event included a series lectures at the embassy, schools and universities in Lima and a poster exhibition highlighting CONOPA's work in population genetics and especially the connection with the Darwin Initiative in relation to the present guanaco and past vicuña projects. The posters were lent to National Museum, Ricardo Palma University and several schools and were exhibited at different institutions across Peru (Appendix AC). In addition to the CD of the first conservation biology course, a more comprehensive DVD of course materials was produced for the second course.

(8) A British ex-postdoc from MWB's lab in Cardiff (SC) volunteered on the project for 10 weeks between 3rd July 2004-10th September 2004. SC assisted with training JR and KY and took part in fieldwork in Catac and general laboratory activities.

(11b) A number of articles were published in national and international journals which discussed the objectives of the Guanaco 1 project as well as other aspects of camelid research conducted by the project team. These are detailed in Appendix II.

(14a) A one-day conference was held on 6th April 2006 at which the results of the guanaco genetic analysis and Vortex modelling were disseminated (Appendices S & T). This meeting was held in addition to the Workshop.

(14b) A number of talks were given throughout the duration of the project, which raised awareness of the Guanaco 1 project and the Darwin Initiative in Peru. These included international conferences, special events organised for the project, and invited presentations. A total of xx presentations were given by MWB (6), JW (20), DH (1), CD (2), KY (1), JR (1), HC (1). Specific details are given in Appendix II.

(15b) Press releases were issued to local newspapers to advertise the conservation biology course Open Access Days in 2004 and 2005. These resulted in at least one advertisement for the course being posted on the internet on a Colombian conservation website (http://www.humboldt.org.co/chmcolombia/servicios/jsp/redes/a_p/ListarEventosDetalle.jsp?mes=6&ano=2005&texto=Junio/2005&categoria2=9) (Appendix AY).

(15c) The BBCNews website reported the problem of extinctions including the plight of the Andean guanaco (http://news.bbc.co.uk/1/hi/sci/tech/3047253.stm) (Appendix AZ)

(17a, b) A web-based contact network was established by the students on the conservation biology course in 2004 to enable them to continue to collaborate and exchange ideas about conservation biology. This network was enhanced in 2005 by the students attending the second course.

(20) Six text books were purchased by CONOPA or privately by JR for use by CONOPA and for use by the students on the courses (Appendix K). The approximate value of these books is £200.

Outputs that have only been partly achieved or still need to be completed are detailed below:

(8) CD spent 2 weeks less than anticipated in Lima in 2005 to enable completion of the planned laboratory work in Cardiff for year 2. CD spent 12 weeks less than planned in Lima in year 4 of the project. This has not had a negative impact on the training received by JR and KY since KY spent an additional 8 weeks being trained in the laboratory in Cardiff and contact was maintained via email between CD and the trainees up until the end of the project. Overall, the number of training weeks spent by UK staff in Peru has remained the same as indicated in the original project outputs table.

(11a) Two papers were anticipated for the guanaco genetic work, however it was decided by the project leaders that a single paper containing all the genetic results would be more appropriate and would achieve higher impact. In addition, the samples for the last two populations only arrived in Cardiff with KY in July 2005 and coupled with continuing problems with the laboratory work meant that this work was only completed in March 2006. This paper is now in preparation for *Conservation Genetics* and will be submitted by October 2006 The population census and behavioural data is being compiled and a manuscript will be submitted to *Orxy* within the next three months.

Dissemination of outputs.

The information relating to the outputs and outcomes of this project has been disseminated through workshops, courses, conferences, articles and scientific papers (see Appendix III for full details) as well as to members of the communities on whose land the guanacos live. The principal events within Peru are highlighted below.

1st-10th July 2003 – Launch events

A seminar entitled "The applications of DNA in Peru: South American Camelids", was organised at the Peruvian Congress at which, MWB and JW introduced the concept of conservation genetics and discussed the importance of the present Darwin Guanaco and previous Darwin Vicuña projects in insuring the conservation and survival of these species (Appendix Y).

A stakeholder meeting was held, with the assistance of CONAM and Conservation International, which brought together all interested parties and set the basis for preparing the Workshop to be held at the end of the project.

Public lectures about conservation biology, genetics, the outcome of the previous Darwin project on vicuña and the current guanaco project, were given by MB and JW at the Peruvian Veterinary Academy of Science, San Marcos University and INRENA.

In collaboration with the British Embassy in Lima, CONOPA helped to organize a special exhibition celebrating 50 years of the discovery of DNA (Appendix AC). The event included a series lectures at the Embassy, schools and universities in Lima and a poster exhibition highlighting CONOPA's work in population genetics and especially the connection with the Darwin Initiative in relation to the present guanaco and past vicuña projects. The posters were exhibited at different institutions around the Peru, having been loaned to the National Museum, Ricardo Palma University and several schools.

21st-24th September 2004 – Camelid course

CONOPA and the III Peru Foundation organized a course on camelid genetics which was held at Peru's National Science Foundation, CONCYTEC, and attended by university professors from all over Peru. MWB attended as special guest speaker and gave four talks (Appendices AD & AE). The work of the Darwin Guanaco 1 project and the previous Darwin Vicuña project were discussed in detail.

6th April 2006 – Guanaco 1 Conference

A one day conference was held at Centro Cultural Peruano Británico on 6th April 2006 at which the results of the genetic analysis and the Vortex population viability modelling were presented by JCW, KY, CD and MWB (Appendices S & T). This conference was attended by key stakeholders and community campesinos and co-organised by CONOPA and CONACS with help from the British Embassy, Lima.

16th-17th May 2006 –Workshop

The workshop was held at CONCYTEC and was the second event organised by CONOPA and CONACS to discuss the problem of the conservation of guanaco in Peru, based on the results of the Guanaco 1 project. The aim of the meeting was to formulate recommendations for the guanaco's protection and to lay the foundations of a National Plan for the Conservation of the Guanaco to enable the recovery of the species for future sustainable management which will benefit the local communities on whose land the animals live. Key stakeholders participated in the meeting and signed a resolution agreed by consensus at the end of the meeting for the conservation of the guanaco in Peru (Appendix B).

The two events were publicised on a number of internet sites (Appendix BA) including those of CONOPA, CONACS and CAMELYDAPERU. A campaign poster (Appendix BB) and a flyer were developed by CONACS and CONOPA and distributed to delegates at the conference and workshop, as well as appearing on the CONOPA website and as a backdrop to the reception areas at both events (Appendix BC).

Dissemination of the results of this project will continue after project completion. CONOPA is fully committed to camelid conservation and research within Peru. The high profile which CONOPA enjoys in Peru and its collaboration with the Peruvian authorities will ensure that

the results of this project and the management plan will be implemented into direct conservation action. All parties will be involved in the dissemination of the results of the project through the production of scientific papers, local and national media.

The partners in this project (MWB and JW) continue to work together in camelid research and have already submitted applications together with (CD and KY) to conduct research on guanaco parasites and other proposals are in preparation.

7. Project Expenditure

	2003-2004			2004-2005			2005-2006			2006-2006		
Item	**Budget**	**Expenditure**	**Balance**	**Budget**	**Expenditure**	**Balance**	**Budget**	**Expenditure**	**Balance**	**Budget**	**Expenditure**	**Balance**

Total Darwin Grant: £201,015

Annual Darwin Grant: 2003-2004 = £50,400
2004-2005 = £68,229
2005-2006 = £66,428
2006-2006 = £15,591

2003-2004

Extra expenditure on flights was necessary due to the rapidly escalating cost of six-monthly tickets from the UK to Peru, which affected the cost of JR's return flight to Cardiff and CD's return flight to Lima.

2004-2005

There is an apparent under spend on travel in this financial period. This is due to the alteration of the original project timetable which has meant that some flights have occurred later than planned and cost more than initially anticipated. This also resulted in an over spend on travel in the previous period, which on balance cancels out the under spend observed here.

2005-2006

There was an overspend on laboratory work since the samples have proven much more difficult to work with than anticipated. Therefore extra work had to be conducted to complete the genetic data.

8. Project Operation and Partnerships

Collaboration with local partners:

The principal local partner for this project was CONOPA Coordinadora de Investigación y Desarrollo de Camélidos Sudamericanos.

Collaboration with other partners:

Universities

Universidad de Cayetano Heredia provided the project members with facilities to organise the conservation biology course in 2004.

Facultad de Medicina Veterinaria, Universidad de San Marcos provided the project members with facilities to organise the conservation biology course in 2005

CONAM

CONAM, the Peruvian institution responsible for CBD compliance, provided continuing support for the activities of Guanaco 1 throughout the project. During the first year, it was thanks to the intervention of Carlos Loret de Mola, the President of CONAM, that INRENA was forced to sign a collaborative agreement with CONOPA, which resulted in issuance of the much delayed sampling permits for Guanaco 1. They helped coordinate and advertise the two conservation biology courses and released staff members so they could attend. They provided strategic support for setting up the PHVA meeting and are playing an active role in developing the guanaco management plan.

INRENA

INRENA, the natural resource institute in Peru, is divided into two branches, one dealing with national parks and protected areas and the other with biodiversity. We had a very difficult time with this institution because CONOPA was the first institution working with genetic resources to attempt to establish an agreement, but once past this hurdle we were able to obtain sampling permits and carry out the project as well as CITES permits for shipment of

the samples to Cardiff for analysis. We have maintained good working relationships with the INRENA field offices but relationships in Lima are difficult. Part of the problem is the lack of clarity in Peruvian law concerning the remits of INRENA and CONACS in the area of South American camelids.

CONACS

CONACS, the South American camelid council, has been a strategic partner in carrying out the project. There has been close collaboration with the field offices during the sampling, with CONACS staff occasionally participating in the fieldwork. CONACS became the CITES institution for South American camelids in Peru in 2005, and CONOPA was named scientific authority in 2006. CONACS and CONOPA worked together as strategic partners in organizing the PHVA meeting and will continue to do so as the guanaco management plan is developed.

Logistic support from Ing. Carlos Ponce del Prado, Vice President of Conservation International, was crucial to resolving the problems with INRENA, and in regard to publicising the Conservation Biology course.

British Embassy

In collaboration with the British Embassy in Lima, CONOPA helped to organize a special exhibition celebrating 50 years of the discovery of DNA. The British Embassy also supported the Workshop, providing invaluable advice about its organization, fundraising and publicity.

Collaboration with international partners

We have established collaborative links with Dr. Juan Carlos Marin (JCM) of Universidad de Chile, Santiago. Through this collaboration we have been able to gain access to vicuna and guanaco samples from a much wider geographic are than would have been otherwise possible. JCM travelled to Cardiff in 2004 and 2006 to work with CD, MWB and JR in the laboratory and he has participated in the conservation biology courses, the camelid course in September 2004 and the Workshop. This collaboration will continue after the project and he is due to visit the laboratory in Cardiff in July 2006.

In 2004 collaboration was established between Prof. Alan Cooper (University of Adelaide) and Jane Wheeler (CONOPA) for research on ancient southern hemisphere faunal populations (DNA) in order to examine the genetic impact and role of climate change and human colonisation in Late Pleistocene and Holocene extinctions. Funded by the Austrailian Research Council, ARC, the project will focus on ancient guanaco populations in South America, including faunal remains from archaeological sites in Peru previously studied by Wheeler.

A new collaboration between the project leaders and Dr. Oswaldo Ramirez (OR) of Universidad de Cayetano Heredia began in 2005 and OR travelled to Cardiff to work in MWB's laboratory. This collaboration is investigating the origin of domestication of guinea pigs in Peru and conservation genetics of wild populations.

9. Monitoring and Evaluation, Lesson learning

All progress within the project has been monitored in Cardiff and in Lima through weekly lab meetings held by MB and JW respectively. These meetings provide the opportunity to outline progress and discuss problems and future work with the project team and in Cardiff provides the opportunity to discuss ideas with other lab members and tap into their expertise where required. Contact was maintained between CD (whilst in Peru) and MB via a weekly email update outlining the progress and or issues arising during the week. In addition there have been a number of specific project and planning meetings with MB and JW.

The trainees' work has been verified at all stages of the process by CD through day-to day discussion of the procedures and results. In addition, regular laboratory and project meetings have ensured that all aspects of the work have been monitored and approved by the project leaders.

Progress of the students on the conservation biology courses was continually assessed by CD, MB and JW through discussion, workshops and presentations. The students were formally assessed at the end of the course before receiving their certificates. The high percentage of students receiving a Certificate of Completion (31/34) and the positive evaluation of the course by the students (through an evaluation form) (Appendix BH) demonstrate the success of the courses.

Problems:

INRENA

Significant difficulties were encountered with one particular official at INRENA who refused to issue the permit necessary to allow sampling to commence. This issue took almost one year to resolve and as a consequence, fieldwork had to be delayed until mid-April 2004. Subsequent expeditions were successful and fieldwork was ahead of schedule in September 2004 with the last two populations being sampled in December 2004.

Fieldwork

The fieldwork aspect of this project proved to be much more demanding than originally anticipated. Due to the scarcity and remoteness of guanaco populations, and frequent lack of reliable information concerning their location and facilities available in the area, it was often difficult to predict the duration of expeditions, and adequately prepare supplies and provisions for members of the field team, who had to take or carry sufficient provisions and kit with them. As sampling progressed, the team learned how best to prepare and efficiency increased with experience, something that could only be learned in the field.

Laboratory work

A number of difficulties arose with the molecular work as a result of DNA quality associated with faeces. Throughout the project, different modifications to extraction protocols and new methods of DNA extraction were tested. Particular problems were encountered with faecal samples from the Calipuy population, for which numerous extraction methods were tested. Final modifications to the Qiagen Stool Mini Kit protocol (Appendix AL) and the CTAB extraction protocol (Appendix AM) finally resolved the problem for most samples.

There were associated problems with the amplification of DNA from these samples. It was not possible to amplify long fragments (650 bp) of the mitochondrial control region from many of the faecal DNA extracts. Using the Qiagen Multiplex Kit for PCR amplification overcame the problem for some samples, but the resultant sequences were often of poor quality. Reducing amplicon length by designing a variety of new primers that generated a series of shorter overlapping fragments resolved the issue.

Difficulties which arose with the microsatellite analysis involved problems common to amplifying faecal DNA such as allelic dropout and the amplification of erroneous alleles. Conducting repeat PCRs for the same individual (up to seven times for some) produced a reliable final genotype.

In Lima, problems were encountered with separating mtDNA haplotypes using SSCP analysis. Some progress was made with this technique up until December 2005, but it was not possible to achieve the required level of resolution to separate haplotypes that differ by only a few substitutions. This was most likely because of the lack of temperature controlled electrophoresis equipment in the lab in Lima. Another technique which may have been suitable for this purpose (DGGE) was attempted in Cardiff, but again requires the use of

specialised equipment which was not available in the lab in Lima. However, the need for separating mtDNA haplotypes in this manner is no longer an issue in CONOPA. Future work requiring sequencing will be outsourced to a company (such as Macrogen) which offers sequencing at a very competitive price and produces high quality results.

Timing of the Workshop

The Workshop was planned as a three day event from 5th-7th April 2006. However, violence was threatened by the party of one of the presidential candidates for the Peruvian Election, which was held on 9th April, therefore the organisers decided to postpone the event until 16th-17th May 2006. In addition, a one day dissemination conference was organised for the 6th April 2006 at which the results of the genetic analysis and the Vortex population viability modelling were disseminated by JCW, KY, CD and MWB. This conference was filmed and the presentations were be played at the Workshop in May since it was not possible, due to budgetary and time constraints, for CD and MWB to return to Peru.

Evaluation:

Monitoring of the project's progress and outputs was monitored on a regular basis. Weekly lab meeting were held with project leaders in Cardiff and Lima and laboratory work conducted by the Trainees was monitored on an almost daily basis by CD. We evaluated our project internally each year during our annual meetings in Lima and against the original list of outputs.

The progress of the students on the course was monitored informally through discussions, exercised and workshops and through three days of examination at the end of the course. Student evaluation forms were given to the students at the end of the second course in 2005, the responses of whom were very positive. The views of the students on the first course in 2004 were taken into consideration when preparing the second course and modifications were made accordingly.

Our annual reports were always on time and were evaluated positively.

Lessons:

The main lesson was the benefit of a continuation from a previous project. Through an additional 3 year's funding we have been able to have a disproportionately larger impact, moving beyond pure scientific research through the Conservation Assessment Workshop meeting and leaving a mechanism in place for development of a management plan.

10. Actions taken in response to annual report reviews

We have endeavoured to respond to all comments made by the project reviewers in our annual and six-monthly reports.

Following the review of the first annual report, we provided a map of sampling locations (Appendix E), a flow diagram of CONOPA's relationship with the Peruvian authorities responsible for camelids (Appendix C), more detailed information about the exit strategy, monitoring and evaluation processes, and project expenditure.

In response to comments received relating to the second annual report, we included the questionnaire (Appendix AH) used in the community surveys conducted as part of the sampling process, addressed the issue of sample numbers for genetic analysis and emphasised lessons relating to CONOPA's ability to respond to government .

The review of the third annual report was very positive and we were not required to provide any further information. All reviews of the progress and accomplishments of the project throughout its duration have been positive and have been circulated to the project team. Any

issues were discussed via email and at annual project meetings where progress was assessed.

11. Darwin Identity

The project has widely publicised the Darwin Initiative within the host country from the outset of the project. In country the Guanaco 1 project is synonymous with Darwin Initiative funding as well as that for the previous Darwin vicuna grant. In our experience (and that of Anna Karp, via her analysis of Peruvian closed projects) our projects are highly visible and their funding is inextricably linked.

The Darwin logo, and the Guanaco 1 logos have been widely used throughout the project on posters, leaflets, magazine articles and presentations. These are listed below with evidence of the use of the logo being given in the appendices:

- Conservation biology course publicity (leaflets, posters) (Appendix AU), programmes (Appendices L-N), certificates (Appendix R) CD/DVD's and powerpoint slides for lectures (see Appendix BI disc 1 & 2).
- Workshop publicity, including programmes (Appendix S), presentations (Appendix T) and seven websites publicised the Darwin Initiative in relation to the project (Appendix BC). The CONOPA website also featured the Darwin Initiative and project logos.
- Three magazine articles discussed the project and featured the Darwin Initiative and project logos (Appendices BD-BF)
- The guanaco conservation campaign poster (Appendix BB.
- Numerous powerpoint presentations given by members of the project team have featured the Darwin logo and have raised awareness of the Darwin Initiative in the host country, within the UK, other European (Appendices G, H, W & X) and South American countries (See Appendix II 14b for a full list).

Guanaco 1 had a high profile within Peru from the beginning of the project, helped in part by the series of prominent launch events in July 2003 (See section 6 above). The project had a distinct identity with clear goals that were achieved by the end of the project and which have left a continuing legacy within Peru and which will result in direct conservation action implemented by the Peruvian authorities in consultation with CONOPA.

12. Leverage

Funds have been pledged by CONACS for development of an education campaign concerning the Guanaco. Additionally, APECO, one of Peru's longest standing NGO's working in conservation education, will join the campaign and applications seeking funding are currently in preparation. On the scientific level, it is anticipated that funds will become available through Peru's National Plan for Science Technology and Innovation in South American Camelids through a 6 million dollar loan from the Interamerican Development Bank for implementation of the plan. This should provide funding for further research on guanaco population genetics. Additionally we are developing further applications to obtain funding for on the ground conservation efforts in the communities.

The laboratory element of the project went significantly over-budget, due to the technicalities encountered with the Calipuy samples. In addition to the viring of funds from other within-grant budget headings to consumables, MWB's lab budget and other funding helped to offset these costs – the precise value of this additional funding is impossible to estimate, although it certainly ran to four figures. Due to our activities, JC Marin was able to gain funding from his university sponsors in Chile to make two trips to Cardiff to continue the collaboration with

approximately $4,000 expended. Additional funds were sought for KY's PhD project in Cardiff (from the DI itself and the Royal Society). Unfortunately we have not been successful with these bids. More funding opportunities are being explored.

13. Sustainability and Legacy

A working group was commissioned at the Workshop to develop the recommendations of the Guanaco Declaration into a management plan which is likely to be implemented in the near future by the Peruvian authorities, primarily CONACS, CONAM, INRENA and SVG. These will provide an enduring framework for guanaco conservation within Peru for the foreseeable future. In addition, a conservation education programme is to be developed in collaboration with CONOPA.

MB and JW (CONOPA) will be heavily involved in the follow-up activities of the project in Peru and are planning future projects in camelid conservation and genetics. JR and KY continue with masters degree courses at Universidad de Cayetano Heredia and Universidad National Mayor de San Marcos respectively. In addition, KY in collaboration with CD, MB and Dr Joanne Cable (JC) of Cardiff University will continue to seek funding so that she can return to Cardiff to undertake a PhD. The increased capacity in CONOPA for conservation genetics through the training of JR and KY continues to benefit students and colleagues in CONOPA and UNMSM. CONOPA will continue genetic research into guanaco, compiling data on some of the smaller populations that were not included in this project.

As stated above, perhaps the most important impact of the guanaco project will be recognition of the fact that the guanaco is completely distinct from the vicuna and cannot be managed in the same way. In the long run, with the production of a management plan, this will produce changes in legislation that will offer better protection, and perhaps salvation, for the guanaco.

CONOPA's efforts will continue unchanged, but strengthened, after the DI Guanaco 1 project. They are actively working for conservation of biodiversity in both wild and domestic camelids. The collaboration between CONOPA and Cardiff is longstanding and will not end with this project. They are currently seeking funding for projects to map genetic diversity in Peru's alpaca populations and for mapping the alpaca genome.

As in the case of the previous Darwin Vicuna project, the impacts of the DI Guanaco 1 project are immediate and will be far reaching. Prior to this project there has been virtually no scientific research on the species in Peru, and at its conclusion the information is now available for development of a management plan. More importantly, the output of the project has already had a major impact on consciousness raising leading to the Guanaco Declaration and the prospect of a formal management plan in the near future.

Application of the projects research findings was completed during the project schedule and one paper has been submitted with five more papers currently in preparation for submission to peer reviewed journals. Two papers were published as conference proceedings before the end of the project. The project findings will be incorporated into the management plan. The Workshop that was organized at the end of the project was vital for bringing together all the key stakeholders necessary for effective conservation of the species and was essential for raising awareness at a public and governmental level of the importance of conservation of the guanaco in Peru.

A proposal for establishing a private conservation area at Huallhua in Ayacucho is being developed with the community, CONOPA and SPDA to be submitted to Fondo de las Americas.

14. Value for money

We were able to accomplish all the outputs, together with additional ones with a relatively small budget. We comprehensively trained two Peruvian scientists in molecular genetics, ran two successful conservation biology courses and two international workshops as well as

conducting large scale field expeditions and laboratory analysis of challenging genetic material. Therefore, these activities demonstrate the very high value for money achieved by the project in realizing its aims.

15. Appendix I: Project Contribution to Articles under the Convention on Biological Diversity (CBD)

Project Contribution to Articles under the Convention on Biological Diversity		
Article No./Title	**Project %**	**Article Description**
6. General Measures for Conservation & Sustainable Use	5	Develop national strategies that integrate conservation and sustainable use.
7. Identification and Monitoring	20	Identify and monitor components of biological diversity, particularly those requiring urgent conservation; identify processes and activities that have adverse effects; maintain and organise relevant data.
8. In-situ Conservation	5	Establish systems of protected areas with guidelines for selection and management; regulate biological resources, promote protection of habitats; manage areas adjacent to protected areas; restore degraded ecosystems and recovery of threatened species; control risks associated with organisms modified by biotechnology; control spread of alien species; ensure compatibility between sustainable use of resources and their conservation; protect traditional lifestyles and knowledge on biological resources.
9. Ex-situ Conservation	0	Adopt ex-situ measures to conserve and research components of biological diversity, preferably in country of origin; facilitate recovery of threatened species; regulate and manage collection of biological resources.
10. Sustainable Use of Components of Biological Diversity	0	Integrate conservation and sustainable use in national decisions; protect sustainable customary uses; support local populations to implement remedial actions; encourage co-operation between governments and the private sector.
11. Incentive Measures	0	Establish economically and socially sound incentives to conserve and promote sustainable use of biological diversity.
12. Research and Training	40	Establish programmes for scientific and technical education in identification, conservation and sustainable use of biodiversity components; promote research contributing to the conservation and sustainable use of biological diversity, particularly in developing countries (in accordance with SBSTTA recommendations).
13. Public Education and Awareness	5	Promote understanding of the importance of measures to conserve biological diversity and propagate these measures through the media; cooperate with other states and organisations in developing awareness programmes.
14. Impact Assessment and Minimizing Adverse Impacts	0	Introduce EIAs of appropriate projects and allow public participation; take into account environmental consequences of policies; exchange information on impacts beyond State boundaries and work to reduce hazards; promote emergency responses to hazards; examine mechanisms for re-dress of international

		damage.
15. Access to Genetic Resources	10	Whilst governments control access to their genetic resources they should also facilitate access of environmentally sound uses on mutually agreed terms; scientific research based on a country's genetic resources should ensure sharing in a fair and equitable way of results and benefits.
16. Access to and Transfer of Technology	10	Countries shall ensure access to technologies relevant to conservation and sustainable use of biodiversity under fair and most favourable terms to the source countries (subject to patents and intellectual property rights) and ensure the private sector facilitates such assess and joint development of technologies.
17. Exchange of Information	5	Countries shall facilitate information exchange and repatriation including technical scientific and socio-economic research, information on training and surveying programmes and local knowledge
19. Bio-safety Protocol	0	Countries shall take legislative, administrative or policy measures to provide for the effective participation in biotechnological research activities and to ensure all practicable measures to promote and advance priority access on a fair and equitable basis, especially where they provide the genetic resources for such research.
Total %	**100%**	**Check % = total 100**

16. Appendix II Outputs

* Additional output. See section 6 for details.

Code	Total to date (reduce box)	Detail (←expand box)
Training Outputs		
1a	0	
1b	0	
2	0	
3*	15 16 3 1 1 1 Total = 37	Peruvian scientists received Certificate of Completion for the conservation biology course 2004 Peruvian scientists received Certificate of Completion for the conservation biology course 2005 Peruvian scientists received Certificate of Attendance for the conservation biology course 2005 Jorge Rodriguez, 2003-2004, Thesis to obtain the title of Veterinarian, Faculty of Veterinary Medicine, San Marcos University, parentage testing in alpaca. (Appendices G, H, J) Eric Chavez, 2003-2006, Thesis to obtain the title of Veterinarian, Faculty of Veterinary Medicine, San Marcos University, Biologia del Guanaco, *Lama guanaicoe cacsilensis.* Hugo Castillo, 2004-2006. Thesis to obtain the title of Veterinarian, Faculty of Veterinary Medicine, San Marcos University, Contribucion al edstudio del parasitismo gastrointestinal en guanacos (*Lama guanicoe cacsilensis*) silvestres.
4a*	1	Sara Gomez Ibanez (SGI), an undergraduate veterinary student from Cornell University visited CONOPA in Lima June-August 2005
4b*	8 weeks	SGI was trained in conservation biology, laboratory work, fieldwork and veterinary medicine relating to camelids. She was trained by CD, JR and other CONOPA staff
4c	0	
4d	0	
5	1 1 2 1 2 Total = 7	JR trained in laboratory in Cardiff 2003-2004 by CD JR trained in laboratory in Cardiff 2004-2005 by CD JR and KY trained in laboratory in Lima 2004-2005 by CD and KY also trained by JR KY trained in laboratory in Cardiff 2005-2006 by CD JR and KY trained in laboratory in Lima 2005-2006 by CD
6a	2	JR and KY attended MWB's undergraduate conservation biology module in Cardiff in 2003 and 2005 respectively.
6b*	20 24 24 2 x 20 2 x 6 32*	2 x 10 weeks training for JR and KY to attend MWB conservation module in Cardiff JR received 24 weeks of molecular genetics training in Cardiff 2003-2004 JR received 24 weeks of molecular genetics training in Cardiff 2004-2005 JR and KY received 20 weeks each of molecular genetics training in Lima 2004-2005 JR and KY received 6 weeks each of molecular genetics training in Lima 2005-2006 KY received 32 weeks of molecular genetics training in Cardiff 2005-2006

Code	Total to date (reduce box)	Detail (←expand box)
	Total = 132	
7*	1 1 1 1 Total = 4	CONOPA educational poster for the exhibition celebrating 50 years since the discovery of DNA – in collaboration with the British Embassy, Lima. 1 CD of course materials in 2004 (Appendix BI - disc 1) 1 DVD of course materials in 2005 (Appendix BI - disc 2) 1 CD of course materials (Trujillo course 2006) (Appendix BI – disc 3)
Research Outputs		
8*	35 7 10* Total = 52	UK Darwin post-doc CD - 2 weeks in Lima (July 2003) for project start-up activities - 25 weeks in Lima training KY and JR in the laboratory, preparing for and teaching on the conservation biology course (March-September 2004) - 6 weeks teaching on the conservation biology course and training JR, KY and SGI in the laboratory in Lima (June-July 2005) - 2 weeks preparing for dissemination conference and final project meeting UK Project Leader MWB - 1 week in Lima (July 2003) for project start-up activities - 2 weeks in Lima (June 2004) teaching on the conservation biology course - 2 weeks in Lima (June 2005) teaching on the conservation biology course - 2 weeks in Lima preparing for dissemination conference and final project meeting UK scientist Stephen Casey - volunteered for 10 weeks on the project in Lima training JR and KY and teaching on the conservation biology course (July-September 2004)
9	1	Guanaco Declaration (Appendix B)
10	1	Laboratory protocols and research data handed over to CONOPA
11a*	1 1 1 1 Total=5	Dodd, C.S., J. Rodriguez, D. Hoces, R. Rosadio, J.C. Wheeler and M.W. Bruford. 2006. Genetic Diversity and Management Implications for Vicuña Populations in Peru. In: M. Gerkin and C. Renieri, Eds. *South American Camelid Research,* **1**: 87-96. Wageningen Academic Publishers, Wageningen. (Appendix X) Rodriguez, J., C. Dodd, J.C. Wheeler, R. Rosadio and M.W. Bruford. 2006. Paternity testing using microsatellite DNA in alpacas (*Vicugna pacos*). In: M. Gerkin and C. Renieri, Eds. *South American Camelid Research,* **1**: 87-96. Wageningen Academic Publishers, Wageningen. (Appendix H) Domingo Hoces R, May 2005. Guanaco: El Camelido Injustamente Olvidado. *AgroNoticias*. (Appendix BF) Jane C. Wheeler, June 2005. Camelid Research in Peru. *International Camelid Quarterly*. (Appendix BD) Jane C. Wheeler, March 2006. Guanaco 1 – Working to Save Peru's Endangered Guanacos. *International Camelid Quarterly*. (Appendix BE)
11b*	1 Total = 1	Vicuna mtDNA. Heredity (Appendix AJ)
12a	1	Database of guanaco field samples and genetic data established and handed over to CONOPA. (Appendix F)
12b	1	Guanaco sample and genetic database enhanced the existing database of camelid samples and genetic data held by CONOPA

Code	Total to date (reduce box)	Detail (←expand box)
13a	0	
13b	1	Guanaco samples are archived in the collection at CONOPA in Lima which has enhanced their existing camelid reference collection.
Dissemination Outputs		
14a*	1 1* 1* 1 Total = 4	launch events in Lima in 2003 (Appendices Y, Z, AA) Camelid genetics course/conference September 2004 (Appendices AD, AE) Results dissemination conference in Lima on 6th April 2006 (Appendix T) Workshop 16-17th May 2006 in Lima
14b*	1 1 1 1 1 1 1 1 1 1 3 4 1	**Talk** - MWB, The Applications of DNA in Peru: South American Camelids, special exhibition for the Peruvian Congress, 4 July 2003 **Talk** - JW , The Applications of DNA in Peru: South American Camelids, special exhibition for the Peruvian Congress, 4 July 2003 **Talk** - MWB, DNA and the management of genetic resources: worldwide applications. Peruvian Academy of Veterinary Sciences, 6 July 2003 **Talk** - MWB, Application of Biotechnology for Conservation of Endangered Species in Peru. INRENA, 9 July 2003 **Talk** - JW, Past, Present and Future of the South American Camelids in Peru. INRENA, 9 July 2003 **Talk** - JW, TWNSO–GEF–UNEP International Conference on "Implementing Programmes to Conserve Biodiversity in Arid and Semi–Arid Regions in Developing Countries," Rabat, Morocco, 27–30 August 2003. **Talk** JW, Los Camélidos Sudamericanos y la Puna. Curso Taller Educación Ambiental y Uso Sostenible de las Vicuñas. Course organized by CONOPA, Universidad de Valencia el Proyecto MACS y el Gobierno Regional. Chincha, Peru. 6 September, 2003 **Talk** - JW, Cuidando los Rebaños de los Apus: Los Camélidos Sudamericanos, Universidad de Trujillo. Trujillo, Peru. 30 October 2003. **Talk** – JW, CONOPA, Peru and CBD. CONAM Board of Directors. Lima, Peru. 22 December 2003. **Talk** – JW, Conservación del la Biodiversidad de Camelidos Domesticos XVII Congreso Nacional de Ciencias Veterinarias. Tacna, Peru. 12 September 2004 **3 Talks** – JW Origin y evolución de los camélidos domesticos, Genética y conservación de la vicuña y el guanaco en los Andes, Conservación de la biodiversidad en animales domesticos:Preservación de especies y razas amenazadas, Relaciones entre fentipo y genotipo en camélidos sudamericanos, Curso Internacional Camélidos Sudamericanos: del Fenotípo al Genotípo, organized by CONOPA, IPEN, CONCYTEC and the III Peru Foundation. Lima, Peru. 21-24 September 2004. **4 Talks** - MWB Mapeo Genético usando analísis de ligamento, Secuenciamento de Genomas y Transcriptoma, Genómica de Poblaciones. Curso Internacional Camélidos Sudamericanos: del Fenotípo al Genotípo, organized by CONOPA, IPEN, CONCYTEC and the III Peru Foundation. Lima, Peru. 21-24 September 2004. (Appendix AE) **Talk** – DH Estado Actual del Conservación de la Población de Guanacos (*Lama guanicoe cacsilensis*) en el Departamento de Arequipa, Perú. Aprovechamiento Sostentable de Guanacos en Argentina. Bariloche, Argentina, 16-18 September 2004.

Code	Total to date (reduce box)	Detail (←expand box)
	1	**Talk** – Jane Wheeler, Peruvian Atomic Energy Agency, IPEN, and the International Atomic Energy Agency, IAEA. Lima, Peru. 5th October 2004.
	1	**Talk** - Ciara Dodd, 4th international Symposium on South American Camelids, Gottingen, Germany, October 2004 (Appendix W)
	1	**Poster** - Jorge Rodriguez, 4th international Symposium on South American Camelids, Gottingen, Germany, October 2004 (Appendix G)
14b (cont)	1	**Talk** – JCW, Molecular Genetics and Conservation of the South American Camelids, to Peru's largest scientific organization at the Colegio de Ingenieros in Lima., 6th November 2004
	1	**Talk** – JCW, Darwin research projects and vicuña and guanaco conservation at Peru's British School, Newton College, Lima, 9th November 2004
	1	**Talk** – JW Conservacion de la Vicuña en el Perú. Asociación Ancash, Huaraz, Peru. (12-05-05)
	1	**Talk** – JW La vicuña y la puna. Taller Internacional Sobre Educación Ambiental y uso Sostenible de la Vicuña organized by CONOPA, Universidad de Valencia, IVITA and Proyecto MACS. El Mantaro, Huancayo, Peru. (22-06-05)
	1	**Talk** – JW, Aplicación de la Genética Molecular en el Mejoramiento y Conservación de los Camélidos Sudamericanos. Conferencia Internacional de Camélidos Sudamericanos REDICAS, Arequipa, Peru. (14-07-05)
	1	**Talk** – JW, Lessons for the Future of Vicuña in the Andes. Towards Sustainable Management of the Vicuña in the Andes. Meeting organized by MACS, Macaulay Land Use Research Institute and Johnstons of Elgin. Elgin, Scotland. (02-09-05)
	4	**4 Talks** – JW Origen, Evolución y Filogenia de los Camélidos Domésticos, Relaciónes entre Fenotípo y Genotipo en Camélidos Sudamericanos, Conservación de la Vicuña en el Perú, Conservación de la Biodiversidad en Animales Domésticos: Preservación de Especies y Razas Amenazadas. Curso Taller Mejoramiento y Conservación de Camélidos Sudamericanos Curso Taller Mejoramiento y Conservación de Camélidos Sudamericanos. Meeting organized by CONOPA and INCAGRO. Cusco, Peru. (05 to 06-10-05)
	1	**Talk** – HC, Situacion del Guanaco en el Peru. Conferencia Internacional de Camelidos Sudamericanos REDICAS, Arequipa, Peru 30th-31st March 2006 (Appendix BG)
	4	**4 Talks** – JW, CONOPA and Guanaco 1, KY, Guanaco 1 fieldwork and laboratory methods, CD, Guanaco 1 Genetic results and MWB, Population viability modelling of guanaco in Peru. Conference of the results of Guanaco 1. Lima, Peru. 6th April 2006 (Appendix T)
	1	**Talk** – JCW, Historia Natural del Guanaco. II Simposium Internacional de Investigacion de Camelidos Sudamericanos, Arequipa, Peru May 2006
	1	**Talk** – JCW, Proyeccion estocastica de poblaciones de guanacos en el Peru. Jane C. Wheeler, Domingo Hoces and Michael Bruford IV Congreso Mundial sobre Camelidos, Catamarca, Argentina Oct. 2006
	Total=38	
15a	1	National press release in Peru for launch events
	1	National press release in Peru for Workshop 2006 resulting in publicity on 7 websites (Appendix BA) http://www.conacs.gob.pe/informe.htm ; http://www.conacs.gob.pe/proyectoguanaco.htm http://www.camelydaperu.org.pe/index.php?option=com&task=view&id=112&

Code	Total to date (reduce box)	Detail (←expand box)
	Total = 2	Itemid=74 http://www.inrena.gob.pe/comunicaciones/boletin/bn0605/bn060515.htm http://www.britishembassy.gov.uk/servlet/Front?pagename=OpenMarket/Xcelerate/ShowPage&c=Page&cid=1058275183084&date=2006-05-01 http://www.teorema.com.mx/articulos.php?id_sec=49&id_art=1632&id_ejemplar= http://www.infocusco.com/modules/news/index.php?storytopic=20
15b*	1 1 1 Total = 3	Local press release in Peru to advertise conservation biology course 2004 Local press release in Peru to advertise conservation biology course 2005 Local press release in Peru for Workshop 2006
15c	1 1 Total = 2	National press release in UK to advertise launch events 2003 National press release in UK to advertise Workshop 2006
15d	1	Local press release in UK to advertise Workshop 2006
16a	0	
16b	0	
16c	0	
17a	1*	Web-based contact network established by students on conservation biology course in 2004
17b	1*	Web-based contact network expanded by students on conservation biology course in 2005
18a	0	
18b	0	
18c	0	
18d	0	
19a	0	
19b	0	
19c	0	
19d	0	
Physical Outputs		
20	200	6 – text books purchased on conservation biology and genetics for use by CONOPA and students on the courses (c. £200) (Appendix K)
21	0	0
22	0	0
23	0	0

17.Appendix III: Publications

All publications and other material included with this report are marked (*)

Type * (e.g. journals, manual, CDs)	**Detail** (title, author, year)	**Publishers** (name, city)	**Available from** (e.g. contact address, website)	**Cost £**
Proceedings*	Genetic Diversity and Management Implications for Vicuña Populations in Peru. Dodd, C.S., J. Rodriguez, D. Hoces, R. Rosadio, J.C. Wheeler and M.W. Bruford. 2006 (Appendix X)	In: M. Gerkin and C. Renieri, Eds. *South American Camelid Research,* **1**: 87-96. Wageningen Academic Publishers, Wageningen.	www.conopa.org	free
Proceedings*	Paternity testing using microsatellite DNA in alpacas (*Vicugna pacos*). Rodriguez, J., C. Dodd, J.C. Wheeler, R. Rosadio and M.W. Bruford. 2006 (Appendix H)	In: M. Gerkin and C. Renieri, Eds. *South American Camelid Research,* **1**: 271-276. Wageningen Academic Publishers, Wageningen.	www.conopa.org	free
Journal*	Camelid Research in Peru. Jane C. Wheeler 2005 (Appendix BD)	*International Camelid Quarterly*	www.llamas-alpacas.com www.conopa.org	free
Journal *	Guanaco 1 – Working to Save Peru's Endangered Guanacos. Jane C. Wheeler 2006 (Appendix BE)	*International Camelid Quarterly*	www.llamas-alpacas.com www.conopa.org	free
Journal*	Guanaco: El Camelido Injustamente Olvidado. Domingo Hoces R. 2005. (Appendix BF)	*AgroNoticias*	www.conopa.org	free
CD*	An International Course in Conservation Biology 2004 (English and Spanish) (Appendix BI disc 1)	CONOPA and Cardiff University	www.conopa.org	free
DVD*	An International Course in Conservation Biology 2005 (English and Spanish) (Appendix BI disc 2)	CONOPA and Cardiff University	www.conopa.org	free
CD*	Conservation biology course, Trujillo 2006 (Spanish) (Appendix BI disc 3)			
DVD*	April 6 2006 conference (Appendix BI disc 4)	CONOPA	www.conopa.org	free
CD	Guanaco Workshop 16-17 May 2006	CONOPA	www.conopa.org	free
Power point presentation*	Situacion del Guanaco en el Peru. Hugo Castillo D. 2006 (Appendix BG)	Conferencia Internacional de Camelidos Sudamericanos REDICAS, Arequipa, Peru March 2006	www.conopa.org	free
Power point presentation	Historia Natrural del Guanaco. Jane C. Wheeler	II Simposium Internacional de Investigacion de	www.conopa.org	free

	2006	Camelidos Sudamericanos, Arequipa Peru May 2006		
Power point presentation	Proyeccion estocastica de poblaciones de guanacos en el Peru. Jane C. Wheeler, Domingo Hoces and Michael Bruford 2006	IV Congreso Mundial sobre Camelidos, Argentina Oct. 2006	www.conopa.org	free

Appendix IV: Darwin Contacts

Project Title	Genetic diversity and management implications for Andean guanaco populations in Peru.
Ref. No.	*162-12-022*
UK Leader Details	
Name	Professor Michael W Bruford
Role within Darwin Project	Principal Investigator
Address	School of Bioscience, Cardiff University, Main Building, Park Place, Cardiff, CF10 3TL
Phone	
Fax	
Email	
Other UK Contact (if relevant)	
Name	Dr Ciara S Dodd
Role within Darwin Project	PDRA
Address	School of Bioscience, Cardiff University, Main Building, Park Place, Cardiff, CF10 3TL
Phone	
Fax	
Email	
Partner 1	
Name	Dr Jane C Wheeler
Organisation	CONOPA
Role within Darwin Project	Co-Investigator
Address	Los Cerezos 106, Urb. Recaudadores de Salamanca, Ate, Lima 3, Peru
Fax	
Email	
Partner 2 (if relevant)	
Name	
Organisation	
Role within Darwin Project	
Address	
Fax	
Email	