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**Darwin Plus:
Overseas Territories Environment and Climate Fund
Final Report**

Darwin Project Information

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Project Title	<i>Socio-economic aspects of turtle conservation in the Cayman Islands</i>
Territory(ies)	Cayman Islands
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Partner Institutions	University of Exeter
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Project Leader Name	Janice Blumenthal
Project website/Twitter/Blog etc.	http://www.doe.ky/turtles/darwin
Report author(s) and date	Janice Blumenthal, Ana Nuno, Gina Ebanks-Petrie, Timothy Austin, Brendan Godley, Annette Broderick 30 June 2016

1 Project Overview

The Cayman Islands (Grand Cayman, Cayman Brac, and Little Cayman) are located in the Caribbean Sea, approximately 240 kilometres south of Cuba and 270 kilometres northwest of Jamaica (Fig. 1).



Fig. 1. Map of study area (the three Cayman Islands) and surrounding countries.

Throughout the history of the Cayman Islands, turtles have played an important role in the economy and culture and turtle is now a national emblem, represented on the flag and currency, and turtle meat is considered by some to be the Cayman Islands' 'National Dish'. The islands once hosted one of the largest green turtle nesting populations in the Atlantic but by the early 1800s massive commercial exploitation resulted in near-extirpation of this rookery. In 1968, a commercial captive breeding operation, the Cayman Turtle Farm (CTF), was established to provide turtle meat for consumption, reduce demand on wild stocks, and replenish the wild nesting population through the release of hatchling and yearling turtles. CTF is now a company owned by the Cayman Islands Government.

Legal protection for the Cayman Islands wild turtle nesting populations was instituted in 1978. However, illegal take of turtles threatens nesting population survival. Production and sale of turtle meat by CTF, as well as the current importance and current prevalence of turtle consumption, is controversial in the Cayman Islands. The Farm has also recently been subject to an international campaign to end turtle farming by the international NGO World Animal Protection (WAP).

It has been argued in a recent review (Tenson 2016¹) and previous scientific publications that wildlife farming can benefit conservation when the following considerations are met: 1) Legal products form a substitute for wildlife products; 2) Demand is met and does not increase; 3) Legal products are more cost-effective; 4) Farms are not restocked from the wild; and 5) Laundering is absent. However, data on demand and supply for legal and illegal turtle meat were lacking in the Cayman Islands prior to this project. With support from the Darwin Initiative, we aimed to determine how turtle farming by CTF relates to these criteria and how changes can be made in order to improve conservation benefits for Cayman Islands wild sea turtle populations.

The objective of the “*Socio-economic aspects of turtle conservation in the Cayman Islands*” project was thus to provide robust scientific data on the role of CTF in wild turtle conservation – a priority which has been identified by stakeholders. The project, granted to the Cayman Islands Department of Environment (DoE) in collaboration with University of Exeter (UoE), aimed to determine cultural importance, current prevalence, and socio-economics of legal and illegal turtle consumption and purchase, through a comprehensive national socio-economic survey. To begin the study, a researcher from UoE conducted in-depth interviews with stakeholders to identify key questions regarding turtle meat in the Cayman Islands. A socio-economic survey tool was then developed and stakeholders were invited to comment on the resulting survey instrument. Interviews then targeted 597 randomly selected resident households (approximately 100 in each geographical district of the Cayman Islands) and included sections about turtle meat consumption and purchase, consumer preferences, participation in illegal behaviours related to sea turtles (i.e. buying turtle meat harvested from the wild and eating turtle eggs), and socio-demographic information. Additional surveys of 174 high school students (to further explore age effects), 117 international cruise ship tourists, 87 stay-over international tourists and 39 restaurants (to further investigate demand) were also successfully completed. Additionally, to investigate turtle meat supply and pricing we entered and analysed data over 3,700 sales receipts that were made available by CTF.

In all, nearly 1,000 interviews with households, high school students, international tourists, and restaurants were used to establish cultural and age effects in the consumption of turtle meat and the influence of price and availability of farmed turtle meat, preference for farmed or wild product, demand, and environmental awareness in incentivising or reducing take of wild turtles.

To determine Cayman Islands green turtle population size (and thus assess vulnerability to illegal take) and to identify the contribution of farm-released turtles to the wild population, a comprehensive night-time tagging study was carried out in 2014 and 2015. Turtle nesting in the Cayman Islands has increased in recent years, with an annual average of 141 green turtle nests documented in Grand Cayman over the past five years. However, number of females in the nesting population was unknown as green turtles do not nest every year and each female can lay more than one nest per breeding season. Between 1980 and 2016, almost 32,000 turtles were released from the Cayman Turtle Farm, approximately 80% of these marked with tags or living tags (the latter of which are lifelong marks on the shell). Thus, some turtles released from the Farm can be identified through tags documented during night surveys carried out in this project. Additionally, tissue samples were collected from farm turtles, wild nesting females and wild hatched nests for genetic analysis to refine estimates of farm contribution to wild stocks and wild turtle population size.

By using both social and ecological methods, our aim was to conserve a national cultural icon by: 1) assessing the role of the Cayman Turtle Farm in supply and demand for turtle meat, 2) assessing illegal take and how this may be influenced by supply and demand, 3) establishing management targets to reduce illegal take, and 4) evaluating the contribution of the farm to wild stocks.

¹Tenson L (2016) *Under what circumstances can wildlife farming benefit species conservation?* Global Ecology and Conservation vol 6, p 286-298.

2 Project Achievements

2.1 Outcome

The project has been very successful in achieving its two outcomes: 1) Reduced incentive for illegal take of marine turtles; and 2) Assessment of wild nesting population vulnerability and contribution of the Cayman Turtle Farm.

Outcome:	<i>Reduced incentive for illegal take of marine turtles</i>		
	Baseline	Change by 2016	Source of evidence
Indicator: Generation of an evidence-based management plan to inform economic policy, enforcement and awareness	Management processes were operating in absence of a robust evidence base.	An evidence-based management plan has been developed in the form of the following documents: “Turtle Species Action Plan”, “Turtle Species Conservation Plan”, and “Project Recommendations”, supported by a key results report and scientific publications. To facilitate enforcement, partnerships were formed between DoE Enforcement Officers, Customs, and Police and awareness was raised through extensive community involvement.	<ul style="list-style-type: none"> • Key Results Report (http://www.doe.ky/marine/turtles/darwin/cayman-key-results-report/) • Species Action Plan (attached) • Species Conservation Plan (attached) • Project recommendations (attached) • Scientific publications: <ul style="list-style-type: none"> ○ Nuno et al. submitted (attached) ○ Walker et al. submitted (attached) • See Output Table for evidence relating to enforcement training and awareness.
Outcome:	<i>Assessment of wild nesting population vulnerability and contribution of the Cayman Turtle Farm</i>		
	Baseline	Change by 2016	Source of evidence
Indicator: Accurate estimate of population size and Cayman Turtle Farm contribution in two nesting seasons.	Lack of capacity for tagging and genetic analysis to estimate population size and CTF contribution.	<ul style="list-style-type: none"> • It was estimated that there are approx. 100 female green turtles nesting in the wild. • Minimum direct contribution of CTF to the wild was estimated at approx. 50%. • Illegal take quantified through the socio-economic survey (>195 households estimated to have bought illegal turtle products in the 12 months prior to the study. 	<ul style="list-style-type: none"> • Genetics report (attached) • Key Results Report (see above for link)

Socio-economic results provided rigorous data on demand for turtle products and factors which may promote or reduce illegal take (according to the criteria outlined by Tenson 2016 and other researchers). For a detailed discussion, see the Project Recommendations. At the beginning of the project, we met with stakeholders and following completion of data collection and analysis,

we presented survey results and sought feedback through a series of 10 meetings (open to all stakeholders and to the public. Sample presentation: http://www.ananuno.net/uploads/2/5/6/2/25623460/cayman_findings_anuno.compressed.pdf), a press conference and press releases (<http://www.doe.ky/turtles/darwin>), and development and distribution of the Key Results Report and an overview leaflet (<http://www.doe.ky/marine/turtles/darwin/leafletturtleconsumption/>).

To assess wild nesting population vulnerability and contribution of CTF to nesting populations, we conducted a nighttime tagging programme and analysed genetic sample collected from nesting female turtles, wild turtle nests, and CTF female “breeders” in order to estimate wild population size and relatedness between farmed and wild stocks. Thus, biological monitoring, conducted in concert with social science research, has shed light on the vulnerability of Cayman turtle populations and the contribution of CTF.

All results have been incorporated into management planning in a way that is inclusive of stakeholders and a process for continued public consultation is in place:

- **Key findings report** published and presented to stakeholders and the public.
- **Recommendations document** produced for Government, Cayman Turtle Farm, other stakeholders and the public.
- **Turtle Species Action Plan** fully updated. This Species Action Plan under the Cayman Islands National Biodiversity Action Plan sets out strategic targets for turtle conservation, including new recommendations for socio-economic monitoring.
- **Turtle Species Conservation Plan** drafted by DoE. Species Conservation Plans are legally binding under the Cayman Islands National Conservation Law (2013) following public consultation and voting by the Cabinet.

A **formal public consultation** on the “Turtle Species Conservation Plan” will be held under the terms of the National Conservation Law (2013): the draft plan will be approved for public consultation by the National Conservation Council (which includes public representatives from all districts and from specialist fields such as marine conservation and sustainable development). Responsibility for drafting Species Conservation Plans has been delegated to DoE by the Council. Public consultation will take place for at least 28 days after the second written notice of publication of the draft. After the National Conservation Council incorporates public feedback, the plan will be submitted to Cabinet and elected representatives will have 60 days in which to request amendments or vote the plan into law. The recommendations document and the species conservation plan are not legally binding and will be published when informal stakeholder consultation on these documents is complete.

To implement practical conservation efforts to decrease illegal take of turtles, we developed collaborations between DoE Research and Enforcement Officers, Royal Cayman Islands Police, Cayman Islands Customs, and the tourism sector. Rather than a single workshop for all groups, smaller consultations were held to target the particular needs and concerns of each sector. Through meetings with DoE Conservation Officers and Police, we forged a partnership for collaborative operations and developed training materials (enforcement presentation <http://www.doe.ky/wp-content/uploads/2016/06/Enforcement-presentation.pdf>, police brochure, attached). The customs training session focused on reducing illegal import and export of turtle products (customs presentation <http://www.doe.ky/wp-content/uploads/2016/06/CITES-Training.pdf>). Materials for visitors and the public (developed via a collaborative approach with the Cayman Islands Tourism Association and volunteers) raise awareness about illegal take and the legality of importing/exporting turtle products (<http://www.doe.ky/marine/turtles/darwin/outreach/cites-brochure/>) and present guidelines for reducing disturbance of nesting turtles (<http://www.doe.ky/marine/turtles/darwin/outreach/>, tourism brochure, <http://www.doe.ky/marine/turtles/darwin/outreach/guide-encounters/>). Education, outreach, and community participation was a focus of the project: Darwin Interns and DoE staff hosted more than 40 field events to build interest and enthusiasm for turtle conservation (public and school nest excavations and hatchling releases, protocol: <http://www.doe.ky/wp-content/uploads/2016/06/PublicReleaseGuide.pdf>) and gave 30 talks for the community and schools which highlighted the role of the Darwin project in sea turtle

conservation (sample presentation: <http://www.doe.ky/wp-content/uploads/2016/06/TurtlePresentation.pdf>)

Meetings with CTF resulted in a groundbreaking change in operations: as a result of the Darwin project, all turtle products will be sold in barcoded food-safe plastic bags with tamper-evident seals (an appropriate manufacturer has been selected and bespoke bags are being designed). This will make legal farmed turtle meat distinguishable from illegal wild meat and will greatly reduce opportunities for laundering. Furthermore a strategy was developed for the distribution of turtle meat beyond the single distribution point of Cayman Turtle Farm: this will prioritise access to turtle meat for traditional Caymanian consumers and reduce illegal take in these areas (based on results obtained in the household survey). For additional changes resulting from the project, please see section 2.2.

In summary, to reduce incentives for illegal take of turtles, we have collected robust socio-economic and biological data and produced evidence-based recommendations which have already resulted in key changes. Over the course of the project, data have been gathered, analysed, presented and discussed, and translated into management efforts in a way that is inclusive of stakeholder and public feedback. We have also increased capacity for enforcement via meetings and materials for DoE Conservation Officers, Customs Officers, and Police, built a volunteer base (more than 70 volunteers across the three islands), created opportunities for continued education of visitors, and raised awareness in the public. All of these efforts have contributed to the specific management changes detailed below.

2.2 Long-term strategic outcome(s)

This project has been successful in embedding sound social and biological science research into decision making in the Cayman Islands.

As a result of the project, the following changes will be made:

- 1) Cayman Turtle Farm has committed to selling all turtle meat products in barcoded bags with tamper-evident seals. This will reduce opportunities for laundering turtle meat i.e. selling illegal wild turtle meat as if it is farmed by allowing DoE Enforcement officers and Police to differentiate between wild and farmed meat.
- 2) Cayman Turtle Farm has committed to distributing turtle meat beyond the current single distribution point of the Farm (which is at a great distance from several geographical districts where turtle is traditionally consumed). Results showed that if distance to obtain farmed turtle meat is too great, consumers show more willingness to purchase illegal wild turtle. A more equitable distribution system will prioritise access to turtle meat for traditional Caymanian consumers versus international tourists and reduce illegal take.
- 3) The key results report and recommendations document provide robust information on the impacts of price, distance, source, and other factors in the sale of farmed meat and the marketing of wild meat. This allows management decisions to be made on the basis of sound scientific evidence.
- 4) Key biological data have been gathered for the first time on green turtle nesting population size and origins.
- 5) Research results were included in a comprehensive update to the Turtle Species Action Plan under the National Biodiversity Action Plan 2009, a variety of action steps originally outlined in that document were achieved, and new targets for continued socio-economic monitoring were set.
- 6) Results were used to draft the Turtle Species Conservation Plan, which will become a legal document under the Cayman Islands National Conservation Law. Based on project findings, the draft Species Conservation Plan requires that turtle products be marked and that consumers store turtle meat in original sealed bags until use.
- 7) We have set out recommendations for further research and DoE has committed to continuing monitoring efforts.

These changes will result in protection of biodiversity (sea turtle nesting and foraging populations in the Cayman Islands) and will provide a possible case study on incorporating robust social and biological data in environmental decision-making.

The project delivered excellent value for money due to high levels of in kind support from partners and contributions from volunteers (see section 6.3).

2.3 Outputs

We achieved or over-achieved all outputs, detailed as followed:

Output 1:	<i>Reduced incentives for illegal take of marine turtles.</i>		
	Baseline	Change recorded by 2016	Source of evidence
1.1 Socio-economic assessment of the cultural value and drivers of turtle meat consumption and the prevalence of illegal take.	Government and CTF acting in the absence of scientific data on these factors.	Govt and CTF can now base decision-making on a robust body of evidence gathered during this study.	<ul style="list-style-type: none"> • Key Results Report (http://www.doe.ky/marine/turtles/darwin/cayman-key-results-report/) • Nuno et al. submitted (attached)
1.2 Presentation of socio-economic results so Govt and the Cayman Turtle Farm have valid information on the role of turtle meat production in increasing or decreasing pressures on wild stocks.	Information not previously available to CI Govt or CTF.	Govt and CTF informed through meetings, key results report and management documents. We expanded this output to include extensive stakeholder consultation (10 meetings).	<ul style="list-style-type: none"> • Stakeholder presentation (http://www.ananuno.net/uploads/2/5/6/2/25623460/cayman_findings_anuno.compressed.pdf) • Key results report (see above) • Recommendations, Species Action Plan, Species Conservation Plan draft (attached)
1.3 A collaborative approach is developed to protect nesting female turtles.	Lack of inter-agency cooperation and public involvement	Police will work with DoE conservation officers to reduce illegal take; Customs Officers will prevent illegal export or import of turtle products, and tourism representatives will disseminate information to guests.	<ul style="list-style-type: none"> • Presentations for Enforcement (http://www.doe.ky/wp-content/uploads/2016/06/Enforcement-presentation.pdf) and Customs (http://www.doe.ky/wp-content/uploads/2016/06/CITES-Training.pdf). • Brochures for Police (attached) and tourism - CITES (http://www.doe.ky/marine/turtles/darwin/outreach/cites-brochure/) and tourism encounters brochure (http://www.doe.ky/wp-content/uploads/2016/06/GuideForSeaTurtleEncounters.pdf) • 30 talks for schools and the public (http://www.doe.ky/wp-content/uploads/2016/06/TurtlePresentation.pdf) and >40 field events (protocol: http://www.doe.ky/wp-content/uploads/2016/06/PublicR

			<p>eleaseGuide.pdf</p> <ul style="list-style-type: none"> Additional materials: http://www.doe.ky/marine/turtles/darwin/outreach/
1.4 Members of the public are aware of the need to reduce illegal take of marine turtles.	No tagging data to establish population size, hindering communication efforts.	Awareness was raised through press releases, production of educational materials, and recruitment of volunteers.	<ul style="list-style-type: none"> Educational materials (http://www.doe.ky/marine/turtles/darwin/outreach/) and press releases (http://www.doe.ky/marine/turtles/darwin/press/) Articles on import/export of turtle and other wildlife products accepted by Destination Cayman Magazine (annual print circulation 420,000) and Key to Cayman (annual print circulation 90,000).
Output 2:	<i>Assessment of wild nesting population vulnerability and contribution of the Cayman Turtle Farm.</i>		
	Baseline	Change recorded by 2016	Source of evidence
2.1 Quantification of marine turtle nesting population size and the farm contribution to assess vulnerability to illegal take.	Marine turtle nesting population size was unknown, as was farm contribution and prevalence of illegal take.	60 green turtles were tagged, genetic samples were analysed, and quantification of illegal take was achieved through socio-economic surveys. Information has been incorporated into management plan documents and will guide future conservation efforts.	<ul style="list-style-type: none"> Genetics report (attached) Key Results Report (http://www.doe.ky/marine/turtles/darwin/cayman-key-results-report/) Volunteer updates 2014 (http://www.doe.ky/marine/turtles/darwin/update-2014/) and 2015 (http://www.doe.ky/marine/turtles/darwin/update-2015/).
2.2 Completion of genetic analysis of >500 samples.	No data on population size or farm contribution; genetic analysis of green turtle nesting population never before conducted.	704 analyses completed for green turtle samples using microsatellites, mtDNA-dloop and mtDNA-STRS. Information on turtle population size and farm contribution will inform future policy decisions on management of the CTF turtle release programme.	<ul style="list-style-type: none"> Genetics report (attached)

Detailed reporting on outputs:

1.1 Socio-economic assessment of the cultural value and drivers of turtle meat consumption and the prevalence of illegal take (Key milestones: methods training workshop June 2014, >100 interviews completed by November 2014, analysis completed March 2015). Through this output, we set out to reduce illegal take of turtles by determining factors which influence legal and illegal trade and consumption.

Following in-depth interviews with stakeholders (protocol:

http://www.ananuno.net/uploads/2/5/6/2/25623460/stakeholder_surveys.docx), a socio-

economic survey tool was developed for households

(http://www.ananuno.net/uploads/2/5/6/2/25623460/questionnaire_final_a_all_1.pdf), high school students

(http://www.ananuno.net/uploads/2/5/6/2/25623460/questionnaire_schools_a.pdf), stay-over

tourists (http://www.ananuno.net/uploads/2/5/6/2/25623460/questionnaire_airport_v1.pdf) and cruise ship tourists

(http://www.ananuno.net/uploads/2/5/6/2/25623460/questionnaire_cruise_ships.pdf).

Methods training workshops on the administration of the surveys were organised for 10 field enumerators in August and September 2014. Enumerators trained during the workshops completed a large number of surveys with a low non-response rate. For household socio-economic surveys (conducted from September to November 2014), we approached 597 individuals, of whom 37 refused to participate (non-response rate = 6.2%). Surveys targeted resident households to assess culture value and drivers of turtle meat consumption and prevalence of illegal take and surveys of 174 high school students, 204 international tourists, and 39 restaurants further investigated age effects and demand (restaurant protocol: http://www.ananuno.net/uploads/2/5/6/2/25623460/survey_restaurants.pdf). Sales information from 3,712 sales receipts provided by Cayman Turtle Farm was also entered and analysed.

Key management-relevant results of the survey were as follows (see Key Results Report, Nuno et. al. submitted, and project recommendations for details):

- 30% of all residents and 62% of Caymanians by descent, i.e., having a Caymanian grandparent, consumed turtle meat at least once during the 12 months prior to the study.
- Key reasons for eating turtle included taste, tradition and culture, and celebrating special occasions.
- In 2014, a total of 60,862 pounds of turtle meat were sold by CTF, obtained from 1,292 turtles.
- Possible generational effects among residents who are Caymanian by descent may be important in the long-term because younger people (<35yrs) within this socio-demographic group were significantly less likely to have eaten turtle during the 12 months prior to this study.
- In general, turtle meat consumers were significantly influenced by the price of turtle meat, distance which must be travelled to obtain it, source of the meat, how often they can purchase turtle and the size of the wild turtle nesting turtle population, preferring lower prices, shorter distances, farmed meat, intermediate frequency consumption levels and larger number of nesting turtles in the wild. Among the potential factors considered in this study, price was the main driver of turtle meat purchasing decisions by consumers.
- In a choice experiment, an economic tool to assess consumer preferences, conducted with household representatives, we found that the majority of consumers preferred turtle sourced from CTF. Taste was the main reason for preferring wild turtle. While farmed meat was generally preferred, wild meat was selected if distances to obtain farmed meat were too great.
- CTF receipt data showed that the traditional product of 'turtle stew' (a mixture of turtle meat and offal for stewing) was sold by CTF at cost of CI \$9 / \$11 USD) per pound at the time of the study. Purchasing of wild turtle meat was investigated through household surveys, with 21 respondents providing information on price paid for illegal turtle meat (median price paid CI \$5 / USD \$6 per pound).

- In a ranking of potential management strategies, 17% of Cayman Islands residents felt CTF should transition away from meat production. This was also the most unpopular option, being the least favourite of 63%.
- Despite the presence of a legal source of turtle meat, levels of illegal take documented in this study are of concern: at least 195 households are estimated to have bought illegal wild turtle meat during the 12 months prior to this study.

A manuscript based on these results has been submitted to Biological Conservation (Nuno et al. submitted - attached). Preliminary results were presented in an invited seminar presentation by Ana Nuno entitled “*Saving turtles and eating them too? A multidisciplinary analysis of conflicts over farming of endangered species*” (http://www.ananuno.net/uploads/2/5/6/2/25623460/cayman_dice-ilovepdf-compressed.pdf) at the School of Anthropology and Conservation, University of Kent, UK, on the 11th of March 2015. Preliminary findings were also presented at the International Conference on Conservation Biology (ICCB15), Montpellier, France on the 8th of August 2015 (http://www.ananuno.net/uploads/2/5/6/2/25623460/iccb15_ana_nuno.pdf).

Additionally, a dissertation project on media framing of CTF and potential implications for conservation conflicts was completed in September 2015 by Jessica Walker, Conservation Science & Policy MSc, University of Exeter (<https://jessicarabbitson.files.wordpress.com/2015/06/dissertationjwalker.pdf>). This work also resulted in a poster presentation at the University of Kent “Towards a sustainable and legal wildlife trade” symposium in June 2015: (<https://jessicarabbitson.files.wordpress.com/2015/06/conservation-turtle-trade-and-media-friends-or-foes.pdf>) and paper which has been submitted to Animal Conservation (attached).

Overall, we significantly overachieved on the initial deliverable of 100 surveys to allow a more rigorous quantitative analysis: nearly 1,000 interviews were conducted. Results elucidated cultural value and drivers of turtle meat consumption and quantified illegal take.

Change that occurred: for the first time, rigorous management-relevant data is available on legal and illegal turtle consumption and trade in the Cayman Islands – allowing decision-making to be based on sound scientific evidence.

1.2 Presentation of socio-economic results so Government and the Cayman Turtle Farm have valid information on the role of turtle meat production in increasing or decreasing pressures on wild stocks (Key milestone: presentation of policy paper to CI Government Sep 2015). A total of 10 meetings were held in order to best present results and seek the feedback of each stakeholder group and the public. Results were presented to: Cayman Turtle Farm management staff, Cayman Turtle Farm Scientific Advisory Board, Cayman Turtle Farm Board of Directors, Cayman Islands Governor’s Office, Cayman Islands Department of Environment research and enforcement staff, and the World Animal Protection NGO (WAP). Other stakeholders, including the public and members of the Seafarers Association, the National Trust, and the hotel, tourism, and restaurant industries were invited to a public meeting. In order to provide information necessary for CI Government decision making, results were presented to Cayman Islands Department of Environment management staff, the Cayman Islands National Conservation Council, the Cayman Islands Government Minister responsible for Environment, and a Member of the Legislative Assembly representing the Tourism Ministry (responsible for the Turtle Farm). Additionally, a key results report and a leaflet over-viewing results were developed to present findings in a user-friendly format. These materials were distributed to all stakeholders and results were also disseminated through print, television, radio and social media following a press roundtable meeting (see output table for links).

Change that occurred: following recommendations developed based on project findings, Cayman Turtle Farm committed to changing its model for meat marking and distribution to prevent laundering. The Cayman Islands Government has fully updated the Cayman Islands Sea Turtle Species Action Plan, and a Sea Turtle Species Conservation Plan has been drafted based on project results which will become legally binding following public consultation and voting by the Cayman Islands Cabinet.

1.3 A collaborative approach is developed to protect nesting female turtles (Key milestones: Workshop for DoE, Police, Tourism, and Customs Oct 2015). Presentation of

socio-economics results regarding turtle consumption and prevalence of illegal take facilitated a discussion with stakeholders and the public, and more than 70 volunteers were recruited across the three islands. Extensive outreach to the public and schools via presentations and field events built commitment to turtle conservation (see output table for links to presentation and protocol). Meetings were arranged with Customs, tourism (Cayman Islands Tourism Association staff and members), and DoE Enforcement and Police (see output table for links), resulting in collaborative partnerships to facilitate the protection of nesting turtles.

Change that occurred: DoE and Police will work in collaboration to protect nesting turtles, Customs officers are trained to prevent illegal import or export of turtle products, and brochures were collaboratively developed with the tourism sector to inform visitors.

1.4 Members of the public are aware of the need to reduce illegal take of marine turtles (Key milestones: educational materials produced and distributed, press releases, public consultation and recruitment of volunteers May 2014 and May 2015). Educational talks and field events (e.g. participation in turtle nest excavations) were conducted for local schools and for community groups and more than 70 volunteers were recruited per year across the three islands. Press releases were issued resulting in local newspaper, radio, and television coverage and educational materials were distributed to beachfront property owners and residents, water sports operations, and 30 beachfront condominiums and hotels in key nesting habitat. To further educate visitors, flyers were produced and distributed and articles on import/export of turtle and other wildlife products were accepted by key destination magazines (see output table for links).

These efforts resulted in increased public awareness and active participation of volunteers in conservation efforts.

Change that occurred: more than 70 volunteers per year assisted with turtle conservation and continue to assist after the end of the project and awareness has been raised in the public and key stakeholder groups.

1.5 Management and Evaluation: (Steering group meetings April, July, October 2014; January, April, July, October 2015). To initiate the project, discussions and interviews for the post of Darwin Project Officer were held in April 2014 (via Skype). A one week steering committee workshop was held in June 2014 after recruitment of the Project Officer (topics covered: review of project aims, milestones, and deadlines, delineation of key tasks, discussion of socio-economic and biological project components and their integration, discussion of project dissemination and outreach, discussion of how outputs will be used for management), along with presentations to various stakeholder groups (Cayman Turtle Farm, FCO representatives, Minister of Environment, and Department of Environment's Research, Operations, Administration, and Enforcement Staff (sample presentation: <http://www.doe.ky/wp-content/uploads/2016/06/DarwinPlusPresentation.pdf>). Steering group meetings were held via Skype in October 2014 (to discuss fieldwork progress) and January 2015 (to discuss progress on the analysis of socio-economic survey data). In 2015, Skype meetings were organised in January (to discuss progress on survey analysis and restaurant surveys), June (to discuss update on surveys, planning for biological monitoring), and September (to discuss planning for stakeholder consultation), the Annual Report was collaboratively developed via email in April, and in-person meeting between DoE and the University of Exeter Project Officer were organised in October during the stakeholder consultation process. A final steering group meeting was held via skype in January 2016 to discuss project progress. Publications and the final report were collaboratively developed by email.

2.1 Quantification of marine turtle nesting population size and the farm contribution to assess vulnerability to illegal take (Key milestones: recruitment of interns for turtle nesting night survey fieldwork May 2014, May 2015, completion of two night survey field seasons 2014 and 2015). Four interns for turtle tagging and genetic sample collection were recruited and began fieldwork at the beginning of the green turtle nesting season each year. Green turtle samples were collected from wild nesting female turtles and hatched nests and analysed to determine estimated farm contribution to the wild and estimated green turtle nesting population size. By calculating relatedness between farmed and wild stocks, we estimated a minimum direct contribution from the farm to the wild of approximately 50%.

Furthermore, by linking sampled wild females with sampled wild nests, we were able to determine the portion of the total wild turtle nesting population tagged each year and thus estimate size of the total population (taking into account the proportion of turtles newly tagged in each year and the proportion returning from previous years). Using this method, we estimated that there are approximately 100 female green turtles nesting in the wild in Grand Cayman.

Two night survey field seasons were completed each year and nesting population size was estimated. This allowed us to determine vulnerability to illegal take, which was quantified through household surveys (see output 1.1) (see output table for links).

Change that occurred: for the first time Cayman Islands green turtle nesting population size has been quantified, with an estimate of approximately 100 female green turtles nesting in the wild. This highlights the critical need for its protection.

2.2 Completion of genetic analysis of >500 samples (January 2016). In addition to wild turtle samples from nesting females and hatchlings, 259 samples from the Cayman Turtle Farm were collected and analysed. As noted in our project application, a pilot study for the biological component of the project was funded by the CI Governor's office and was conducted in 2013, including field collection of genetic samples from turtles and hatchlings. These samples were analysed along with those collected during the project field seasons. Analysis of samples at University of Barcelona has been completed (see genetics report, attached). A significant contribution was seen from CTF to the wild (approximately 50% minimum direct contribution). While population size is critically low, it was determined that genetic variability is very high in comparison with other green turtle populations independent of the marker used (microsatellites, mtDNA-dloop or mtDNA-STRs), both within the farm and the wild population. This is surprising considering that the wild population presumably has faced a strong bottleneck (it was thought to be extinct), and that captive populations are expected to show a decline in variability. The direct consequence of this finding is that inbreeding depression is very unlikely to occur in the near future, increasing survival and recovery potential for the population.

Genetic analysis has been completed and key biological and management-relevant results are available. Manuscripts based on these results are in preparation and will acknowledge Darwin support.

Change that occurred: for the first time, wild turtle population size and turtle farm contribution have been estimated. This information is essential in managing wild turtle conservation efforts and evaluating the current CTF release programme.

2.3 Management and evaluation (Steering group meetings April, July, October 2014; January, April, July, October 2015). Please see above (output 1.5).

2.4 2.3 Sustainability and Legacy

Junior and senior DoE staff trained in socio-economic methods remain with the department, which has a very low staff turn-over. Equipment outlasting the project has remained with DoE and the department has committed to continuing biological monitoring efforts and gathering additional socio-economic data in collaboration with partners (e.g. now that the survey tool has been developed, it can be adapted and used in future research).

Already in 2016, the network of volunteers established during the project has been mobilised and turtle tagging and protection work is continuing: as turtles do not nest every year, a fourth season of tagging data will be valuable in refining estimates of population size. Partnerships forged with other organisations (e.g. CTF, Economics and Statistics Office, Police, Customs, Tourism etc.) will continue to facilitate a collaborative approach to turtle conservation in the Cayman Islands and we aim to cement the achievements of this project when the Turtle Species Conservation Plan is voted into law.

3 Project Stakeholders/Partners

In this project, stakeholders have been engaged throughout the process. The need for the project was acknowledged by many stakeholders and we began the project with stakeholder

interviews: the main stakeholders involved in the conservation, management and exploitation of sea turtles in the Cayman Islands were interviewed a researcher from UoE (protocol for stakeholder selection and interviews:

http://www.ananuno.net/uploads/2/5/6/2/25623460/stakeholder_surveys.docx). Snowball sampling was used to select these participants, using recommendations from interviewees to establish contact with others most relevant to the study; this purposive sampling approach is suitable for identifying stakeholders and capturing the widest range of perspectives, while avoiding potential biases due to researchers' perceptions about the system. The number of interviews per organization represented the number of people familiar with the topics under discussion, ensuring coverage of different roles within the organizations. The final list of interviewees at this stage included representatives from CTF, DoE, Department of Tourism, the hospitality and dive industries, and members of the Seafarers Association. WAP was also consulted as an international NGO that had expressed interest in the project findings with respect to their campaign to end turtle farming.

There is no active turtle fishery in the Cayman Islands but we made efforts to speak to those who have historically fished for turtle: we interviewed members of the Seafarers Association and one fisher with a valid turtle harvest license (only three remained at the time of study, none of whom had taken turtles since pre-2008).

Interviewees were asked if they wished to provide input on the finished survey instrument (questionnaire). Comments were received from DoE, CTF and WAP.

Nearly 1,000 people were interviewed during the study. In surveys, we asked respondents to rank various scenarios, conducted choice experiments in order to gauge public preference and opinion, asked open ended questions, and collected demographic information.

Project results were presented to all stakeholders with 10 meetings including an open meeting to which all respondents and members of the public were invited.

In order to translate research results into management action, meetings were held with DoE Enforcement, Police, Customs, and Tourism, and presentations were given to the public and to volunteers. Stakeholders have also been consulted in the development of materials for public education, and during the project we have recruited more than 70 volunteers per year to directly participate in monitoring efforts. Education and outreach efforts also extensively involved school children and the public.

Opinion and preference information gathered in surveys and feedback from stakeholders was included in drafting the Species Conservation Plan, and only when the formal public consultation process is complete will a plan be sent to the Legislative Assembly for voting. These mechanisms ensure that public opinion has been taken into account throughout the project, and that the resulting plan is based on a participatory and inclusive process.

4 Lessons learned

The DoE has a very small research staff, without socio-economic expertise and with broad responsibilities for national biodiversity research and management. The ability of the DoE to obtain relevant socio-economic data for management was revolutionised by recruitment of a Darwin Project Officer (post-doctoral social scientist) with expertise in management of exploited species under conditions of uncertainty, and in specialised questioning techniques and other socio-economic survey methods for obtaining reliable information on illegal take.

The Project Officer was based in the Cayman Islands for 6 months during the first year of the project, allowing her to gain an in-depth knowledge of local management issues during the design phase of the project. Before designing the socio-economic survey, she conducted interviews with stakeholders to identify key questions and conducted a pilot study. This allowed the socio-economic survey design to be refined in order to ensure that management objectives were met.

To develop local capacity, DoE staff took part in the process of developing the research tool and local enumerators (who had been trained in general survey administration by the Cayman Islands Economics and Statistics Unit) were recruited and trained to administer the household questionnaires. As the enumerators were currently unemployed, this made a contribution to

local livelihoods, increased local capacity to carry out socio-economic surveys dealing with natural resource management, and allowed a large number of surveys to be completed.

Biological monitoring was conducted efficiently by a team of four interns with the assistance of community volunteers. Enthusiasm of volunteers was built through public events (e.g. public excavation of turtle nests, volunteer meetings, presentations and volunteer appreciation events on the three islands).

Further experience for DoE staff was gained in translating research results into informed environmental decision-making through development of the marine turtle Species Conservation Plan (the turtle plan will be one of the first plans to be considered under the newly implemented Cayman Islands National Conservation Law). This process may also provide a case study for other UKOTs attempting to use socio-economic science in species protection.

Prior to the project, we underestimated the necessary scope of socio-economic surveys in order to answer all questions of interest to stakeholders and to collect rigorous quantitative data. Fortunately, we were able to adjust and expand the project while remaining on schedule and without going over budget. The project was expanded to include formal stakeholder analysis and key informant interviews, surveys of 597 households, and additional surveys of restaurant owners/managers, international tourists, and high school students (totalling 991 respondents). This allowed much more comprehensive quantitative assessment. The project was also expanded to include work in the Sister Islands (Little Cayman and Cayman Brac), as a comprehensive national survey was essential for informed management. Additionally, DoE interns entered data from 3,712 sale receipts that were made available by CTF to analyse trends in meat sales over time.

Based on genetic results obtained following the first year of sample collection, we conducted additional genetic analysis, which proved essential in answering biological questions.

The flexibility of the Darwin initiative allowed us to expand very significantly on what was originally planned and we learned that it is always helpful to reach out to Darwin to discuss changes when needed to better achieve project aims.

4.1 Monitoring and evaluation

As described above, we made two changes in our project design:

1. We greatly expanded the scope of our socio-economic surveys (from 100 in-person interviews planned to nearly 1,000 completed). In addition to surveying a larger number of households on all three islands, we also included schools, international tourists, and restaurants to further explore age related effects and demand for turtle products.
2. We expanded our genetic analysis to include three genetic markers (microsatellites, mtDNA-dloop, and mtDNA-STRs) and completed 704 analyses of wild and farmed green turtle samples (500 analyses budgeted in the original project design).

Both changes allowed us to better achieve project aims. We are grateful to the Darwin Initiative for allowing us sufficient flexibility to make these changes: while an extension of the project timeline was not required, we requested and received permission to transfer funds between budget lines.

Quarterly steering group meetings were helpful in evaluating progress, and the M&E system was useful in setting out goals and target dates.

One outcome statement of reducing illegal take of turtles by 50% by 2016 was not well phrased: as recognised by the reviewer of our annual report, this will require long-term monitoring. We are confident that this project will result in a measurable decrease in illegal take, but we will not be able to document a change prior to submission of our final report. Through the household survey, for the first time we established baseline levels of illegal take (at least 195 households purchasing illegal turtle meat in the 12 months prior to the study). In order to gain this rigorous estimate of the frequency of this illegal behaviour, we conducted nearly 600 interviews with household representatives in the six geographical districts of the Cayman Islands and used a variety of questioning techniques. Prior to and during the project, we recorded every confirmed incident of illegal take which was documented by DoE. In the nesting season following the project (2016) and subsequent seasons we will be able to assess any

increase or decrease in documented incidents of illegal take. However, our survey results show that number of reported incidents (an average of four confirmed incidents per year) underestimates true levels of illegal take to such an extent that quantitatively documenting change would require repeating the socio-economic survey. As we were only able to conduct one household survey of this scale within the project, we were only able to evaluate levels of illegal take at one point in time. However, we have developed capacity for future research and formed links with relevant agencies. While we will not be able to document change during the project, we have set a baseline for future monitoring efforts and there are a number of indicators that suggest that a reduction in illegal take will take place as a result of the project:

- When legal and illegal products are indistinguishable, this facilitates illegal take and sale of illegal turtle products (Tenson 2016). To combat this, all Cayman Turtle Farm meat will be marked (for detailed discussion on how turtle farming by CTF and changes recommended in this project relate to criteria outlined in Tenson (2016) see the recommendations document).
- Evidence from choice experiments in the household survey suggests that consumers will select wild turtle meat if distance to obtain farmed turtle meat is too great. As a result of this project, meat will be more equitably distributed to the outer districts by CTF, reducing incentives for illegal take in areas where this was estimated to be high.
- DoE Enforcement, Police and Customs training has been conducted to increase effectiveness of enforcement. The need for this training was recognised by stakeholders interviewed the beginning of the project (example stakeholder quote on the need for enforcement training: *“The unfortunate truth is most of them [police officers] don’t keep on current with conservation laws.”*).
- Educational materials have been developed and distributed in collaboration with stakeholders to increase awareness (example stakeholder quote on the need for education: *“Somehow we need to raise public awareness because I don’t think the public comprehends the problem.”*).
- Through biological monitoring, a network of volunteers and beachfront property owners has been developed which will continue to support protection efforts (example stakeholder quote on the need for community involvement: *“I think there is not enough education and conservation just for the regular person out there.”*).

4.2 Actions taken in response to annual report reviews

We were asked to address the following points in our final report:

1. We were asked to include means of verification for the main activities of the project. Response: we have included additional means of verification in our Final Report (via links and attached documents).
2. A concern was raised regarding whether the project would have the capacity to analyse the huge amount of additional survey information from the socio-economic assessment. Response: analysis has been successfully completed and a publication has been submitted.
3. We were asked to include a list of stakeholders and describe stakeholder input to the development of the socio-economic survey design. Response: we present a list of stakeholders and account of stakeholder consultations in section 3 and the stakeholder protocol linked within that section.
4. It was recommended that we consider opening up the presentation of the results of the study to all the stakeholders involved (not just the Government and Farm) - activity 2.1. Response: incorporating this feedback, results were presented to all stakeholders through an extended public consultation (10 meetings) as well as development and circulation of a Key Results Report and summary leaflet. Stakeholders were also consulted as findings were translated into conservation actions: stakeholder workshops resulted in the development of additional materials for Police, Tourism, and Customs. Also please see below.

5. We were asked to explain how stakeholders will be consulted in developing the management plan and how this plan will be implemented. Response: results from the socio-economic survey (including participant ranking of potential management strategies and free-form opportunities to offer opinions) and feedback from stakeholders received during presentations and was incorporated into draft documents (for example, 81% of members of the public ranked licensing of restaurants serving turtle meat as their favorite or second favorite management strategy but restaurant owners expressed concerns that licenses would be prohibitively expensive for small business. Thus, we recommend that if a licensing system is implemented it should be at low cost or no cost to applicants by using existing government infrastructure for issuing licenses and for enforcement). Formal public consultation on the legally binding “Species Conservation Plan” and modification taking into account public feedback will take place before the draft is submitted to the legislative assembly for voting (as mandated under the National Conservation Law and outlined in section 2.1). The management plan (consisting of both legal and non-legal documents) will be implemented through collaborations and partnerships formed during the project and through legislation.

5 Darwin Identity

The Darwin Initiative was recognised as supporting a distinct and cohesive project, with all activities aimed at evaluating the role of the Cayman Turtle Farm in wild turtle conservation and reducing illegal take.

The public in the Cayman Islands is likely to be familiar with the Darwin Initiative due to other projects taking place here. Within the Cayman Islands, the Darwin Initiative was acknowledged during workshops and presentations. Press releases issued under the project recognised the Darwin Initiative and the Darwin logo was used on all educational outputs.

Internationally, Darwin Initiative funding was acknowledged during presentations at scientific conferences and in preparation of manuscripts.

6 Finance and administration

6.1 Project expenditure

Project spend (indicative) since last annual report	2015/16 Grant (£)	2015/16 Total actual Darwin Costs (£)	Variance %	Comments (please explain significant variances)
Staff costs			-9.7%	
Consultancy costs			0	
Overhead Costs			0	
Travel and subsistence			-38.7%	Change approved
Operating Costs			56.6%	Change approved
Capital items			0	
Others			-85.2%	Underspend small in actual dollar terms.
TOTAL	1,500	1,500.00	0	

Staff employed (Name and position)	Cost (£)
Dr Ana Nuno, Associate Research Fellow / Darwin Project Officer	
Dr Annette Broderick	
Dr Brendan Godley	
TOTAL	40,813.21

Consultancy – description of breakdown of costs	Other items – cost (£)
None	
TOTAL	0

Capital items – description	Capital items – cost (£)
None	0
TOTAL	0

Other items – description	Other items – cost (£)

Administrative/bank charges (wire transfer fees, CI driver's permit fees for interns)	
Workshop expenses (rental of projector screen)	
TOTAL	148.28

6.2 Additional funds or in-kind contributions secured

Source of funding for project lifetime	Total (£)
Department of Environment in-kind contribution	
University of Exeter in-kind contribution	
TOTAL	247,710

Source of funding for additional work after project lifetime	Total (£)
Department of Environment funding secured to continue turtle tagging and genetic sampling in the 2016 field season.	
TOTAL	11,271

6.3 Value for Money

This project was cost-effective, presenting a strategic plan to address threats standing in the way of recovery a national emblem, Cayman marine turtles, within the budget framework.

The Department of Environment has a very small research staff, without socio-economic expertise and with broad responsibilities for national biodiversity research and management. Therefore, a Darwin Project Officer was recruited to design, conduct, and analyse surveys – adding value in terms of scope and impact. The University of Exeter was best placed to recruit a post-doctoral social scientist as Project Officer and UoE supported this project by waiving all overhead on this post and on the time of other staff.

Community support also provided excellent value for money e.g. volunteers assisting with fieldwork.

Ambitious aims were only possible due to the commitment of DoE and the University of Exeter through matched funding (>£245,000; >60% of the total project costs was in kind). Funding has also been secured to continue turtle tagging and genetic sampling efforts for an additional field season and collaborations are in place will which allow additional research and conservation efforts to continue.

The project also has the potential to be an excellent case study on the role of sound socio-economic science in species protection for other Caribbean countries.

Annex 1 Standard Measures

Code	Description	Totals (plus additional detail as required)
Training Measures		
1	Number of (i) students from the UKOTs; and (ii) other students to receive training (including PhD, masters and other training and receiving a qualification or certificate)	
2	Number of (i) people in UKOTs; and (ii) other people receiving other forms of long-term (>1yr) training not leading to formal qualification	
3a	Number of (i) people in UKOTs; and (ii) other people receiving other forms of short-term education/training (i.e. not categories 1-5 above)	
3b	Number of training weeks (i) in UKOTs; (ii) outside UKOTs not leading to formal qualification	
4	Number of types of training materials produced. Were these materials made available for use by UKOTs?	
5	Number of UKOT citizens who have increased capacity to manage natural resources as a result of the project	16
Research Measures		
9	Number of species/habitat management plans/ strategies (or action plans) produced for/by Governments, public authorities or other implementing agencies in the UKOTs	2
10	Number of formal documents produced to assist work in UKOTs related to species identification, classification and recording.	
11a	Number of papers published or accepted for publication in peer reviewed journals written by (i) UKOT authors; and (ii) other authors	
11b	Number of papers published or accepted for publication elsewhere written by (i) UKOT authors; and (ii) other authors	
12b	Number of computer-based databases enhanced (containing species/genetic information). Were these databases made	

Code	Description	Totals (plus additional detail as required)
	available for use by UKOTs?	
13a	Number of species reference collections established. Were these collections handed over to UKOTs?	
13b	Number of species reference collections enhanced. Were these collections handed over to UKOTs?	
Dissemination Measures		
14a	Number of conferences/seminars/workshops/stakeholder meetings organised to present/disseminate findings from UKOT's Darwin project work	13
14b	Number of conferences/seminars/workshops/stakeholder meetings attended at which findings from the Darwin Plus project work will be presented/ disseminated	2
Physical Measures		
20	Estimated value (£s) of physical assets handed over to UKOT(s)	
21	Number of permanent educational/training/research facilities or organisation established in UKOTs	
22	Number of permanent field plots established in UKOTs	
23	Value of resources raised from other sources (e.g., in addition to Darwin funding) for project work	\$258,981

Annex 2 Publications

Type * (e.g. journals, manual, CDs)	Detail (title, author, year)	Nationality of lead author	Nationality of institution of lead author	Gender of lead author	Publishers (name, city)	Available from (e.g. weblink, contact address, annex etc)
Scientific paper	Nuno A, Blumenthal J, Austin T, Bothwell J, Ebanks-Petrie G, Godley B, Broderick A. Diversifying the toolbox for investigating demand for legal and illegal wildlife products: the case of sea turtle trade in the Cayman Islands. Submitted to Biological Conservation.*	Portugal	UK	Female	Submitted.	Attached.
Scientific paper	Walker J, Godley B, Nuno A. Media framing of the Cayman Turtle Farm: implications for conservation conflicts. Submitted to Animal Conservation.*	UK	UK	Female	Submitted.	Attached.

Annex 3 Darwin Contacts

Ref No	DPLUS019
Project Title	<i>Socio-economic aspects of turtle conservation in the Cayman Islands</i>
Project Leader Details	
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