Department for Environment Food & Rural Affairs

DARWIN INITIATIVE

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Darwin Initiative
Annual Report

Darwin project information

Project reference	21-001
Project title	Developing a conservation management plan for Samoa's little dodo- the Manumea or tooth-billed pigeon
Host country(ies)	Samoa
Contract holder institution	The Australian National University
Partner institution(s)	The Samoan Conservation Society and the Samoan government, Birdlife, The Department of Conservation NZ, Auckland zoo
Darwin grant value	£229,842
Start/end dates of project	01 May 2014 – 31 December 2017
Project leader's name	Robert Heinsohn/Rebecca Stirnemann
Project website/blog/Twitter	WWW.SAMOANBIRDS.ORG @SAMOANBIRDS
Report author(s) and date	Rebecca Stirnemann and Robert Heinsohn 30/4/17

1 Project Rationale

The Manumea or tooth-billed pigeon is found only on the island of Samoa and has until recently been listed as Endangered by the IUCN. Recent surveys in upland and lowland forest on both Upolu and Savaii confirm that Manumea numbers are extremely small. The species was consequently upgraded to Critically Endangered. A major cyclone (cyclone Evan) in December 2012, is likely to have further affected Manumea, and other native bird populations. It was, therefore, vital that the locations of any remaining populations of Manumea were identified and conservation efforts targeted. As stated in the Manumea recovery plan (MNRE, 2006) it is also critical that information on the breeding biology and the spatial requirements of Manumea are understood so that threats can be identified and appropriate conservation management actions can be undertaken. Our project aims to provide a detailed analysis of the status, distribution, ecological requirements and threats faced by this endangered species providing information to enable development of a revised recovery plan and improved capacity for Samoan led on-ground conservation action.

Because the majority of land in Samoa is under customary ownership, local consultations and education regarding the Manumea are critical to enable protection to occur. Furthermore, because both habitat loss and hunting of Manumea are contributing to the Manumea's decline, it is essential to engage the support of village Matai (chiefs). Communities indicated that they would like to be involved with Manumea conservation, but they had too limited means and knowledge to be effective. This project included consultations with the key individuals in villages and conservation education to help develop a sustainable plan of action to empower key communities to be involved with Manumea conservation.

The recovery of the Manumea will take time and needs an organisation behind the project that will target its needs over the long-term. There are currently two 'fledgling' NGOs in place with the support of multiple organisations and with experienced people involved. They are the Samoan Conservation Society (SCS) and Falease'ela Environment Protection Society (FEPS). Both NGOs are new and in need of support regarding capacity development. Therefore, we have been undertaking capacity building support for the local NGOs so that they can, in turn, contribute to the sustainability (and legacy) of the project in the future.

Study area − Samoa is dominated by two large volcanic islands, Savai'i and Upolu, which lie in the South Pacific. Both islands are over 1,000 km2 and are mountainous with a maximum elevation of 1,900 m. The main wet season is December to March.

Fig 1, Location of Samoa in the Pacific. Samoa is made up of two large islands Savai'i and Upolu as well as some smaller islands.

2 Project Partnerships

This project had a strong framework of support from multiple organisations (Fig. 2). Relationships forged with each group resulted in multiple beneficial outcomes for the project. These benefits ranged from financial to physical in-kind support in the form of person-hours, expertise and the lending of equipment.

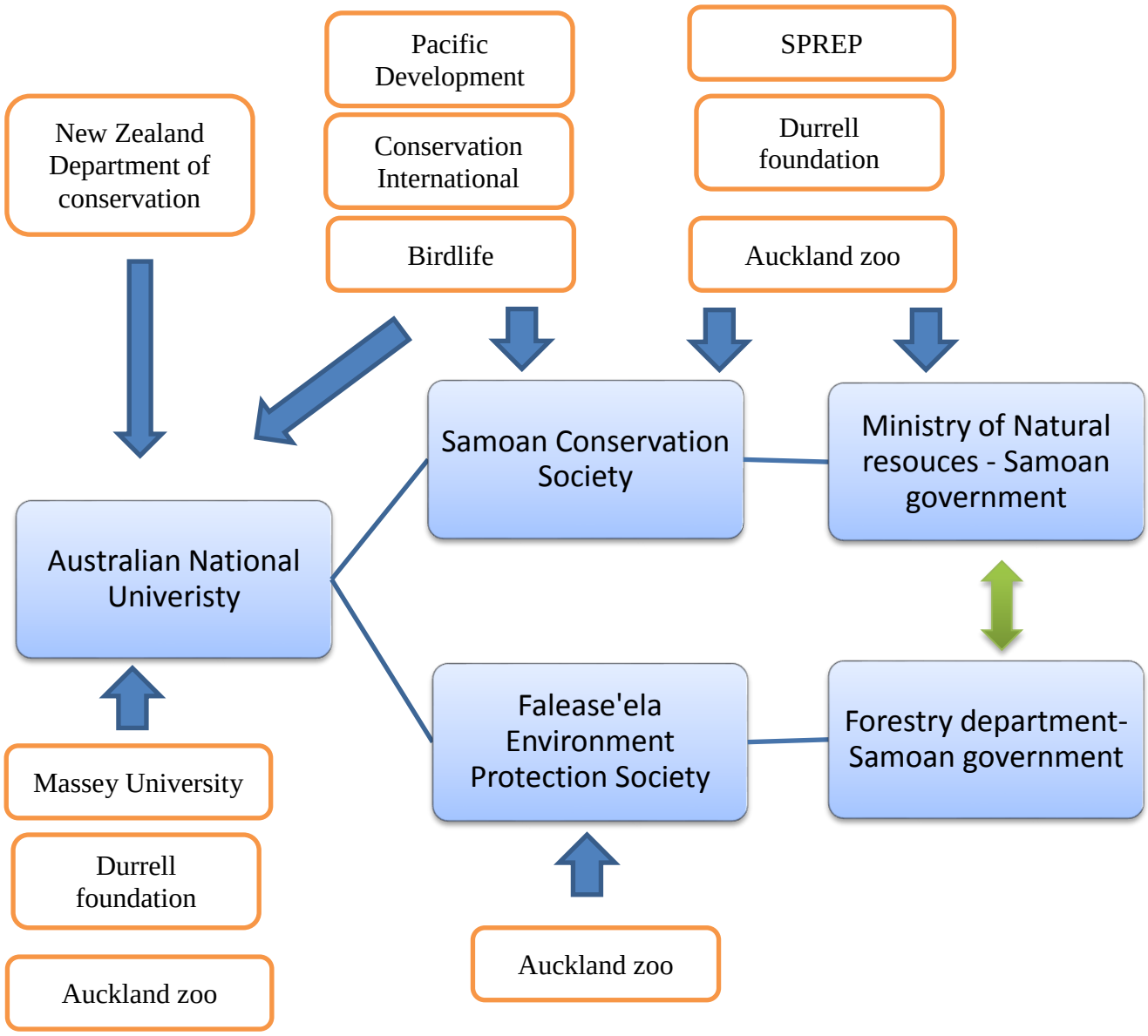

Fig 2. The relationships between the different organisations involved in this project and their point of interaction (arrows).

Australian National University (ANU) was the lead organisation managing the financial side of the project and was the point of contact with the DEFRA Darwin grant staff. They provided scientific, conservation expertise and project management in the form of a staff member (Dr Rebecca Stirnemann) who was predominantly stationed in the country to establish and oversee the project. Rebecca Stirnemann, the ANU project lead, was based out of the SCS offices in Samoa while implementing the project until the end of 2016. Funding to support her salary ran out in September 2016, however she was awarded a visiting status at the ANU to successfully complete aspects of the project post September 2016.

ANU have an MOU with the Samoan Conservation Society (SCS) who are providing operational support for the project in Samoa. One of the main objectives of this project was enhancement and development of the capacity of the NGO.

The SCS formed a partnership with the relevant government environmental department, the Ministry of Natural Resources and Environment (MNRE) of Samoa. The MNRE assists with project liaisons with villages and provides on-ground support and expertise. Some the MNRE staff were also on the board of the Samoan Conservation Society. MNRE staff learnt additional field skills over the course of this project and increased their networks with donors such as the Durrell Foundation and Auckland Zoo.

Over the last year of the project, the ANU representative in the country also built another vital relationship for the project with the Falease'ela Environmental Protection Society (FEPS) who are undertaking forest restoration to provide additional habitat for the Manumea. This was made possible after running community engagement sessions and working jointly conducting field surveys.

The ANU project lead ensured the development and training of local people by forming a support network and directly mentoring local MNRE staff. The aim was to provide local conservationists with additional opportunities. This was achieved by forging the necessary networks and introducing talented individuals to scholarship opportunities. We worked with Durrell in the development of a Darwin scholarship application for two such individuals, Fialelei Enoka and Moeumu Uili, who both worked on the Darwin project and for the local government in Conservation. This was a strategy to ensure long term continued conservation action in the country.

Auckland Zoo provided consistent support towards the project. They provided expertise, funds, staff time and equipment. Their contribution along with The Department of Conservation in New Zealand, The Kiwi Trust and a private consultancy in Australia ensured the success of the sound recorder monitoring project by providing over 120 automatic bird recorders for the survey as well as staff time.

Pacific Development Trust is a new partner and has agreed to donate funds to SCS to undertake the first part of a pest control program. Auckland Zoo has also made a commitment to cover the additional funds needed to extend pest control over a three year period and to build in-country capacity in this regard. The regular meetings between the project lead with the partners in various locations across Australasia aided in the construction of this relationship.

The project lead also worked with FEPS to help them build their capacity and ensure they received further funding. Together they successfully wrote a grant for habitat restoration for the Manumea. They have also been working on an education resource in the form of an engaging children's book to highlight the importance of conservation, with a focus on the Manumea.

SCS have also attracted additional funds in association with the project. For instance, some funds are donated from Conservation International where the new NGO's offices are currently based, and some further funds from Auckland Zoo have been used to cover additional transmitter costs.

3 Project Achievements

3.1 Outputs

Output 1

Activity 1.1 Manumea surveys were undertaken and a monitoring plan developed

The scientific research into the biology of the Manumea forms the largest part of the project and also the most involved since novel techniques were needed to deal with the species' cryptic nature and rarity. Initial studies allowed areas where the Manumea are present to be identified. Individuals were followed to learn more about their behaviour and to try and find nests. One forested area in Upolu, Malololelei reserve, was well used during the fruiting period of *Dysoxylum sp.* (an essential food source). This area was designated as appropriate for implementing a pest control project.

An extensive survey using 72 automatic sound recorders was conducted across the country of Samoa. At the same time, additional information was collected on vegetation to determine the relationship between the presence of the Manumea and habitat quality and plant fruiting times.

An additional survey investigating the impact of hunting and the drivers of this behaviour was also undertaken. This included an analysis of data exploring who were consuming pigeons and other bushmeat. The results of this survey showed that it is consumption by the societal 'elite' that is driving the decline of

Manumea. These results together with an analysis of options for dealing with the issue, have been written as a scientific paper for publication (see appendix).

By contacting museums with ornithology collections and assimilating all known data worldwide we collected information on the breeding biology of the species thereby adding to our knowledge on the timing of breeding.

Activity 1.2 Sites identified where further research/conservation could occur

Sites were identified for further conservation action. Faleseela village was assisted in its efforts to raise funds for undertaking a habitat restoration project. They are currently conducting forest restoration for the Manumea. This will be achieved by targeted planting of the species favoured by the Manumea. The village is also establishing a nursery to grow native trees species favoured by the Manumea which are not currently produced by the Samoan Government Forestry Department. A site for pest control was selected near to Apia and funding support for the next three years has been received.

Activity 1.3 Radio tracking of Manumea

Transmitters were designed and purchased, however, despite many attempts at capture, it was not possible to catch Manumea. We therefore attempted to the information needed on the species' spatial use using an alternative method. Automatic sound recorders were placed simultaneously across the country in various habitats to determine movements and preferred habitat of Manumea. We collaborated with Massey University to automate the process of sorting through the data accurately, providing a valuable methodology which can be used to continue monitoring Manumea in the future. Our results showed that lowland forests were of critical importance for the species. The data is still being analysed to see if we can estimate population size and to determine how it might be used to monitor other species.

Output 2

Activity 2.1 Sites selected for future conservation effort

Sites to target conservation effort have been chosen (see above). It was important to consider not only the presence of Manumea but also the ownership of the land, the quality of the forest, and accessibility of the sites.

Activity 2.2 Both cats and rats controlled in the trial area in the six weeks/ 2weeks before the start of the breeding season

A control plan was developed with the aid of Auckland Zoo and SPREP, and the best position of bait stations was mapped. This plan was presented to the Samoan Government, and the additional funds were gained by writing grant applications during the project and meeting with the potential donors. The Pacific development conservation trust (PDCT) and Auckland Zoo agreed to support a three year period. Initial bird surveys were conducted to form a baseline. Training of MNRE staff in New Zealand and then Samoa is currently being arranged with Auckland Zoo. The Samoan Conservation Society and the local government are lead this activity.

Output 3

Activity 3.1 Development of short educational program on Manumea and forest preservation

After consultations with Auckland Zoo educational specialists, we decided that we would not use the conventional advertising route (posters, brochures, etc.) to spread our message. Instead, we would educate key villages and people by involving them in the project. They would be taught the key messages and then

become conservation leaders within their communities. We are also working directly with hunters to increase local knowledge in an active manner. A children's book on the Manumea is being developed to help educate the children of Samoa about the Manumea. Discussions with TV1 took place about animating this story on the TV to increase reach across the country.

Activity 3.2 Discussions with key village chiefs over the preservation of forest and reduction of pigeon hunting of specific sites

We are combining activities 3.1 and 3.2. Partnership with the Samoan government to undertake the village consultations and design an effective educational outreach program. It was determined that a clear understanding of the forest meat issue was needed to inform methodology for reducing bushmeat hunting impacts on the Manumea. Hunting surveys were designed in collaboration with social scientists to determine the contribution of bushmeat take to the decline of the Manumea. To gain an understanding of who was consuming pigeon meat we collaborated with the Samoan Statistics Department to gain access to the household income and consumption expenditure (HIES) dataset. This provided a large dataset which allowed us to statistically determine who campaigns should target to reduce impacts of hunting.

Activity 3.3 A local native tree planting program established to benefit Manumea in collaboration with the forestry department

This activity is currently being undertaken by FEPS a village run NGO. Following presentations by government staff member Fialelei Enoka and the project leader the community set aside an area of land for forest restoration for the Manumea. The site was surveyed during the project to determine which native trees were present on the land and which invasive plants were a problem. Results showed that in areas such as Faleseela with high cyclone damage the rubber tree is out-competing the native seedlings resulting in functionally dead forest. FEPS is working on determining how to deal with this issue practically and will be trialling removal techniques. FEPS is also currently establishing a nursery to grow new trees needed by the Manumea not provided by the forestry department. They will plant these trees along with trees obtained from the forestry department in a specially designated Manumea reserve area. They also have an ecotourism project which is educating people on the importance of forestry.

Output 4

Activity 4.1 Additional staff hired and trained for SCS

Over the course of the project, two staff members were hired by SCS to work on the project, one to receive training on finance and the other on governance. Continual efforts were also made to train all staff associated with the project on fund raising techniques by collaboratively working on grant applications.

Activity 4.2

Funds applied for to ensure the sustainable future of the Samoan NGOs

Proposals for funds have been submitted to ZGAP, National Geographic, Auckland Zoo and the PDCT. During the project, Juney Ward who was on the board and Posa Skelton also successfully wrote two grants to receive marine funding for the NGO including a large one submitted to PEW.

3.2 Progress towards project outputs

Output 1. Research into the biology of the Manumea and threats

This is the largest component of the project and the most complex. Initial surveys enabled areas where the Manumea are present to be identified. Appropriate habitats with known pairs were targeted to determine

detectability and optimal monitoring times for the species. Individuals were followed to determine patterns of movement and to try to find nests.

We needed to collect this information to establish population estimates. Initial surveys showed that because Manumea are so rare, typical methods of detectability such as repeated point counts would be ineffective. This caused an additional research section to be added to the project. We are currently determining detectability in areas where birds are known using automatic sound recorders. Variability in detectability over a day can then be determined for known individuals so the optimal times for surveys can be established and population size can be estimated. This can be used to determine population size which can then be used to form a baseline to measure the population's response to conservation efforts and external forces such as cyclones.

Transmitter attachment to living Manumea was trialed over a 2.5 year period. Transmitters would have allowed information on spatial use and critical habitat requirements to be determined. However, because capture proved to be tough, we altered our methods to obtain data on spatial use. To do this, we contacted all our partners asking to borrow automatic sound recorders. The response was excellent with five different groups lending us their equipment to undertake what amounted to the largest ever survey in Australasia using simultaneous electronic recorders. Not only is this study critical for Manumea but it will provide a baseline dataset for all other forest bird species in Samoa. While recorders were placed in the forest we also undertook a habitat survey to establish invasive tree spread and important fruiting trees. We are still undertaking the analysis of this data, but early results indicate that lowland forest is critical for Manumea and that rubber trees, especially in damaged cyclone areas, are heavily impacting survival of the food trees Manumea rely on, creating dead monoculture of this invasive species.

Analysis of the data was completed in partnership with Massey University. An automated system was developed which allowed differentiation between the Pacific Pigeon and the Manumea. This was critical because there had been confusion between these species previously and people were worried in the field that they were incorrectly identifying the pigeon species, leading to uncertainty in previous surveys. The data collected can now be used as a baseline to monitor Manumea and other species.

To achieve this output, it was critical that we were flexible in the methodology used and considered all the options for achieving the output. A scientific paper is currently being written, and a map with the locations of the sites is provided in the appendix.

Indicator 1 Revised recovery plan which incorporates biological information on the species

- The government is currently working on this and the data collected from this project will be a key contributor.

Indicator 2 Peer reviewed papers submitted on the biology of the Manumea

- Scientific paper is currently being drafted.

Indicator 3 At least 3 Manumea tracked with radio transmitters

- Instead of using radio tracked birds we used automatic sound recorders. 72 recorders were used to survey both large islands simultaneously.

Indicator 4 At least five new sites identified where Manumea conservation effort can be targeted

- More than five sites have been identified. Two of these are currently undertaking conservation action (pest control and habitat restoration). SCS is also involved in further restoration efforts on Upolu near existing national parks.

We are adding the output to this section:

Indicator 5 Methodology for a monitoring program for Manumea designed

- A monitoring program for the species was designed and implemented across the country of Samoa using automatic sound recorders.

Output 2. Management of invasive species trialled and management plan established

Discussions with experts at SPREP, SCS and Auckland Zoo took place, and a plan was developed, budgeted and presented to the Samoan government. Funding was successfully received to cover the initial year of pest control from the Pacific Development Trust. However, following further discussions with all interested parties, it was established that the area considered should be extended to cover a larger area double that originally suggested by this project. This required additional discussions with land owners. It was also decided that it would be optimal to undertake pest control for at least three years so skills could be built up and the impact would be clear. Consequentially it is hoped that pest control will be applied continually as a management technique to increase populations of endangered birds in the established site. This was important since this is the first project of its kind in Samoa and indeed will precede this technique being used in the neighbouring islands of Fiji and American Samoa. It is hoped these other regions will follow Samoa's example and implement similar management strategies. Following further discussions with donors and MNRE, Auckland zoo agreed to fund additional costs, provide support and training as well as to support pest control over the 3 year period not covered by PDTC. Furthermore, discussions took place between Auckland zoo, the project leader and the company who supply bait and bait stations. The latter offered to fund free bait stations and bait for the project. This required some alteration to the initial PDCT grant. Initial surveys to form a baseline were undertaken during the project. SCS and MNRE are currently leading on the implementation of this output.

Indicator 1 Sites established where monitoring can occur

- Site with bait station locations mapped.

Indicator 2 Management of invasive species trialled at one site

- Management of invasive species planned to occur in 2017.

Indicator 3 Working paper outlining the success of the techniques submitted to the Ministry of Natural resources

- MNRE is leading this aspect of the project but annual reporting is expected.

Output 3. Pigeon hunting bans and logging restrictions for key areas developed through participatory methods with key villages.

Despite illegal hunting being a key conservation issue in Samoa, there has been a paucity of research. We examined the dynamics of hunting and determined how these contribute to biodiversity loss with a focus on the interactive effects of hunting on two species of pigeons: the Pacific pigeon (*Ducula pacifica*) and the critically endangered Manumea. We interviewed hunters, vendors and consumers as well as analysing consumption data collected from 2,348 households. Our findings showed that across the country the wealthiest households consumed 43% of all pigeons, while the wealthiest 40% of households consumed 80% of all pigeons. We estimate that over 22,000 pigeons were consumed per year. Despite not being a target species, the Manumea was shot by 33% (n=30) of the surveyed hunters while targeting the Pacific pigeon. Our results raise serious conservation concerns, as it is likely to be a key factor contributing to the decline of the last remaining species in this genus. Our results indicate that improved economic household incomes can lead to increased pressure on both target and bycatch species. We explored the implications of these results for current conservation interventions to save the manumea. It is critical that these results are now used to develop further techniques to deal with this issue at a government level and into the villages.

Initial steps in this regard have been undertaken as part of this project in meeting with multiple villages. However it is clear that the government must lead action on this issue. Further efforts are being made to publicise the issue by producing a children's book and cartoons.

Indicator 1, increased protection of sites recorded in minutes of village meetings, was determined to no longer be an appropriate measure of this output. However, a scientific paper on the results of the survey has been produced showing the completed results.

Output 4. The capacity for the local conservation NGO (the Samoan Conservation Society) has been enhanced.

The NGO now has a project office and staff and has received additional funds. A website was developed increasing the profile of the organisation. Progress is measured using a tracking tool.

We established a baseline of the organization's status at beginning of the project and the NGO expected to provide updates as to the progress using the Civil Society Tracking Tool, to **measure indicator 1 - Improve the local NGOs (SCS) capacity in working with threatened species conservation action and management**. Progress has been slow in building the NGO. This was partly expected since the NGO was dependent until this point on volunteers who all had full time jobs. One of the key next steps will be building a formal governance system.

3.3 Outcome

The project's outcome is: the establishment of methods, based on sound ecological knowledge, which will halt the decline of the Manumea and its habitat and the support of the community to implement these methods.

During this project we developed a survey to monitor the Manumea using simultaneously monitoring automatic recorders. This method worked despite the species' cryptic nature and rarity since the recorders could record bird calls without an observer being present for long periods of time. All calls could also be verified electronically to ensure there was no confusion between the pigeon species, Manumea and Lupe, an issue the government has previously identified as potentially leading to misidentification. We could also check for male and female calls. The data collected during the sound recorder survey form a baseline against which success over the long-term can be measured. We also undertook field work to understand the threats to the species and develop appropriate conservation action based on a sound ecological knowledge of the species and its threats. Hunting proved to be a substantial issue and effort was made to determine how this might be managed. The management of invasive species has been developed to be over a longer time period and area. Initial steps and partnerships to ensure success have been set in place. Discussions with some key villages (Indicator 3) on hunting and forest restoration occurred. One village is now undertaking its own forest restoration targeted at helping Manumea. The next generation of people is being targeted with a campaign aimed at children to enhance value of native species. Indicator 4, the increasing of capacity of the local NGO continues to occur. Some of the indicators are adequate for measuring the outcome while others have become redundant as the project has developed.

3.4 Impact: achievement of positive impact on biodiversity and poverty alleviation

Our project aims to save the Manumea, thus contributing to Aichi Target 12, which states that "by 2020, the extinction of known threatened species has been prevented and their conservation status, particularly of those most in decline has been improved and sustained."

4 Contribution to Darwin Initiative Programme Objectives

4.1 Contribution to Global Goals for Sustainable Development (SDGs)

The project has helped develop local capacity in two local NGOS and the Samoan government. We have provided training and mentoring and, where talented individuals have been identified, opportunities for further growth.

4.2 Project support to the Conventions or Treaties (CBD, CMS, CITES, Nagoya Protocol, ITPGRFA))

Our project aims to save the Manumea from extinction, thus contributing to Aichi Target 12, which states that "by 2020, the extinction of known threatened species has been prevented and their conservation status, particularly of those most in decline has been improved and sustained." Saving the Manumea will also involve preserving native forest which contains a rich fauna and flora of native species, thus contributing to Aichi Target 11. Thus this project will contribute to the CBD through the conservation of biological diversity it will also increase the sustainable use of components of biological diversity by reducing hunting pressure on the Manumea by working with the local communities hence contributing to Aichi target 1.

4.3 Project support to poverty alleviation

- The project has helped develop local capacity in both NGOS and government. We have provided training, mentoring and further growth.

4.4 Gender equality

This project works with both men and women in villages and within the environmental sector to ensure conservation action is not gender biased. Both sexes also have equal chances of developing skills through training of both MNRE and SCS staff.

4.5 Programme indicators

- **Did the project lead to greater representation of local poor people in management structures of biodiversity?**

Local capacity was enhanced.

- **Were any management plans for biodiversity developed?**

Yes see scientific paper on hunting of native species and the plan for pest control.

- **Were these formally accepted?**

The papers are still in formal review.

- **Were they participatory in nature or were they 'top-down'? How well represented are the local poor including women, in any proposed management structures?**

Both top down and participatory.

- **Were there any positive gains in household (HH) income as a result of this project?**

Not measured.

- **How many HHs saw an increase in their HH income?**

Not measured.

- **How much did their HH income increase (e.g. x% above baseline, x% above national average)? How was this measured?**

Not measured

4.6 Transfer of knowledge

Knowledge was transferred in multiple ways from scientific papers to presentations. Information is also shared in children's books and through the media. Multiple presentations have been given to various stake holders.

Did the project result in any formal qualifications?

If they are accepted two people from the project will be going to get formal qualifications. They are currently short listed for Darwin scholarships. They are from developing countries and one is male and one female.

4.7 Capacity building

- One of the project staff was promoted to lead of national parks and reserves during the project. She is female. Our focus has been on capacity building via the NGOs.

5 Sustainability and Legacy

It is expected that a lot of the impacts of this project will be long term. The networks that have been forged have in particular been critical and will continue to be critical. The probablity for instance that the pest control will continue and inspire other island nations in the pacific such as American Samoa. We also hope that the government will make stronger policies to reduce the impact of taking forest meat. It is expected that the two NGOs will continue to progress and the project staff will grow with them. One clear lack is still lack of capacity in grant writing. Further funding has been gained to enable the NGOS to continue to progress.

6 Lessons learned

The flexibility of the project was key to success. We adapted methods, techniques, partners and interactions as we gained technical results, learnt what did not work, and found new partners.

The opportunity to build relationships with multiple organisations was also critical. Organisations such as Auckland zoo partnered with us after repeated interactions where trust and friendship was built.

One difficult part of the project was the inadequate funding of the project leader's (Stirnemann) wage such that it ceased prior to the completion of the project. This required the project leader to contribute considerable time in a visiting staff capacity to maintain the project. We recommend any further projects fund the project leader for the entire project and if any extensions are given to any of the partners requiring a longer reporting period that additional funds for report writing are provided so the project leader is not negatively affected and having to take unpaid leave.

The feedback from the external reviewers on the project was very useful.

Monitoring and evaluation

The main change to the log frame was the additional task of developing a monitoring method for the species. We also replaced the methodology whereby we monitored spatial use which slightly altered the output goals though the end result was the same.

The M and E was useful but slightly repetitive of the information written earlier in the document.

6.1 Actions taken in response to annual report reviews

The previous annual reports reviews requested:

1) removing bushmeat as a meat source might not be beneficial to the local people
   We completed an analysis using scientific methods and produced a scientific paper to determine the impact the removal of bushmeat from the menu would have on the people of Samoa.
2) That we provide more evidence of work. This is documented in the final annex section of the report.

The reviews were shared with the local NGO.

7 Darwin identity

The Manumea Darwin project was recognised as a distinct project. We took all possible opportunities to link the project with the logo and to increase awareness. This was done through social media and blog posts as well as some newspaper articles.

The government of Samoa was familiar with the project and the donor. This awareness was highlighted by the joint application for funds to provide additional education to the two government people working on the project.

8 Finance and administration

Because of an extension requested by SCS for their activities until the end of 2017 we request an extension to the annual report on finances. The tables below will therefore not be completed yet, only the written report is presented here. The financial details (indicative figures) will be supplied separately to allow cost effectiveness of the project to be assessed.

8.1 Project expenditure

Complete the expenditure table below, providing a breakdown of salaries, capital items and explanations of 'Other' costs. If the budget was changed since the project started, please clarify the main differences. **Explain in full** any significant variation in expenditure where this is +/- 10% of the approved budget lines.

Project spend (indicative) since last annual report	2016/17 Grant (£)	2016/17 Total actual Darwin Costs (£)	Variance %	Comments (please explain significant variances)
Staff costs (see below)				
Consultancy costs				
Overhead Costs				
Travel and subsistence				
Operating Costs				
Capital items (see below)				
Others (see below)				
TOTAL				

Staff employed (Name and position)	Cost (£)

TOTAL	

Capital items – description	Capital items – cost (£)
TOTAL	

Other items – description	Other items – cost (£)
TOTAL	

8.2 Additional funds or in-kind contributions secured

Source of funding for project lifetime	Total (£)
TOTAL	

Source of funding for additional work after project lifetime	Total (£)
TOTAL	

8.3 Value for Money

This project provided value for money with a project that had already been initiated through a CLP project and partners already in place. Developing critical partners reduced the cost of the project by donating time

and equipment. By having people with grant writing skills additional funds were gained enabling further conservation action to occur past the length of the project and beyond.

Annex 1 Project's original (or most recently approved) logframe, including indicators, means of verification and assumptions.

Project summary	Measurable Indicators	Means of verification	Important Assumptions
Impact This project aims to reduce biodiversity loss in Samoa by preventing the continual decline of the Manumea and its associated forest habitat.			
Outcome The establishment of methods, based on sound ecological knowledge, which will halt the decline of the Manumea and its habitat and the support of the community to implement these methods.	Outcomes indicators 1) At least 5 new sites have been identified for future conservation of the Manumea, >30% of forested areas in Samoa will be surveyed for Manumea, More than 3 Manumea have been tagged and radio tracked, position of nests have been identified 2) Management of invasive species trailed in 1 area 3) Increased number of sites given increased protection from hunting and logging agreed upon by community groups, Population metrics of pigeons (not only Manumea) in protected areas increasing 4) The number of experienced and trained permanent staff has increased		

Output 1. Research into the biology of the Manumea and threats to the species	1.1 Peer reviewed publications, surveys, project report, videos, maps, photos	1.1 Maps of surveys, 1.2 Photos of fieldwork 1.3 Scientific papers- One submitted to biodiversity and conservation 1.4 One paper in development 1.5 One large dataset available	1.1 That we could adapt the methods to undertake the research 1.2 That the bird did not go extinct 1.3 that the government and communities supported the research 1.4 that the Ngo supported the research and provided the staff member for work
Output 2. Management of invasive species (targeted species established in output1) trialled and management plan established	2.1 Management plan, surveys, project report	2.1 Dataset from museum available 2.2 Map of plan for pest control 2.3 Survey data baseline 2.4 Pictures 2.5 Funding confirmed for action 2.6 Meeting with government and presentation	2.1 That the government supports the project and that funding is gained 2.2 that the poison can be imported
Output 3. Pigeon hunting bans and logging restrictions for key areas developed through participatory methods with key villages.	3.1 maps, surveys, papers, photos, reports, media coverage	3.1 Scientific paper investigating the drivers of hunting and consumption 3.2 Forest restoration occurring in Faleseela 3.3 funding for Faleseela village is confirmed 3.4 Photos from field work with Faleseela and other village meetings about manumea and forest and hunting lose	3.1 There is local buy in 3.2 That the government support hunting reductions
Output 4. The capacity for the local conservation NGO (the Samoan conservation Society) is enhanced	4.1 Change indicators measured, more staff employed, NGO formalises strategic goals to an annual plan, NGO formalises the governance structure, NGO gains further funds	4.1 Change indicators measured 4.2 More funding gained	4.1 The NGO continues to gain funds 4.2 The NGO is well run by the board 4.3 The NGO wants to grow and interest is maintained 4.4 Staff turnover is manageable

Annex 2 Report of progress and achievements against final project logframe for the life of the project

Project summary	Measurable Indicators	Progress and Achievements
Impact This project aims to reduce biodiversity loss in Samoa by preventing the continual decline of the Manumea and its associated forest habitat.		Knowledge on the species has been enhanced. Conservation areas have been established and threats have been determined. Small steps are in place to increase the Manumea's habitat. However our research identified hunting as a key driver of the decline. We have isolated methods to deal with this issue but the government will need to lead.
Outcome The establishment of methods, based on sound ecological knowledge, which will halt the decline of the Manumea and its habitat and the support of the community to implement these methods.	Outcomes indicators 1) At least 5 new sites have been identified for future conservation of the Manumea, >30% of forested areas in Samoa will be surveyed for Manumea, More than 3 Manumea have been tagged and radio tracked, position of nests have been identified 2) Management of invasive species trialed in 1 area 3) Increased number of sites given increased protection from hunting and logging agreed upon by community groups, Population metrics of pigeons (not only Manumea) in protected areas increasing 4) The number of experienced and trained permanent staff has increased	We have developed methodologies to address the three biggest threats to the species 1) habitat loss 2) invasive species and 3) bush meat hunting of other pigeon species. Item 2 still needs to be run but will now take place over a three year period. 1) Completed 2) All set up to undertake at a larger scale over the long term by SCS and MNRE 3) A few sites have being protected or established for Manumea however more are needed if the species is to be saved. 4) Completed especially if Moeumu Uili and Fialelei Enoka get the scholarships to study from the Darwin project.
Output 1. Research into the biology of the Manumea and threats to the species is currently being undertaken	Peer reviewed publications, surveys, project report, videos, Recovery plan, maps, photos	Research into the species was undertaken with the largest simultaneous sound recorder survey ever to occur in the Pacific occurring in Samoa to monitor the Manumea. Maps, photos, dataset and ultimately a scientific paper on the survey. The latter is still being developed.

Activity 1.1 Manumea surveys undertaken and monitoring plan developed		Completed
Activity 1.2 Sites identified where further research/conservation can occur		Completed
Activity 1.3 Radio tracking of Manumea		Radio transmitters have arrived in Samoa and we will be trialling capture methods in the upcoming months.
Output 2. Management of invasive species (targeted species established in output1) trialled and management plan established	Management plan, surveys, project report	Map of planned pest control sites. Funding letters from PDCT and Auckland zoo. Presentation given to government in partnership with SPREP.
Activity 2.1. Sites selected for future conservation effort		Completed
Activity 2.2. Both cats and rats controlled in the 50ha area in the 6 week/ 2 weeks prior to the start of the breeding season		Funding arranged and design completed for a larger area and for long term (3 year+). Initial baseline survey complete. Control still to occur under MNRE and SCS.
Output 3. Pigeon hunting bans and logging restrictions for key areas developed through participatory methods with key villages.	Videos, village meeting notes, project report, videos, village's report	Survey completed on hunting with an outline of methodology for reducing the activity and consumption COMPLETED. Forest restoration targeting Manumea is occurring. FUNDING for local conservation NGO to undertake this COMPLETED.
Activity 3.1 Development of short educational program on Manumea and forest preservation		A children's book on Manumea is being developed and a short cartoon nearly completed for publication. Village visits have been COMPLETED.
Activity 3.2 Discussions with key village chiefs over the preservation of forest and reduction of pigeon hunting of specific sites		Completed (though more optimally would occur)
Activity 3.3 A local native tree planting program established to benefit Manumea in collaboration with the forestry department		Funding gained and land set aside by Faleseela NGO (FEPS) who are undertaking this restoration project currently.
Output 4. The capacity for the local conservation NGO (the Samoan conservation Society) is enhanced	Project report, meeting notes	We are now using a tracking tool to monitor NGO development which is much more directly indicative of change then project reports and meeting notes. COMPLETED.
Activity 4.1 An additional staff member has been hired by the NGO.		Completed

Activity 4.2 Funds applied for to insure the sustainable future of the organisation	Completed

Annex 3 Standard Measures

We use these figures as part of our evaluation of the wider impact of the Darwin Initiative programme. Projects are not evaluated according to quantity. That is – projects that report few standard measures are not seen as being of poorer quality than those projects which can report against multiple standard measures.

Please quantify and briefly describe all project standard measures using the coding and format of the Darwin Initiative Standard Measures. Download the updated list explaining standard measures from http://darwin.defra.gov.uk/resources/reporting/. If any sections are not relevant, please leave blank.

Code	Description	Total	Nationality	Gender	Title or Focus	Language	Comments
Training Measures							
1a	Number of people to submit PhD thesis	0					
1b	Number of PhD qualifications obtained	0					
2	Number of Masters qualifications obtained	0					
3	Number of other qualifications obtained	5					
4a	Number of undergraduate students receiving training						
4b	Number of training weeks provided to undergraduate students						
4c	Number of postgraduate students receiving training (not 1-3 above)						
4d	Number of training weeks for postgraduate students						
5	Number of people receiving other forms of long-term (>1yr) training not leading to formal qualification (e.g., not categories 1-4 above)						
6a	Number of people receiving other forms of short-term education/training (e.g., not categories 1-5 above)						
6b	Number of training weeks not leading to formal qualification						
7	Number of types of training materials produced for use by host country(s) (describe training materials)						

Research Measures		Total	Nationality	Gender	Title	Language	Comments/ Weblink if available
9	Number of species/habitat management plans (or action plans) produced for Governments, public authorities or other implementing agencies in the host country (ies)						Participatory process?
10	Number of formal documents produced to assist work related to species identification, classification and recording.						
11a	Number of papers published or accepted for publication in peer reviewed journals	1 with 2 more coming					
11b	Number of papers published or accepted for publication elsewhere	1					
12a	Number of computer-based databases established (containing species/generic information) and handed over to host country						
12b	Number of computer-based databases enhanced (containing species/genetic information) and handed over to host country						
13a	Number of species reference collections established and handed over to host country(s)						
13b	Number of species reference collections enhanced and handed over to host country(s)						

Dissemination Measures		Total	Nationality	Gender	Theme	Language	Comments
14a	Number of conferences/seminars/workshops organised to present/disseminate findings from Darwin project work	10	Conference/workshop	F	Pacific Conservation, Invasive	English,	

Dissemination Measures		Total	Nationality	Gender	Theme	Language	Comments
			Conservation	M&F		English/Samoan	
14b	Number of conferences/seminars/ workshops attended at which findings from Darwin project work will be presented/ disseminated.	10	Samoan, Samoan, New Zealand	F, M, F	Conservation in the Pacific, Invasive Species, Conservation	English	

Physical Measures		Total	Comments
20	Estimated value (£s) of physical assets handed over to host country(s)		Unknown exactly however included a computer, desks and chairs and field equipment
21	Number of permanent educational, training, research facilities or organisation established		
22	Number of permanent field plots established	72	Please describe. 72 automatic sound recorder locations were established to form a baseline to monitor population change.

Financial Measures		Total	Nationality	Gender	Theme	Language	Comments
23	Value of additional resources raised from other sources (e.g., in addition to Darwin funding) for project work	7		Female	Conservation	English	

Annex 4 Aichi Targets

	Aichi Target	Tick if applicable to your project
1	People are aware of the values of biodiversity and the steps they can take to conserve and use it sustainably.	tick
2	Biodiversity values have been integrated into national and local development and poverty reduction strategies and planning processes and are being incorporated into national accounting, as appropriate, and reporting systems.	Being undertaken
3	Incentives, including subsidies, harmful to biodiversity are eliminated, phased out or reformed in order to minimize or avoid negative impacts, and positive incentives for the conservation and sustainable use of biodiversity are developed and applied, consistent and in harmony with the Convention and other relevant international obligations, taking into account national socio economic conditions.	Being undertaken
4	Governments, business and stakeholders at all levels have taken steps to achieve or have implemented plans for sustainable production and consumption and have kept the impacts of use of natural resources well within safe ecological limits.	
5	The rate of loss of all natural habitats, including forests, is at least halved and where feasible brought close to zero, and degradation and fragmentation is significantly reduced.	In progress
6	All fish and invertebrate stocks and aquatic plants are managed and harvested sustainably, legally and applying ecosystem based approaches, so that overfishing is avoided, recovery plans and measures are in place for all depleted species, fisheries have no significant adverse impacts on threatened species and vulnerable ecosystems and the impacts of fisheries on stocks, species and ecosystems are within safe ecological limits.	
7	Areas under agriculture, aquaculture and forestry are managed sustainably, ensuring conservation of biodiversity.	
8	Pollution, including from excess nutrients, has been brought to levels that are not detrimental to ecosystem function and biodiversity.	
9	Invasive alien species and pathways are identified and prioritized, priority species are controlled or eradicated, and measures are in place to manage pathways to prevent their introduction and establishment.	In progress
10	The multiple anthropogenic pressures on coral reefs, and other vulnerable ecosystems impacted by climate change or ocean acidification are minimized, so as to maintain their integrity and functioning.	
11	At least 17 per cent of terrestrial and inland water, and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes.	
12	The extinction of known threatened species has been prevented and their conservation status, particularly of those most in decline, has been improved and sustained.	In progress
13	The genetic diversity of cultivated plants and farmed and domesticated animals and of wild relatives, including other socio-economically as well as culturally valuable species, is maintained, and strategies have been developed and implemented for minimizing genetic erosion and safeguarding their genetic diversity.	

14	Ecosystems that provide essential services, including services related to water, and contribute to health, livelihoods and well-being, are restored and safeguarded, taking into account the needs of women, indigenous and local communities, and the poor and vulnerable.	
15	Ecosystem resilience and the contribution of biodiversity to carbon stocks has been enhanced, through conservation and restoration, including restoration of at least 15 per cent of degraded ecosystems, thereby contributing to climate change mitigation and adaptation and to combating desertification.	In progress
16	The Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization is in force and operational, consistent with national legislation.	
17	Each Party has developed, adopted as a policy instrument, and has commenced implementing an effective, participatory and updated national biodiversity strategy and action plan.	
18	The traditional knowledge, innovations and practices of indigenous and local communities relevant for the conservation and sustainable use of biodiversity, and their customary use of biological resources, are respected, subject to national legislation and relevant international obligations, and fully integrated and reflected in the implementation of the Convention with the full and effective participation of indigenous and local communities, at all relevant levels.	Tick
19	Knowledge, the science base and technologies relating to biodiversity, its values, functioning, status and trends, and the consequences of its loss, are improved, widely shared and transferred, and applied.	Tick
20	The mobilization of financial resources for effectively implementing the Strategic Plan for Biodiversity 2011-2020 from all sources, and in accordance with the consolidated and agreed process in the Strategy for Resource Mobilization should increase substantially from the current levels. This target will be subject to changes contingent to resource needs assessments to be developed and reported by Parties.	

Annex 5 Publications

Provide full details of all publications and material that can be publicly accessed, e.g. title, name of publisher, contact details. Mark (*) all publications and other material that you have included with this report

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. web link, contact address etc)
Scientific paper	**Interactive impacts of by-catch take and elite consumption of illegal wildlife**, 2017	New Zealand	Australia	female	Biodiversity and Conservation, Springer,	Will be online once review completed
Scientific paper	**Compounding effects of habitat fragmentation and predation on bird nests, 2015**	New Zealand	New Zealand	female	Austral Ecology, Wiley	Online http://onlinelibrary.wiley.com/doi/10.1111/aec.12282/abstract

Annex 6 Darwin Contacts

Ref No	21-001
Project Title	Developing a conservation management plan for Samoa's little dodo- the Manumea or tooth-billed pigeon
Project Leader Details	
Name	Robert Heinsohn
Role within Darwin Project	Project supervisor
Address	
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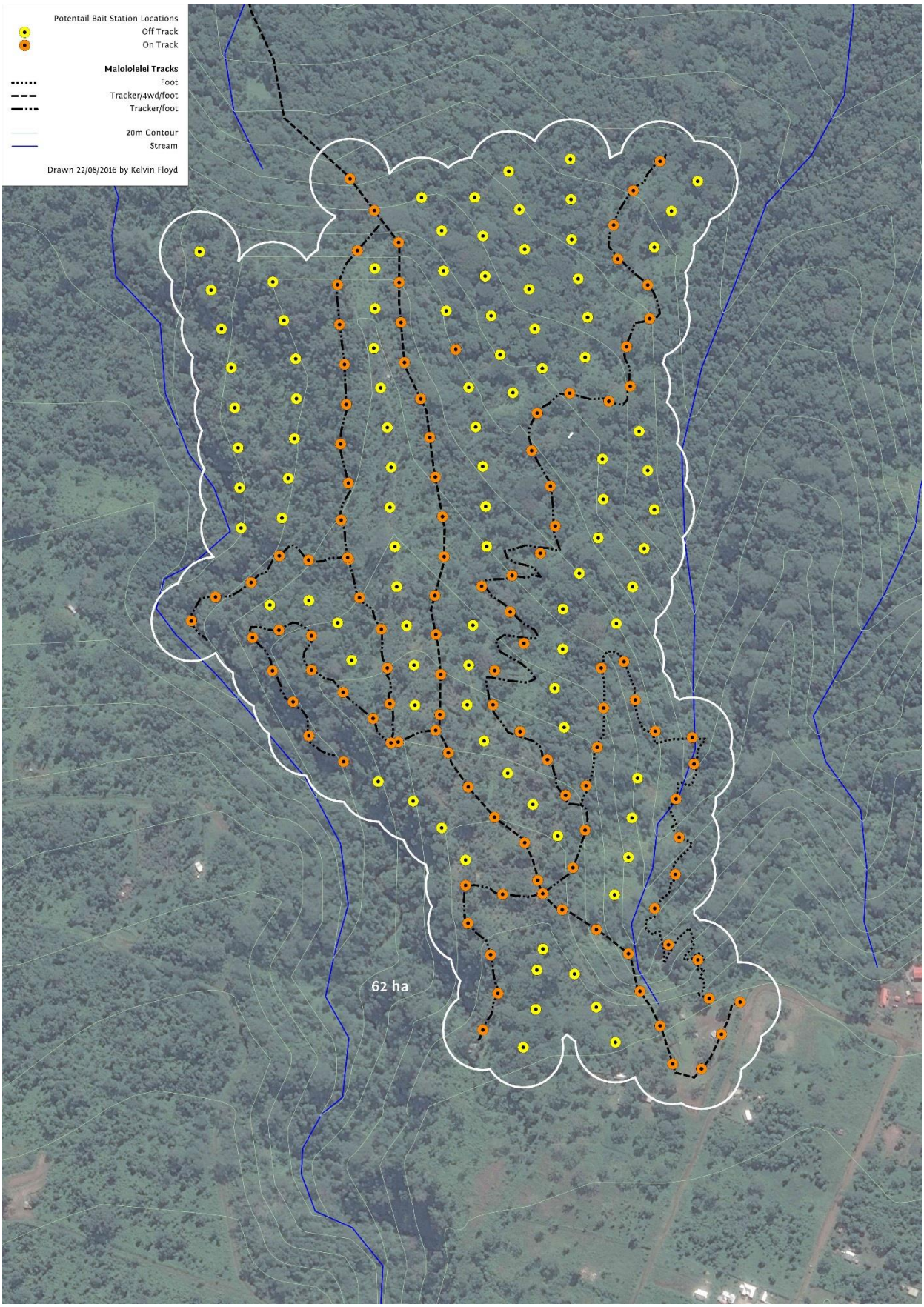
Partner 1	
Name	Rebecca Stirnemann
Organisation	ANU
Role within Darwin Project	Project leader in Samoa
Address	
Fax/Skype	
Email	robert.heinsohn@anu.edu.au
Partner 2	
Name	Mark O'Brien
Organisation	Birdlife
Role within Darwin Project	Adviser
Address	
Fax/Skype	
Email	
Partner 3 etc.	
Name	Moeumu Uili
Organisation	SCS treasurer, MNRE staff
Role within Darwin Project	MNRE liaison
Address	
Fax/Skype	
Email	

APPENDIX 7

1a) map of proposed pest control site and bait station layout



2. Funding for pest control PDCT grant

On Tue, Sep 13, 2016 at 4:34 PM, Trusts <Trusts@dia.govt.nz> wrote:

14 September 2016

Rebecca Stirnemann

Samoa Conservation Society

C/-CI Samoa Office

Hillary Street

Vailima, Samoa

Tēnā koe Rebecca

PACIFIC DEVELOPMENT AND CONSERVATION TRUST – NOTICE OF DECISION

I am pleased to advise that the Pacific Development and Conservation Trust has approved your grant application. On behalf of the Trust, I am able to offer a grant of $17,000 towards the costs of the project *Working to save Samoas little dodo-Manumea: Pest control and restoration.*

The Trust requires that grant money will be used only for the purposes outlined in the application. **The grant can only be used for pest control equipment.** Please note that if for any reason your project does not go ahead, all funds must be returned to the Trust.

8.3.1 **Grant Payment:** Please complete the enclosed Grant Agreement and return this together with a pre-printed bank deposit slip so the grant payment can be deposited into your nominated account. The account number in the Grant Agreement must match the account number on the bank deposit slip. All grant payments are GST inclusive.

8.3.2 **Reporting Requirements:** The Trust requires you to present a progress report on the project every six months and a completion report at the end of your project. A report template will be emailed to you after the grant payment has been made.

8.3.3

8.3.4 **Trust Acknowledgement:** Financial support given by the Trust must be acknowledged in all relevant publicity material, publications, annual reports and similar documents relating to the funding.

If you have any queries regarding the grant, please don't hesitate to contact Scott Nielson, Trust Advisor, on phone 04 460 2275 or email scott.nielson@dia.govt.nz.

Congratulations, and I wish you every success with your project.

Nāku noa, nā

Joe Grace

Manager Regional Services

Community Operations

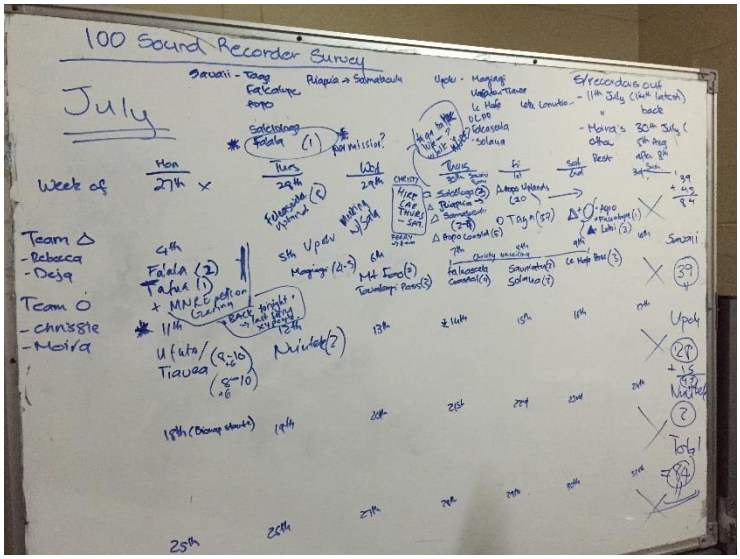
Our ref: PDCONSAM00615-2016

Scott Nielson | Community Advisor
Department of Internal Affairs Te Tari Taiwhenua
Direct Dial: +64 4 460 2275 | Extn: 5075 | 0800 824 824 | www.dia.govt.nz

IMAGES OF PROJECT- FIGURES 3.1

1) Survey of vegetation and birds at Faleseela. Collaboration with FEPS and Auckland zoo
2) Children's book illustration
3) Moeumu Uili and Christine putting out sound recorders
4) Department of Conservation staff member Moira and Rebecca sorting out 100 recorders

5) The time table for putting out all recorders at the same time over two islands
6) Rat nest predation evidence
7) Finding evidence of pigeon take in the lowland forests where manumea chicks and adult birds had been seen.



Remaining three Didunculus strigirostris specimens measured on 3-17-2014

9) Workshop in partnership with UNDP SGP on conservation in Savaii

Figure 10. Fia looking for Manumea spotted in the area during mistnetting.

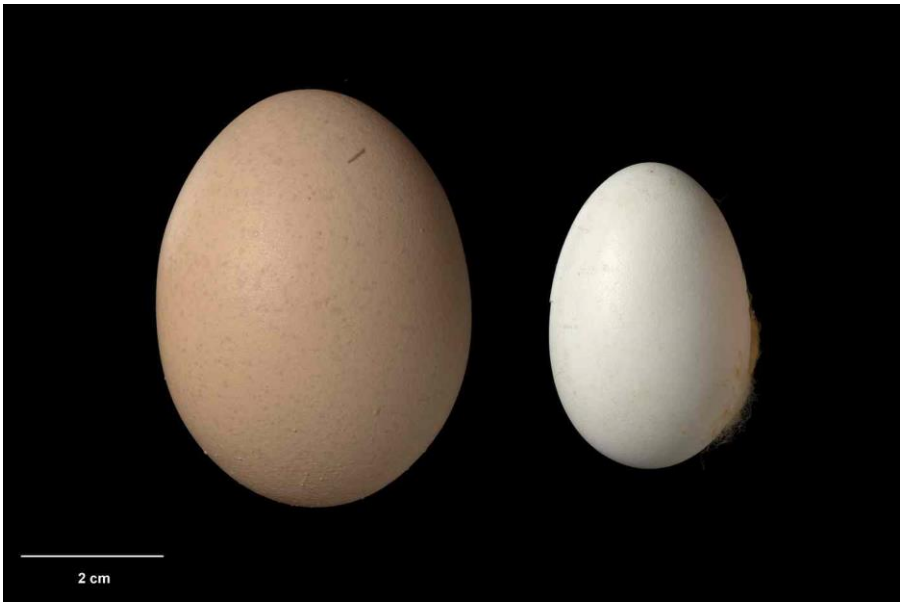


Figure 11. A manumea egg (left) beside a chicken egg (right)

Figure 12. Moeumu Uili (MNRE) undertaking village interviews in Savaii about hunting.

Manuscript in review (*Biodiversity and Conservation*):

Interactive impacts of by-catch take and elite consumption of illegal wildlife

RH: Elite consumption and by-catch take

Keywords: *bushmeat, illegal wildlife trade, supply chain, poaching, hunting, inequality*

Word count: 6202

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9 Abstract

Harvesting, consumption and trade of forest meat are key causes of biodiversity loss. Successful mitigation programs are proving difficult to design, in part because anthropogenic pressures are treated as internationally uniform. Despite illegal hunting being a key conservation issue in the Pacific Islands, there is a paucity of research. Here we examine the dynamics of hunting and determine how these contribute to biodiversity loss on the islands of Samoa, with a focus on the interactive effects of hunting on two species of pigeons: the Pacific pigeon (*Ducula pacifica*) and the critical endangered Manumea (*Didunculus strigiristris*). We interviewed hunters, vendors and consumers as well as analyzing consumption data collected from 2,348 households. Our findings show that across the country the wealthiest households consumed 43% of all pigeons, while the wealthiest 40% of households consumed 80% of all pigeons. We estimate that over 22,000 pigeons were consumed per year. Despite not being a target species, the Manumea was shot by 33% (n=30) of the surveyed hunters while targeting the Pacific pigeon. This raises serious conservation concerns, as it is likely to be a key factor contributing to the decline of the last remaining species in this genus. Our results indicate that improved economic household incomes can lead to increased pressure on both target and bycatch species. Wild meat harvesting and consumption is a key issue leading to species declines and extinctions in the tropics. It is critical that this issue receives the appropriate attention and is addressed in the Pacific.

Keywords: *bushmeat, illegal wildlife trade, supply chain, poaching, hunting, inequality*

10 Introduction

Hunting and harvesting of wildlife is a key threat to biodiversity (Bodmer et al. 1997; Bennett et al. 2002; McCauley et al. 2015). Such harvesting can be legal or illegal and for the purpose of food, stature, traditional medicine among others (Phelps et al. 2016; Cooney et al 2016). Consumption of wild-harvested meat can be motivated by the basic need for food (Dickson 2008), but in many cases, it is a form of elite or conspicuous consumption for special events or by the wealthy in a community (Milner-Gulland and Bennett 2003; Mace et al. 2008).

Mitigating threats from hunting pressure requires a clear understanding of the drivers of consumption and of the supply chain, the mechanism(s) by which the meat from hunting is moved from the site of capture to the consumer's table (Duffy et al. 2016). It has been argued that hunting is driven by the need to find sources of food to sustain livelihoods with limited options and income, particularly for low-income communities (Robinson and Bennett 2002; Fa et al. 2003; De Merode et al. 2004; Kümpel et al. 2010). However, recent research has suggested that forest wildlife hunting is not always driven by a dependence on hunting as a protein source (Bassett 2005; Fa et al. 2009). Indeed, there is evidence of more nuanced interactions between hunting, consumption, and threats to wildlife occurring (see Vliet & Mbazza 2011). For example, low-income individuals may be provided with cash incentives to hunt species sought after for consumption by the wealthy elite. For example, in some African countries poachers have been paid a relatively high price compared to the local incomes to poach species, such as Rhino and Elephants, by East Asian consumers with relatively high expendable incomes (Challender and Macmillan 2014).

Although elite consumption of bushmeat and high value products like rhino horn have been established in Africa, the pressures of elite consumption on other smaller taxa has not been explored. The negative impacts of hunting and the commercial bushmeat trade are well documented in many regions in the world, such as Equatorial Africa (Fa et al. 2003; De Merode et al. 2004; Effiom et al. 2013), the Amazon (Bodmer et al. 1997; Peres et al. 2016) and Southeast Asia (Corlett 2007; Steinmetz et al. 2014; Harrison et al. 2016)[5], however there is little published literature on this issue from the Pacific Islands (Craig et al. 1994; Watling 2004; Walker 2007; Szabo et al. 2012; IUCN 2015). This is despite illegal hunting pressure being known to be having a negative impact, which is linked to both the decline and extinction of numerous species in the area (Craig et al. 1994; Watling 2004; Walker 2007; Szabo et al. 2012; IUCN 2015). This lack of information obscures the creation of effective consumer-centered interventions. There is a clear need for emperical studies in the region so appropriate methodologies can be developed.

This study focuses on the consumption of different species of wild pigeon in the Pacific island of Samoa, and asseses the impacts of elite consumption on the supply chain. The objectives of the present study were, to 1) determine the relationship between consumer income and illegil wild meat consumption, 2) determine the drivers of consumption and hunting, 3) the mechanism and pathway of the supply chain and 4) the impact of hunting pressure on non-target species. We explored the implications of these results for current conservation interventions tackling illegal trade and detail how our research informs future consumer centered conservation actions.

11 Methods

11.11.1 Study area

The Samoan archipelago (13°–15° S, 168°–173°W) is located in the South Pacific, northeast of the- Fiji archipelago. It is politically divided into Samoa and American Samoa. In Samoa, the two main islands are Upolu (1,110 km^2 area; maximum elevation 1,100 m) and Savai‘i (1,820 km^2; maximum elevation 1,860 m). Both islands are mountainous with a maximum elevation of 1,900 m (Ward and Ashcroft 1998). The main wet season is from November to April, but there is high rainfall at high elevation (+600 m) all year (approx. 600–800 cm of rainfall annually) (Ward and Ashcroft 1998). Samoa’s land area of 2,857 km^2 holds a human population of close to 190,000. The majority of land in Samoa is customary land managed by family in villages (Ward and Ashcroft 1998).

Prior to human arrival, both major islands were covered with rainforest at lower elevations and cloud forest at higher elevations, with small areas of recent lava flows (Whistler 1980). Currently, little pristine lowland forest remains in Samoa, and the majority of what is present has been logged (Whistler 1980). In addition to human-driven forest loss, cyclones have also had a severe impact on Samoa’s forests, altering structure and resulting in high tree mortality (Elmqvist et al. 1994).

Samoa has six species of native pigeon: the white-throated pigeon (*Columba vitiensis*), friendly ground dove (*Alopecoenas stairi*), many coloured fruit dove (*Ptilinopus perousii*), crimson-crowned fruit dove (*Ptilinopus porphyraceus*), the Lupe or Pacific Pigeon (*Ducula pacifica)*, and the Manumea or tooth-billed pigeon (*Didunculus strigirostris*). Of these, only the Manumea is endemic. The Manumea, also known as the tooth-billed pigeon, is a Samoan endemic that is currently listed as Critically Endangered on the IUCN red list (IUCN 2015). The Pacific pigeon, locally known as the Lupe, is currently listed as Least Concern by the IUCN red list (IUCN 2012); however, unpublished literature suggests numbers are in decline (Stirnemann pers. obs.). Both the Pacific pigeon and the Manumea are affected by hunting (Merlin and Juvik 1985; Walker 2007; Collar 2015). The loss or significant decline of these pigeons is likely to have significant consequences for ecosystem services, such as the dispersal of large-bodied seeds and the consequent regeneration of native forests (McConkey and Drake 2006; Brodie et al. 2009).

Current estimates suggest less than 250 Manumea remain (Collar 2015). Hunting, habitat losses due to cyclones and deforestation as well as invasive predator impacts are thought to be the primary reasons for the decline of the Manumea (Collar 2015). However, there continue to be many gaps in our knowledge of this rare species (Collar 2015). For instance, little is currently known about the species breeding biology (Collar 2015). However, a slow life-history strategy is likely given that the species is tropical, and reports suggest a clutch size of 1–2 (Stirnemann et al. 2016). A slow life-history strategy would increase the impact of mortality due to hunting or invasive species on the species recovery (Stirnemann et al. 2016).

Pacific pigeons and Manumea have long been hunted in Samoa (and in neighbouring Tonga and American Samoa) with elaborate traps on stone platforms called *tia seulupe* or star mounds (Burley 1996; Collar 2015). The sport of pigeon hunting was firmly

associated with the chiefly elite (Burley 1996).Village chiefs with high status competed to catch the most Pacific pigeons, using a tame bird as a decoy and a long-handled net to sweep up attracted individuals (Herdrich 1991; Burley 1996; Collar 2015). These records suggest Pacific pigeons were once very abundant. Manumea were also hunted and possibly preferred over the other *columbids* (Collar 2015). The methodology of pigeon hunting in Samoa altered with the arrival of guns. Between 1978 and 1979, Collar (2015) reported that Manumea were 'hunted throughout the year' and that 'one local hunter estimated that one of every 10 or 12 pigeons shot belonged to this species'. In 1985 Beichle & Maelzer estimated that 400 Manumea were hunted every year. In 1993, a ban on pigeon hunting under the protection of wildlife regulation was drafted and implemented (MNRE 1998). However, surveys in 2006 by the Samoan government showed that half of the 221 people surveyed had eaten pigeon since the ban was implemented (MNRE 2006).

11.21.2 Data collection

11.2.1 1.2.1 Interviews

Interviews took place over a period of seventeen months between January 2015 and July 2016. Interviews were conducted in a language the interviewees were comfortable with, either Samoan or English. All four assistants received training in social research methods prior to data collection. This training included how to question the interviewee without giving leading questions and how to fill out the form. To obtain information on the use of pigeons as food, we conducted face-to-face interviews using a standardized questionnaire with both multiple choice and open-ended questions. An initial pilot study was completed to test the survey. We directed interviews to the hunters known to the rest of the village, and this allowed us to identify other hunters through word of mouth. Consumers were interviewed using a separate questionnaire. Both hunters and consumers explained the supply chain.

We identified hunters as either active or inactive. The latter were defined as not having hunted within the last 12 months. We also identified 1) subsistence hunters, who hunt for family consumption, and 2) commercial hunters who hunt for an income. Retailers were individuals who purchased meat and sold to someone else.

The questionnaire also asked for demographic information on the interviewee and for their general meat preferences. Information was also collected on hunting activities such as the frequency and location of favored bat and pigeon areas. We also asked a number of questions about the target species with particular interest in determining if Manumea were targeted. During the interview, we established if the interviewee could identify pigeon species and if hunting had occurred accidentally or deliberately. We also asked people to rank pigeon taste compared to other local meat/fish available. When we interviewed people we enquired as to why they consumed pigeons and who they gifted pigeon meat to. In total, 40 people (30 hunters and 10 non-hunting consumers) were interviewed across Samoa in both the islands of Savai'i and Upolu.

11.2.2 1.2.2 Socioeconomic household surveys

In 2013 and 2014, the Samoa Statistics Bureau conducted a Household Income and Expenditure Survey (HIES 2016). This survey included interviews with 2348 households across Samoa. This survey provided a statistically robust dataset on food and non-food consumption expenditure over a twelve-month period and included details of local food, including birds, fish and bats consumed. The survey was conducted in four regions: 1) The Apia Urban area, 2) North West Upolu, 3) the rest of Upolu and 4) the island of Savai'i. Between eight and nine percent of houses in each of the four regions were sampled, and each household was required to keep a detailed daily diary of food consumed and other items purchased. Interviews also captured recalled information on other non-regular expenditure.

Each household in the survey for the HIES study kept a diary over four two-week periods (approximately April and October 2013 and March and April 2014) during the twelve-month survey period. We examined data collected on the consumption of one item listed in the COICOP (Classification of Individual Consumption According to Purpose) expenditure category codes as 11201701 fresh, chilled or frozen meat of pigeon. The pigeons represented by the values recorded were either caught and consumed by the household or purchased from someone else. Some pigeons may also have been gifted.

The HIES dataset was also used to calculate the total weekly expenditure per household in each region. Weekly expenditure was used as an indicator of household wealth. This metric was converted to deciles where the first decile referred to the 10% of households in each region that had the lowest per capita total weekly expenditure and the tenth decile referred to the 10% of households with the highest levels of total weekly per capita expenditure.

To compare the costs of different meat options, we also surveyed a haphazard selection of supermarkets and shops selling meat to determine the cost of purchasing different types of meat. The estimated unit value of pigeons consumed was recorded in the diaries; this value was based either on the household's estimate of the value of the pigeons or on the actual price paid if purchased. We used the data recorded in the diaries to calculate the number of pigeons consumed. Consumption of pigeons was also analysed in relation to the capita total weekly expenditure.

12 Results

Both species of pigeon were consumed. However, hunters predominantly only targeted the Pacific pigeon. In most cases when the Manumea (n=30) was shot, the Pacific pigeon was the target species. All (100%; n=30) of the hunters and all the consumers who were not hunters (n=10) stated the meat of the Manumea was not very appetizing and therefore not commonly consumed. However, despite this, thirty percent (n=30) of hunters reported they had accidentally shot at least one Manumea during their hunting career, with 27% (n=30) of the surveyed hunters having accidentally shot multiple individuals. Accidental shooting of Manumea was most commonly reported as occurring over three years ago but was also reported to have occurred twice in 2016. On average, commercial hunters made 4–5 hunting trips per week unless limited by bullet availability. Commercial hunters reported an average of 10–15 pigeons were shot per hunting trip.

Results from the HIES data indicate approximately 22,000-33,000 pigeons are consumed each year. We can calculate the number of shooting days as the number of pigeons consumed divided by the number shot per day. Assuming 22,000 pigeons are hunted and given that the surveys revealed that 10–15 pigeons were shot per day, this calculation would estimate 1466–2200 pigeon shooting days occur per year. Given the average of 4–5 hunting trips per week over a seasonal –-7 month period, it is estimated that approximately 73–114 hunters would be actively shooting pigeons for consumption in Samoa. The total expenditure on pigeon meat is estimated from the HIES data at USD 129,181 (1 USD = 2.56087 WST) annually.

12.12.1 Extent of pigeon hunting

Of the 30 interviewed hunters, 93% stated that pigeons were considered to be a seasonal resource (hereby referred to as seasonal hunters), with October to December and June to December being recorded as the most commonly listed months for hunting. The other 7% of non-seasonal hunters hunted pigeons throughout the year. The main reasons given for seasonal hunting was the fruiting of particular food trees preferred by pigeons, such as Ma'ali (*Canariun samoense*) between October to December, and Moso'oi (*Cananga odorata*) between June to December. Seasonal hunters stated that hunting during these time periods "made the pigeons fatty and more tasty". However, the availability of pigeons for special Samoan festival dates, such as the White Sunday feast in early October, the special day for children in Samoa, was also important for consumers as pigeons are traditionally eaten during these times of the years Non-seasonal hunters collected Pacific pigeons for any special occasion, such as when guests came to the village or as gifts. Pigeon meat was gifted to people by 60%, n=23) of the hunters surveyed. These hunters stated that they had gifted to people within the community, such as "pastors", "church leaders", "high chiefs" and "older family members". Pigeon meat was considered to be a valuable gift due to the flavor and high market price. When compared to other meat types (fish, beef, chicken, lamb) pigeon meat was consistently ranked the highest, in terms of taste by all surveyed people who had tried pigeon meat (100%, n=18).

Our study also investigated where consumption was occurring. The results showed consumption occurs across the country in both regional areas in Savaii and Upolu and the main city of Apia (Fig. 2). However, the majority of consumption is occurring away from the central city of Apia and in the Northwest area of Upolu and in Savai'i (Fig. 2). Because of village rules, which are strictly enforced, pigeon hunting in some areas is limited or banned completely in some local areas. However, some villagers (n=4) stated that even if they no longer hunted on their own lands, hunters from neighboring villages are coming and shooting on their land. None of the surveyed hunters (0%, n=30) or consumers (0%, n=10) believed that the Pacific pigeon population was overharvested or that hunting was impacting Manumea populations.

12.22.2 Supply chain

Our results showed hunters were in three categories: (1) sport hunters, (2) commercial hunters and (3) subsistence hunters. Sport hunters typically came from outside the village to hunt as a hobby and for personal consumption. Commercial hunters tended to hunt for trade and often shot between 10–15 Pacific pigeons in a single day. Part-time commercial and/or subsistence hunters and wealthier commercial hunters from Apia often targeted bats in addition to pigeons

Two different types of traders were identified: (1) restaurants that purchase from vendors and (2) vendors who trade to non-hunting consumers. All vendors we spoke with were also hunters. However, some hunters, acting as middlemen, sold either bats or pigeons to other vendors. Vendors did not sell in the markets but instead went door-to door-visiting targeted customers. Three commercial hunters reported selling to customers who sought them out deliberately and pre-arranged pigeon orders. Some vendors also on-sold to restaurants, and most had regular customers.

The pigeon meat supply chain (Fig. 3) is in part regulated by a variety of networks of power and control (i.e. through local chiefs, regional and national government officials and the police through control of firearms and ammunition sales). However, access to ammunition for firearms is regulated by the Samoan police. To sell firearm ammunition legally, each retailer must obtain a permit from the police, which must be renewed annually. The annual license fee for retailers to sell ammunition was 200 WST prior to 2012 but has now been increased (2016) to 1,000 WST per year. All retailers confirmed that buyers also needed permits from the police to purchase ammunition. In addition, it costs 20 WST to license a gun annually. However, none of the retailers reported maintaining a record of how much ammunition they sold or bought annually or had any information on species that are illegal to shoot.

Changes to ammunition and gun access since 2012 have limited some wildlife hunting activity by reducing the number of bullets sold to bullet vendors and thus the amount of ammunition permitted for sale by the ammunition retailers. Indeed, a number of village hunters stated that ammunition was difficult to obtain, reducing the amount of hunting of both pigeons and bats. Other hunters reported wealthy patrons who provide firearms and ammunition or finance the purchase of those items in exchange for supplies of pigeons and bats.

12.32.3 Livelihood value of hunting

On average, the value of a pigeon was somewhere between the range of SAT10.00 to SAT15.00 each. These prices were consistently high. Pigeon hunting is therefore a profitable business given that the average household income in 2013–2014 was 685.60 WST/week (SBS 2016). Even taking account of the cost of ammunition (average cost for a box of twelve-gauge shot was SAT35.00, for shotgun shells [25 per box] was SAT65 in 2016, and for a box .22 calibre [50 per box] was SAT35) and gun license fees (assuming the firearm used is licensed), a single day of hunting pigeons with an average of 10–15 birds shot per day will earn between SAT100 and 225 in sales. Pigeon meat costs approximately SAT27.23–35.56 per kg. Pigeon was more expensive than other meat types available for purchase. Indeed, pigeon was nearly nine times more expensive than chicken, the cheapest meat available for purchase. There were no discounts to our knowledge for buying pigeons in bulk.

The consumption dataset shows that people in the wealthiest decile were the dominant consumers of pigeon (Fig. 1), with the top 40% consuming 79.5% of all pigeons. The lowest decile (10%) consumed no pigeons (Fig. 1). Consumption was predominantly by the wealthiest people across the country.

13 Discussion

A better understanding of what motivates people to hunt illegally is needed to minimize biodiversity loss from that source (Duffy et al. 2016). Here, we demonstrate how consumption was predominantly by those with the highest household income. Furthermore, we highlight the conservation impacts of hunting on non-target species.

13.13.1 Drivers of consumption

Our findings indicate that a large number of native pigeons are hunted and consumed every year in Samoa. However, poorer members of society do not often consume these pigeons even if they may be undertaking the hunting; instead, consumption is primarily by the wealthier individuals. Given that consumption by the elite is the primary driver of hunting activity and that even with other incomes available the profit gained from hunting is substantial, it is unlikely that alleviation of poverty in rural areas will successfully improve conservation outcomes for these species. Instead, surveys indicate that consumption by the elite is likely to occur in part because these wild meat foods are valued for their flavor, high market price and the associated status linking consumption to prestige and wealth. This is probably because these households have the discretionary income to spend on expensive food, while the poorer households buy the cheaper options, such as chicken. In Samoa, historically, pigeon meat was a high-status food hunted by high chiefs (Burley 1996). Our survey results suggest that this link between consumption and high status has not altered.

The problem of illegal wildlife consumption being driven by those in positions of high prestige and wealth is now a global issue (Corlett 2007; Zhang et al. 2008; Harrison et al. 2016; Phelps et al. 2016). For example, in China, the main consumers driving illegal wildlife trade are young educated males with good incomes (Zhang et al. 2008). It is critical that these drivers are considered when designing mitigation strategies and when predicting the impact of the future market. Increases in status are also occurring as the number of chiefly titles in Samoa, which are split in response to population increases, produce more positions of higher status. If wealth/status is a driver of consumption, it can be expected that a shift toward further increases in middle and upper classes and more people accessing greater income levels will create a higher demand for this high-status food.

13.2

13.33.2 Implications for management

Our research identified the pigeon meat supply chain involved in the process of pigeon trade and consumption in Samoa (Fig. 3). We outline potential management techniques that could intercept the various points in the supply chain. Four points of intercept (action preventing hunting) were isolated by this study: (1) Top-down influencers (Firearm and ammunition licensing and retail) (2) Harvesters, (3) Intermediaries and (4) Consumers (Fig 3).

Firearm and ammunition licensing and retail can have a top-down effect on the entire supply chain. Action could take the form of decreasing or banning the sale of ammunition suitable for hunting pigeons on the wing – i.e. shotgun pellets/bird shot. Such

restrictions would have the greatest impact on illegal pigeon hunting and thereby in reducing Manumea bycatch. While pigeons can also be hunted using 0.22 calibre firearms when birds are feeding or roosting, this usually requires the hunter to sight the target bird for long enough to distinguish between the Pacific pigeon and Manumea, thereby providing an opportunity for hunters to reduce Manumea bycatch.

Effective interventions must recognize that pigeon hunting involves a diversity of hunter types and purposes (Phelps et al. 2016). Different types of intervention would therefore be needed to target different types of hunters (Phelps et al. 2016). In Samoa, hunting from villages may be reduced by using existing village community structures to restrict hunting. This restriction would only be likely to occur if villages are successfully convinced to impose the necessary bans and if they are willing to enforce them (Ostrom 2008). However, the effectiveness of such bans may be reduced because neighboring villages may not respect the ban. Restricting hunting through village enforcement will also not be effective with the sport hunters who operate outside village systems. Instead, police enforcement and education targeted at this group may be required. An alternative option to completely banning hunting might be to have strong enforcement in core Manumea protected areas and have other safe areas where seasonal legal hunting activity could occur. This would, however, require further research to determine the spatial and seasonal drivers of Manumea movements to designate appropriate protected areas and, conversely, 'safe' areas for hunting where Manumea are unlikely to be present.

Understanding the motivations of the hunters is also important. Low-income individuals gain substantial profits for hunting pigeons, and therefore, profit could be an indirect driver for hunting activity as long as there is a market. The expected profit from pigeon hunting is likely to drive the continual hunting of pigeons as long as there are consumers. Because hunting is largely driven by the consumer chain, if profit is reduced or the likelihood of punishment in some form (village fines/criminal conviction) is increased, hunting activity is expected to decline (Cooney et al. 2016; Biggs et al. 2016). This provides a strong strategic reason to allocate capital towards a psychologically effective campaign reducing demand of wild meat by the elite.

The international community is currently focused on cross-border trade of wild meat. This is failing to address overexploitation of wildlife within countries because hunting and consumption of wild meat is largely a local issue. It is critical that the impacts of hunting in the Pacific are highlighted and appropriate action is taken. Stronger laws, penalties and enforcement are needed for all aspects of the supply chain from hunting to consumption in addition to the appropriate campaigns. Unless there is a strong change in efforts to reduce wildlife exploitation, the region will likely lose most of its iconic species, within the next few years. Given that seed dispersers are key target species this will also have considerable ecosystem repercussions (McConkey and Drake 2006; Brodie et al. 2009)(REF).

13.43.3 Conservation implications for Manumea

Our findings show how despite not being a target species, the Manumea or tooth-billed pigeon, the last remaining species in the *Didunculus* genus, is frequently killed incidentally while hunters are targeting the Pacific pigeon. Other species, such as the Saola

(*Pseudoryx nghetinhensis*) an antelope species incidentally captured in snares targeting other wild meat for Chinese medicine, are simularlity emerging as conservation problems (Corlett 2007; Schaller and Rabinowitz 2009). Although there are few studies of terrestrial by-catch in the literature, the issues that effect by-catch species in marine environments are likely to occur in terrestrial environments. For instance, a by-catch species can be at greater risk than a targeted species (Hutchings & Reynolds 2004) because the "effort" needed to successfully hunt the by-catch species is determined by the "effort" to capture the target species. In contrast to a target species, for a by-catch species, there is no point at which the capture effort will decrease, unless the target species is no longer hunted (Hutchings & Reynolds 2004). Therefore, if the by-catch species has a demographic which makes the harvesting unsustainable or is range-restricted, the impact of increased mortality is expected to be greater (Tuck et al. 2001). Although little is still known about the life cycle of the Manumea, many tropical species are slow breeders with low fecundity (Stirnemann et al. 2016). Therefore, the extinction risk to the critically endangered Manumea from Pacific pigeon hunting needs be taken seriously. Furthermore, we highlight that by-catch impacts may be more important in terrestrial systems than originally thought. We suggest further investigations on the impact of incidental hunting on terrestrial species are needed. However, even more importantly an effective campaign to change the behavior of pigeon consumers should be a priority for Manumea conservation.

Efforts to reduce pigeon hunting will not only aid in reducing the risk of extinction for the Manumea but are also essential for retaining ecosystem health and function. Large pigeons are important large-seeded tree dispersers in forest ecosystems (Harrison et al. 2016). The forests of Samoa are increasingly under pressure from development and are dominated by invasive plant species (Stirnemann pers com), with flow-on effects for the terrestrial and near shore marine environment (McCauley et al. 2012). For widespread change which will save forests and the important large bodied seed dispersers, it will be necessary to combine the strategies of publicity and education.

Globally elite consumption is an important driver of wildlife trade, and understanding the supply chain is critical to identifying interventions to reduce risks to species and habitats. Despite recent research showing wealthy consumers can drive the food chain (Milner-Gulland and Bennett 2003; Mace et al. 2008) many donors continue to direct funds towards alleviating poverty and assume a link between poverty reduction and positive conservation outcomes. Though in some cases this poverty eluviation may reduce the pressure on wildlife (Vasco and Sirén 2016). Our study shows that poverty alleviation may instead have the opposite effect for wildlife trade and forest health and that this is a dynamic that requires careful consideration.

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FIGURES AND TABLES OF RESULTS

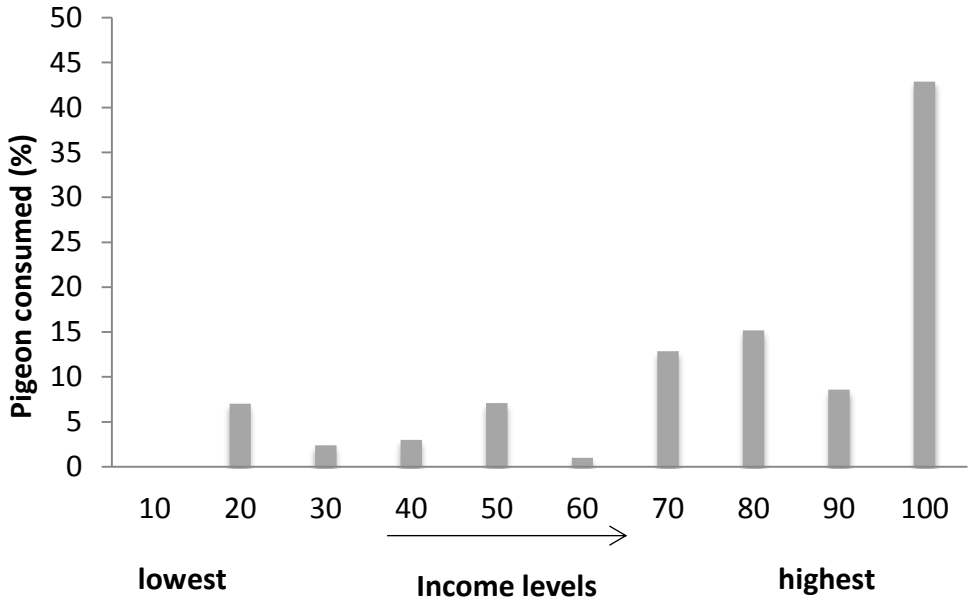

Figure 1. Percentage of native pigeons consumed in Samoa by different income groups ranked from lowest to highest income deciles.

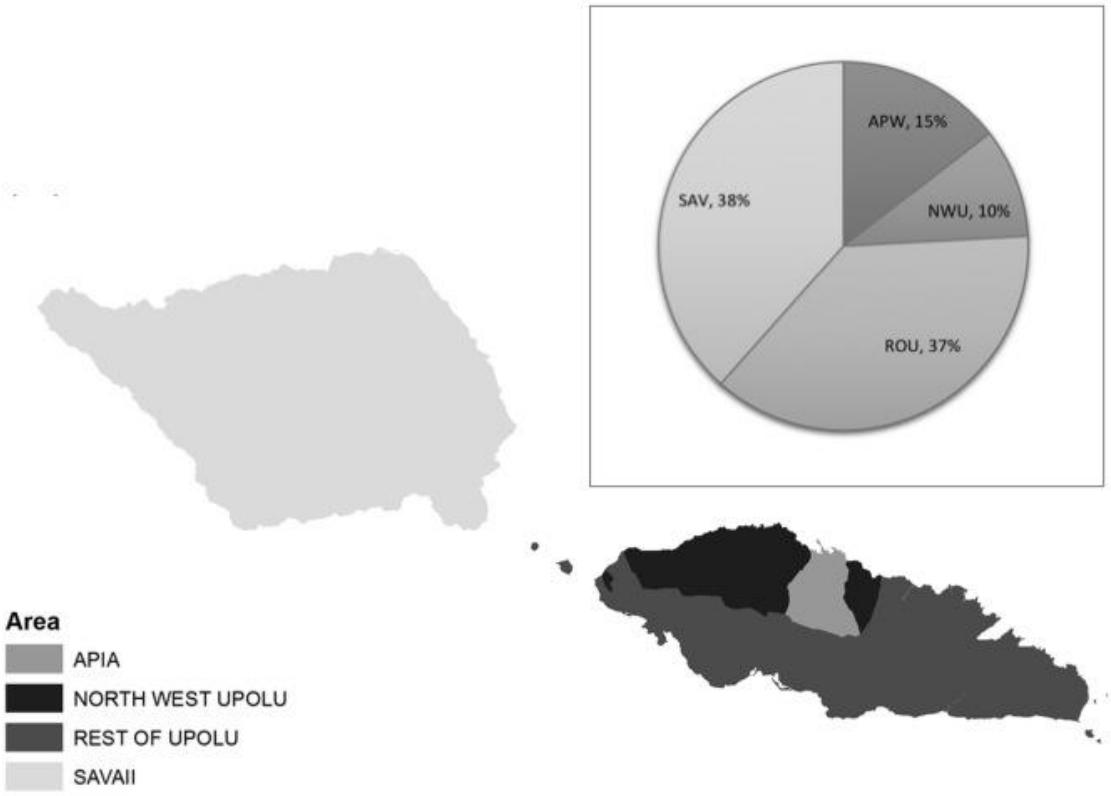

Figure 2. The percentage of pigeon consumed (pie chart) in each of the four HIES areas (mapped) Savaii (SAV) and Upolu (regional NWU and ROU) and the capital city of Upolu, Apia (APW).

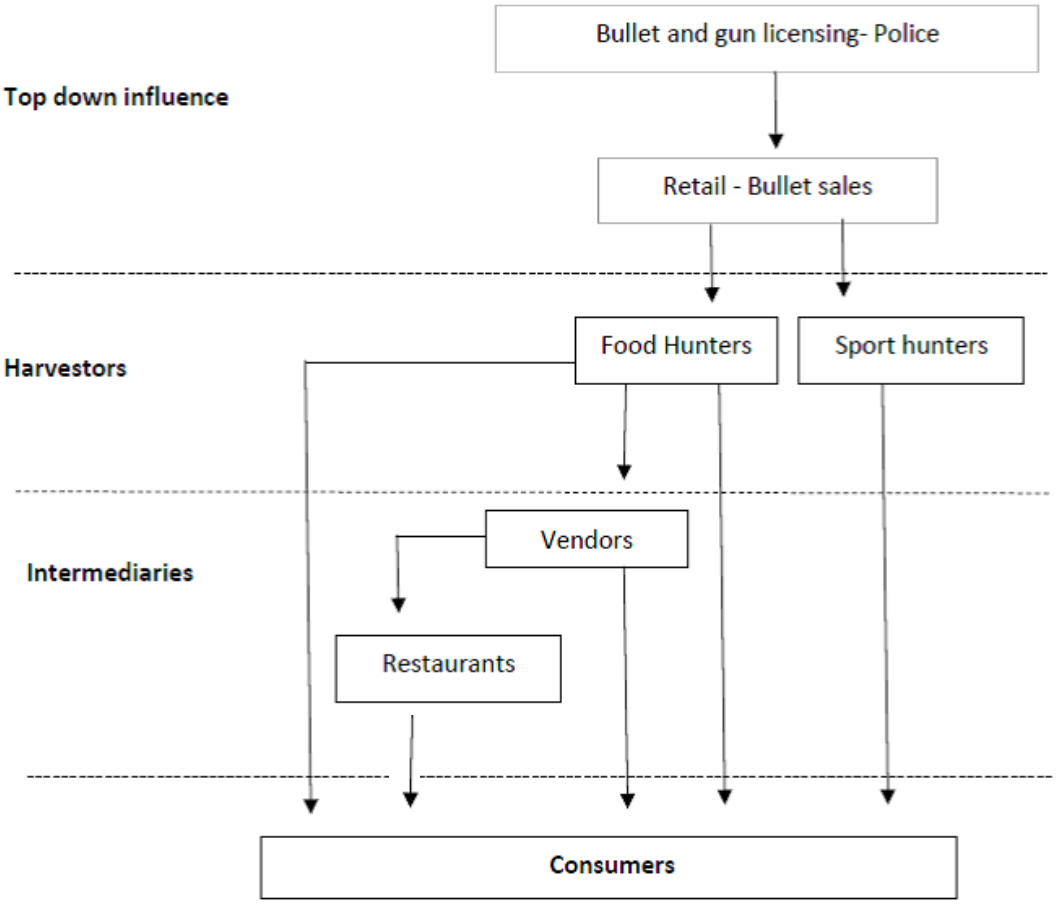

Figure 3. Points of intercept where control can potentially occur to reduce illegal wildlife trade prior to and within the supply chain.