

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

**Final Report  
Darwin Project Information**

Project Ref Number	DPLUS033
Project Title	Enhancing biosecurity and biological control capacity in the Falkland Islands
Territory(ies)	Falkland Islands (FI), UK
Contract Holder Institution	CABI
Partner Institutions	Falkland Islands Government (FIG)
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Start/end date of project	1 April 2015- 31 March 2017
Project Leader Name	Norbert Maczey, transferred from Dave Moore in March 2016
Project website/Twitter/Blog etc.	<a href="http://www.darwininitiative.org.uk/project/DPLUS033/">http://www.darwininitiative.org.uk/project/DPLUS033/</a> <a href="http://www.cabi.org/projects/project/32771">http://www.cabi.org/projects/project/32771</a>
Report author(s) and date	Norbert Maczey, Nick Rendell, March 2017

## 1 Project Overview

The Falkland Islands (FI), as with many island ecosystems is vulnerable to invasive species, with wide ranging social and environmental consequences. DPLUS033 aimed to improve the biosecurity capacity of FI through training, establishing an appropriate biosecurity/quarantine facility, and by developing an improved biosecurity policy for the Falkland Islands Government (FIG). As a case study for this, the release of two tachinid parasitoids for the classical biological control (CBC) of the European Earwig, *Forficula auricularia*, was carried out during the course of the project. European earwigs have become a problematic pest species, especially around Stanley, causing considerable damage to horticulture and being of health and safety concern. There is a considerable threat that their further spread into native grass- and heathland habitats will alter the composition of invertebrate communities. There are also fears that high densities of the *F. auricularia* in Stanley increase the risk of accidental introduction to South Georgia.

FIG has funded preliminary work on the earwig and its parasitoids, largely through collections in UK and studies on their rearing and host specificity. DPLUS033 has now enabled the FI to test their biosecurity facility and protocols on the release of the parasitoids.

The project focused on the town of Stanley where the earwigs are most troublesome. With the support from FIG and the Governor the Government House Gardens (GHG) at the central western end of Stanley have been selected as the primary release site for both control agents. Throughout the project staff at GHG have been very helpful in accommodating activities conducted here. This site provides sheltered conditions, a high density of the target species and is also the location where a first quarantine facility has been erected during 2015. Although well suited for the purpose of this individual project it became apparent that the new facilities at GHG may not be sufficient for some more specific quarantine purposes after the termination of the project. It was therefore decided to convert a second building belonging to the Department of Agriculture (DoA) into a permanent quarantine facility based on the template and experience gained during the construction and usage of the first one.

At the start of the project biosecurity personnel in the FI had only limited experience and training applying Pest Risk Assessments (PRA) during the process of controlled introductions of biological specimens into the islands. This was addressed during the project, again using the earwigs as a case study, by developing a PRA template tailored to the needs of the FI, but which may in the future also become a useful tool in other South Atlantic UK OTs. The development of this template and training to integrate this into future importation procedures were carried out as a joint exercise between CABI and several UKOT partners. Using recently installed modern communication technology it was possible to include scientists and biosecurity personnel from St Helena and South Georgia in the process of developing and testing the PRA template. The main event for this was a workshop held in Stanley with the remote participation of these two OTs.

## 2 Project Achievements

### 2.1 Outcome

Outcome:	CBC carried out with no adverse effects, as anticipated with this project where the natural enemies are highly specific, will remove much of the unfounded concern regarding CBC present amongst some people of the FI. Significant control would demonstrate the potential efficacy of CBC.		
	Baseline	Change by 2017	Source of evidence
Indicator 0.1	CBC has never been applied as a control method on the FI	Successful release of two parasitoid flies <i>Triarthria setipennis</i> and <i>Ocytata pallipes</i> for the control of <i>Forficula auricularia</i>	Lab and field work protocols, summarised in this section further below; abstract for presentation of results submitted for Island invasive conference, July 2017 Dundee

Outcome:	The professional capacity to manage some biosecurity and CBC issues in the FI will increase and this in turn will further promote acceptance of CBC, to control some of the more environmentally damaging invasive plants.		
	Baseline	Change by 2017	Source of evidence
Indicator 0.1	No quarantine facilities and in particular none to supervise living specimens imported in existence	Two quarantine facilities constructed during the course of the project	Figures 1 to 5 and report section further below
Indicator 0.2	Only basic administrative procedures in place to deal with the import of biological specimens; no PRA tailored to the FI available	PRA developed and staff trained in its usage	PRA template and case study template for <i>T. setipennis</i> (annex 4, 5, 12)

Outcome:	Greater acceptance of CBC for use in subsequent control programmes will provide FIG with a mandate for control of more damaging invasive species.		
	Baseline	Change by 2017	Source of evidence
Indicator 0.1	No widespread engagement with the concept of CBC either within the wider public or the scientific community before the start of the project	A wide range of stakeholder consultations held, with increasing positive feedback; environmental committee and legislative assembly representing residents on the Falklands licensing the release of agents for CBC for the first time in the FI	Separate report to FIG on awareness raising activities held before the licensing of the release of parasitoids for the control of earwigs (annex 6); flyer (annex 13)
Indicator 0.2	CBC not considered for control of invasive alien species	Based on the positive experience during DPLUS033 and a now much wider acceptance by the public for CBC this method is now considered to be employed for the control of other problematic species	Feasibility studies for biological control of <i>Berberis microphylla</i> and <i>Hieracium pilosella</i> (annex 7 and 8)

The key milestones of the project have been realized, and the overarching goal to release two agents for the biological control of earwigs has been achieved.

Part of the outcome is a significantly increased public support of CBC on the FI. In particular intensive stakeholder engagement focusing on the safety and benefits of this method, whilst always being open about the remaining risk that a complete control of earwigs might in the end not be fully achieved, has in our opinion led to a greater public support for this control method. Providing evidence for a successful implementation of the earwig case study up to the point of significant control of earwig populations was not within the scope of this 2-year project as had already been detailed in the application and the main objective was a successful release of the control agents. Provided the agents establish, this in itself will already have kick-started the potentially sufficient and self-sustaining control of the target species, hopefully without the need for further intervention. Despite an initial setback caused by the fact that the biology of both control agents is still not fully understood, the project team completed the release, which is arguably the most important phase within every CBC program, of both control agents during this project. Initial efforts had been hampered by poor collecting seasons in the UK and difficulties in synchronizing the lifecycle of the control agents to southern hemisphere conditions. This was addressed in the annual project report and adjustments were approved by the DI. More details describing the difficulties encountered are given in 2.3.

As the final outcome of the project will only become apparent after the termination of the project, it was important to put mechanisms in place to monitor and evaluate establishment and impact of the control agents over coming years. This was initially planned to be organized and conducted by volunteers trained during the course of the project. However, because of the reasons detailed in 2.3 this turned out to be unrealistic despite considerable efforts put towards this aim. As a solution, the monitoring activities beyond the end of the project will be coordinated and continued on a voluntary basis by the South Atlantic Environmental Research Institute (SAERI). All stakeholders involved agree that this will provide a much higher level of sustainability with regards to the project's legacy, than could have been hoped for by relying on citizen science within a very small community.

Public engagement and a very open and transparent conduct of the project have in itself greatly improved the awareness for the danger invasive species pose to the unique environment of the Falkland Islands. This is reflected by strong public interest in the project during countless discussions with individual residents of the FI, which gave the opportunity to explain and demonstrate the case study activities first hand to a comparably large proportion of the community (for example >30 visitors to an open day event held in November 2013 out of a population of less than 3,000 in Stanley). This has helped that the entire community is likely to embrace CBC in future projects. Discussions are already underway regarding the use of CBC for other damaging invasive species such as Mouse-eared Hawkweed and Calafate.

The case study using CBC for earwig control, a species generally loathed by the residents in Stanley, paved the way for a better understanding and wider acceptance of this approach as an environmentally friendly, sustainable and safe method. It was, however, also an ideal catalyst for the other outcomes of the project, increased biosecurity by providing facilities to keep biological specimens under quarantined conditions and increased capacity in embracing an up-to-date approach to PRA procedures.

The project saw the construction and completion of improved FIG biosecurity and containment facilities (see figures 1 to 5). Fly pupae of both control agents were stored within the new quarantine facilities and hatched here under controlled conditions. At this stage of the biological control program the flies had already been licensed for release and quarantine facilities were mainly used to provide an additional layer of security, in this case to prevent the accidental introduction of hymenopteran hyperparasitoids. Again, the case study on earwigs allowed for adequate training of FIG personnel to independently handle the controlled release of hatching parasitoids after shipments of these was brought to the FI during both project years.

Already of essential use during this project these facilities will provide sufficient capacity to allow the implementation of future CBC projects, particular in combination with the on the job training of personnel conducted during the earwig case study. The new quarantine facilities are also very much appreciated by the DoA, with biosecurity in general being improved through the increased capacity to store, monitor and treat intercepted goods for contamination with potentially invasive species and biosecurity risk organisms.

Hand in hand with the physical improvement of biosecurity through the converted quarantine sheds went the capacity building on the administrative side with a focus on PRA procedures and the development of a suitable template for PRA. Here the challenge was to develop a form, which covered all necessary aspects in as much detail as possible whilst not becoming overly complicated considering limited availability of staff dealing with all aspects of importation of biological specimens and the limitations concerning the accessibility of information. Exceeding the original scope of the project, training in this area was extended to include biosecurity personnel from other UKOTs (St Helena, South Georgia). The newly developed open access CABI Invasive species compendium (ISC) proved to be a valuable tool to mitigate otherwise limited or costly access to information on individual species (this in turn has led to further discussions within CABI to include more information on such species and not only their target hosts in future versions of the ISC).

Awareness activities and continuous engagement with the public, scientists and decision makers has in our opinion been able to dispel most of the initial concerns about CBC brought forward initially. Although this is difficult to be evidenced in a scientific way, one indication of a much higher degree of acceptance and how CBC has been embraced, is the decision of the environmental committee to support the release of control agents for earwig control and the lack of critical comments or complaints thereafter. A dedicated and widely advertised link on the FIG website inviting the public to share any concerns did not receive any submissions up to the end of the project.



Figure 1: Refitting a shed into a makeshift quarantine facility.



Figure 2: Double door entry system into the inner quarantine chamber

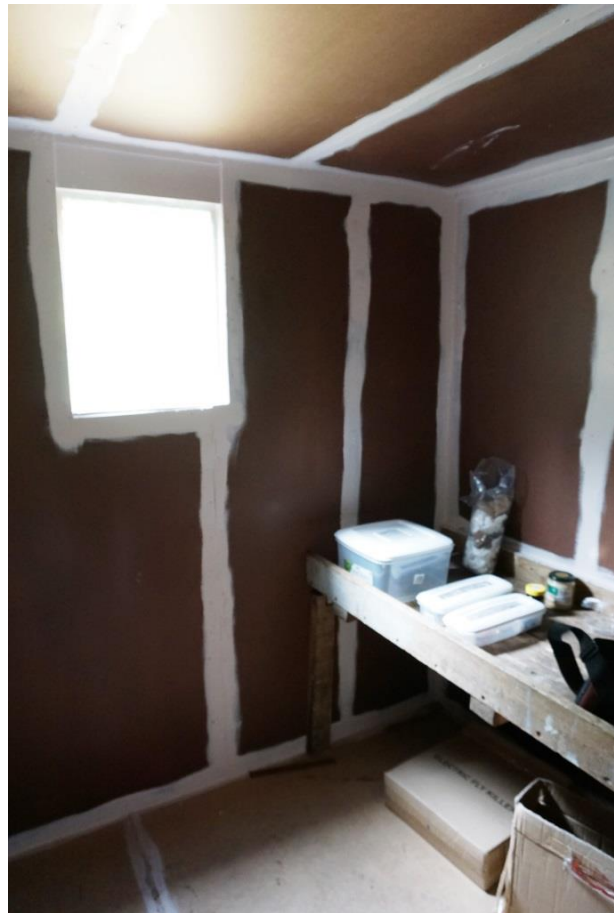


Figure 3: Sealed inner quarantine chamber



Figure 4: Second quarantine shed on the premises of the DoA



Figure 5: Second shed at the start of being converted into quarantine facility

## 2.2 Long-term strategic outcome(s)

The project is strengthening the capacity of FIG to combat environmental threats from invasive species. The improved biosecurity facilities are simple, but have all the requirements to enforce quarantine. This will assist FIG in reducing invasive species entering the islands and also be a resource for CBC attempts in the future. The earwig case study provided suitable training to use the newly installed facilities and release trials have already been conducted by local personnel with minimal supervision from the CABI team towards the end of the project. By training biosecurity personnel in the use of PRAs and the joint development of up-to-date PRA procedures the level of security has increased both with regards to intended imports of biological specimens and assessing the best approach after accidental introduction of potentially invasive species. This also includes a wider scope to respond to individual cases /incidents with specific measures to prevent accidental introduction of some of these species in the first place.

Engagement with the public at any stage of the project has helped to gather a much wider support for using CBC as an environmentally and long term sustainable control for invasive species. The majority of meetings with stakeholders were held as part of a strategy to develop greater acceptance of CBC. This was also reflected by a very positive response to the progress of the project during the last meeting with MLAs (Members of the Legislative Assembly) in January 2017. The more positive perception for CBC based both on stakeholder engagement and frequent updating of the public about any activities carried out during the earwig control case study activities has already started to support the FIG long term goal of tackling the threats of invasive species to the unique island ecosystem. The currently positive endorsement of CBC initiated in most parts by this project will hopefully be underpinned by a significant reduction of earwig densities in Stanley, perceivable by everybody directly or by a diminished need to use pesticides. As with any biological control programs a significant control of the target species after successful establishment, will only become apparent after a number of years and the scope of a 2-year project has naturally to be limited to the initial release of control agents. At this stage it is still too early to deem the biological control of earwigs on the Falklands a success, as it will take time before the control agents are fully established and begin to impact on earwig densities, something only the monitoring activities put in place during this project will be able to record. That the project has helped to promote CBC as a sustainable, safe and environmentally sound alternative to other control methods has also become apparent by new considerations to integrate this method more thoroughly into future weed control activities. Increased interest in CBC is reflected by two feasibility studies for the control of *Berberis microphylla* and *Hieracium pilosella* completed towards the end of the project and the aim to cover other priority species soon. The promotion of CBC also supports the long term goal to reduce the level of pesticides currently in use for earwig control.

## 2.3 Outputs

Output 1:	Significant control of earwigs achieved			Comments (if necessary)
	Baseline	Change recorded by 2017	Source of evidence	
Indicator 1.1	Economic costs, treatment data, and a certain degree of public concern for chemical control obtained from FIG surveys was the only information available at the outset of the project. No scientific data on earwig densities has ever been recorded.	The endpoint of this project was the successful release of the control agents. However, as outlined in the proposal the final output of significant control of earwigs through CBC can only be achieved after the termination of the project. To this end, 27 monitoring stations were installed throughout East Falkland during the project to record earwig levels and their spread into natural habitats before the establishment of the control agents. Monitoring activities will continue after the termination of the project under supervision of SAERI.	Locations and data from monitoring stations obtained in East Falkland during the project in annex 9	

Output 2:	Improved capacity to manage invasive species and other biosecurity risks			Comments (if necessary)
	Baseline	Change recorded by 2017	Source of evidence	
Indicator 2.1	Limited level of biosecurity containment exists	The biosecurity facilities installed have all the requirements to enforce quarantine. This will assist FIG in reducing invasive species entering the islands and also be a resource for CBC attempts in the future.	Photographs and report section above	
Indicator 2.2	No individuals with CBC experience	In total 3 FIG employees (Nick Rendell, Environmental Planning Department; Ross James, Department of Agriculture; Jeremy Poncet, GHG) have actively been involved and trained during the project. As a result the release trials have been conducted by local personal in Stanley with some supervision from CABI.	Training was mostly informal and on the job, with more detailed written instruction provided through e-mail correspondence. Training to use the newly installed facilities took place during CABI team visits in Nov. 2015, Sept. 2016 and Jan. 2017. In addition, FIG staff (J. Poncet) visited CABI Egham for two weeks training in August 2016.	

Indicator 2.3	Limited biosecurity experience	Increased biosecurity through development of improved PRA procedures; Nine biosecurity, and staff dealing with import of biological material training in usage of PRA	Workshop on PRA held in the court and council chambers, 29th/30th Sept. 2016 (figure 8); PRA template and case study template for <i>T. setipennis</i> attached as annex 4 and 5; workshop presentation on CABI project website; programme annex 12	
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Output 3:	Greater acceptance of CBC on FI at government and population levels			Comments (if necessary)
	Baseline	Change recorded by 2017	Source of evidence	
Indicator 3.1	A proportion of the population have negative views of CBC	It is difficult to measure acceptance levels precisely. However, it was noticeable over the course of the project that initially perception of CBC was frequently based on insufficient information about the benefits and safety of this method. After discussions, often repeatedly, with many individuals we feel that most of the initial concerns could be dispelled and that the vast majority of the residents of the Falklands are now in favour or at least accepting the usage of this method and that only very little concern about safety remains. At all stages it was made clear that there is no guarantee that CBC will be successful to a degree that other more costly control options will eventually become obsolete. This remaining uncertainty has been widely accepted, but of course support for future CBC programs will be influenced to a certain degree on the impact of the released control agents on population densities of earwigs, which will only become	Awareness raising activities are listed in more detail in a separate report provided to FIG (annex 6), with additions given in the annual and this project report; selection of ppt presentations on CABI project website.	With the support from matched funding a range of awareness raising activities for CBC in general and the release of parasitoids for earwig control specifically were conducted in 2015. These included several presentations, an information stall at the visitor centre, as well as TV and radio interviews. In addition discussions were held with a wide range of other stakeholders (growers, farmers, DoA, decision maker, conservation groups etc.).  During the visits of the CABI team in the second half of this project this was extended through additional updates in discussions with stakeholders, radio and newspaper announcements, 1 presentation on CBC given in Stanley and 2 well perceived open days at the release site in GHG (figure 7).



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Although most outputs, improved biosecurity and containment capacity and greater acceptance of CBC were achieved satisfactorily during the first year the release of the control agents was not successful. First release trials failed for both parasitoid control agents and switching the lifecycle of the agents to southern hemisphere conditions proved particularly difficult.

Emergence of *O. pallipes* in 2015 was poor and most emerging flies either died at emergence, or shortly afterwards. Dissection of unhatched pupae showed that most were of a similar stage of development with the larvae having successfully developed into adult flies before they died. The most likely cause for this was the prolonged storage of fly pupae under cold conditions to synchronize hatching with southern hemisphere seasons and to prevent premature hatching before November. One major problem the project faced was switching the lifecycle from a northern hemisphere rhythm to the seasons in the Falkland Islands. *Ocytata pallipes* normally remains in the pupal stage for only a short period (ten days to three weeks) and therefore we tried to delay hatching until the Falkland summer through storage at lower temperatures hoping to slow down development. Unfortunately, our results indicate that the species does not tolerate being stored for long periods at low temperatures resulting in poor hatching rates.

Lesson learned from this failure led to a significant adjustment of methods for the second project year. Suggestions for these adjustments were included into the annual project report and subsequently approved of by reviewers. Main adjustment for *O. pallipes* was a decision to ship pupae to Stanley several times between August and October 2016. A successful release in Stanley during this period was relying on creating a suitable local environment to allow for an initial infestation of the earwigs by this species during late winter/early spring in Stanley. Therefore we planned to release flies in an artificially heated environment (greenhouse and/or polytunnel) warm enough to allow earwig and flies being active during the winter months. Earwigs are known to be active in polytunnels and green houses in Stanley on warm days during winter even without additional heating. In addition, culturing of *O. pallipes* in greenhouses in Surrey showed that flies will hatch and produce viable eggs during winter months when kept warm enough.

The first release trial for *T. setipennis* also failed but because of different reasons. In Europe *T. setipennis* hibernates in the pupal stage and ~ 230 pupae of this species collected during 2015 were brought into cold storage in the UK to imitate hibernation, before shipment in Nov. 2015 at the beginning of the summer in Stanley. However, this species did not hatch at all in Stanley during November and December 2015, and only started to emerge in low numbers and badly synchronized in January/February 2016. Sometimes encouraging an earlier (premature) emergence can lead to a less well synchronized hatching over a prolonged period and this is what we experienced with this species in Stanley. Any hatched flies of this species were kept in the mating tent and after 6 days released into the polytunnel. Again from lessons learned adjustment were made for the second project year moving the release periods into early 2017. This allowed a much longer and more natural hibernation period whilst still allow hatching flies a sufficiently long period during the summer period in the Falklands for the completion of a full life-cycle.

Changes made to the methodology turned out to be very positive and both fly species could subsequently be released during the second year of the project. *O. pallipes* (225 pupae) brought over during shipments in August and September 2016 hatched successfully, were cultured inside insect tents, mated and finally deposited a large number of micro-eggs. 1,800 earwigs collected during this period were infected with *O. pallipes* by feeding them with pieces of carrots contaminated with fly eggs. These earwigs were then released inside GHG in Oct. 2016. Equally, the hatching rate of 256 pupae of *T. setipennis* transported to Stanley in January 2017 was good (185 flies hatched). Some flies died within a short period after hatching, but a large proportion could be released into GHG.

To collect pre-release baseline data and to monitor the development of earwig populations, their spread away from settlements and the establishment of the released control agents, 27 earwig monitoring stations (example shown in figure 6) were setup and distributed over East Falkland. Monitoring started in January 2017. After termination of this project monitoring protocols and the accompanying database will be handed over to SAERI, which is committed to continue monitoring activities on a voluntary basis for the foreseeable future.



Figure 6. Earwig monitoring station under rocky overhang 'Wireless Ridge', East Falkland.

Development of a PRA template also took place in the second year. It was tailored in first instance for the needs of the FI, but which can easily be adjusted for implementation in other UKOTs. Primarily, this aimed at capacity building to independently deal with future introduction of biological control agents, but right from the outset it was decided that the PRA template should also be able to cover a wider range of biological material such as ornamental plants, pets, etc.. The joined development of such a suitable template and training of how to use it included the involvement of staff from St. Helena and South Georgia who remotely attended a two day workshop on PRA procedures. Staff from these OTs also contributed before and after the workshop in the development of the template. Biosecurity staff from Ascension Island were invited to join these activities, but could not attend the workshop in September 2016.

Encouraged by the positive feedback from the initial awareness raising activities and stakeholder meetings in combination with the first release of the biological control agents for CBC in the FI, the scope for further implementation of this methodology was considered. This resulted in the joined development of feasibility studies for the control of *Berberis microphylla* and *Hieracium pilosella*, both invasive weed species posing threats to agriculture and endemic species in the FI, for which eradication may eventually prove impossible.



Figure 7. Dave Moore demonstrating the fly rearing tents during open day at Government House gardens, Stanley in Nov. 2015 (photo: Sharon Jaffray, Penguin News).

## 2.4 Sustainability and Legacy

As in all CBC programmes, once established the natural agents will maintain their own populations, continuing control and so will be completely self-sustained. This will be checked as part of the monitoring programme initiated during this project. SAERI has taken on the task to voluntarily continue the monitoring and maintain a database for the foreseeable future. In addition, a joint proposal for a research PhD, looking in more detail into this subject is currently under development including FIG, SAERI, CABI and RHUL being project partners. More importantly, the community will decide if control has been satisfactory from their own experience.

Another project benefit, a greater knowledge of CBC and its benefits amongst the community should facilitate the further use of CBC against other invasive pests. This Darwin project has already kick-started feasibility studies looking into the CBC control of further alien invasive weeds. Such projects will benefit from the quarantine facilities constructed during this project. It is also planned to use these on a regular basis to quarantine specimens or contaminated material intercepted by biosecurity staff when inspecting imported goods.

Material used during the release trials, and training provided during this project, are being employed in the curating and building of a reference collection of terrestrial arthropods, now housed at the DoA and under supervision of staff involved in this project. This will in the future reduce the need to send off specimens for identification abroad.

On an individual basis, none of the project staff involved in this project had spent more than 30% of their time on this project and most significantly less. However, training received during the project is expected to improve their continued work with regards to biosecurity significantly. This is particularly the case as they had been actively taking part into the development of a tailored PRA procedure which is a new tool ready to be used in upcoming biosecurity issues. Towards the end of the project the PRA template has been used to assess a new application for the introduction of a commercially used biological control agents for indoor pest control in Stanley.

### 3 Project Stakeholders/Partners

This Darwin+ project on capacity building for CBC on the Falklands was focused very strongly on stakeholder involvement. In particular, it built on a string of pre-project activities, which started with a Defra-funded feasibility study for CBC in the SAUKOTs in 2011/2012. The feasibility study used stakeholder engagement right from the beginning as an important tool to identify suitable target species for CBC. During a workshop held in Stanley, which was part of this study, earwigs were chosen jointly by decision makers, scientists and members of the public as the most suitable case study (compare: <https://goo.gl/n3jwPV>). A tight collaboration with all key stakeholder groups continued through to a phase of host range testing and matched funding of FIG to the Darwin+ project specifically focused on awareness raising activities in March 2015 for CBC in general and the control of earwigs specifically. These activities were then followed up during further visits in November 2015, September 2016 and January 2017.

The residents of Stanley are aware of the ongoing project activities and its funding support by the DI. Every visit of a team member to Stanley and all major activities were always publicly announced (newspaper, TV, website) and both the CABI team and project partners from FIG have been constantly available to respond to questions or feedback of any kind from the public.

Stakeholder groups engaged with during the project included:

- Residents of the Falkland Islands
- Military operators at Mount Pleasant
- Farmers
- Horticultural Growers
- Pest controllers
- Members of the Legislative Assemblage (MLA)
- Environment Committee Members
- FIG Environmental Planning Department
- FIG Department of Agriculture (DoA)
- South Georgia Government
- Falklands Conservation (FC)
- South Atlantic Environmental Research Institute (SAERI)

Stakeholder engagement took place through:

- Five presentations given in Stanley (2 at the Chambers of Commerce), Goose Green, and Mount Pleasant Airport, March 2015, September 2016
- Information stall at Jetty Visitor Centre, Stanley, March 2015
- 2 open days at Government House Gardens in November 2015 and September 2016
- TV presentation at presentations at the Chambers of Commerce and during open day event at Government House Gardens; three radio interviews during 2015
- Project information website installed at FIG website including FAQ page and invitation to submit questions and queries
- Announcement and advertising of events in local newspaper and through radio
- Distribution of information fact sheets through supermarkets in Stanley
- Three meetings with MLAs at Gilbert House, Stanley in March 2015 and January 2017
- One meeting with representatives of the Government of South Georgia in 2015; joint development of PRA with biosecurity staff from St Helena and South Georgia in 2016

- Several meetings with staff from the DoA throughout the course of the project
- Numerous meetings with individual stakeholders from the groups above



Figure 8. Picture taken during the PRA workshop held in the court and council chambers, Stanley, Sept. 2016.

#### 4 Lessons learned

Collaboration with all involved project partners and stakeholders worked very well and there was great support for this project from the residents of the Falkland Islands. As a direct result, one of the major objectives of the project, greater understanding and wider acceptance of CBC, has been achieved in a very straightforward way. It has certainly been helpful that there was a string of activities paving the way towards this outcome before the DI project had started. As residents in Stanley are part of a very close-knit community it was also helpful that the staff from our project partners in the FI directly involved in the project were also highly supportive of the project and themselves respected members of this community.

Progress on the case study part (release of biological control agents) was initially slower than expected and the challenge to adjust lifecycles of species highly adapted to seasonal phenology patterns proved more difficult than anticipated. This had a direct impact on the possible scope of M&E activities as most of these are linked to the progress of the release program, and which will now mostly take place after the termination of the project.

It is difficult to foresee problems of the type encountered, and the nature of this type of work includes generally a highly empirical approach, gaining knowledge during the duration of the project and requiring a continuous adjustment of methods. The only way to deal with delays caused by difficulties, which can be anticipated but not quantified (for example the unexpected breakdown of parasitoid populations in the UK during 2015 and of earwigs in 2016) would be the optional extension of the project allowing it to cover an additional release season.

Initially, we tried to encourage active involvement of the public through engagement in earwig monitoring activities, as well as the public having the opportunity to take part in every decision making process throughout the whole project (see protocols annex 10 and annex 11). This

however, is not realistically achievable when such activities are required to be done during the summer season, coinciding with a tightly organised tourist season and peak working periods in most other sectors making up the economy of the FI. This alone allows little room for additional volunteer activities. Another factor which diminishes the scope of what citizen science can achieve, is that the larger the pool of people to draw interested volunteers from the better. Within an overall very small community of permanent residents in the Falklands it is difficult to get enough involvement, particularly when dealing with comparable unattractive insect species.

#### **4.1 Monitoring and evaluation**

Project milestones of all planned activities had been met and achievements for capacity building had been reached evenly over the whole course of the project, even though, internal project monitoring identified the need for a different scheduling of activities during the first release trial in 2015. This mainly concerned adjustment of release methods for earwig parasitoids (e.g. creating a suitable environment for the release of *O. pallipes* towards the end of the winter in the Falklands and a shift of the release of *T. setipennis* into the early month of 2017). These adjustments were approved by Darwin at the end of year one and have led to successful releases in the second project year.

Ultimately, the impact of the released parasitoids will only become apparent after the termination of the project. Therefore a strong focus of any discussions between CABI, FIG and also SAERI had been on developing ways to set the monitoring procedures in place, as they have been described further above. This was also a direct reaction to difficulties in finding volunteers to engage in citizen science activities. Monitoring stations for earwigs have now been installed at 27 sites covering large parts of East Falklands.

#### **4.2 Actions taken in response to annual report reviews**

Overall the score given during the annual review was 2 and most activities and outputs regarded as being on track. It was however pointed out that:

- The enrolment of citizen scientist into monitoring activities was delayed, due to the delay in the releases of the control agents (as described above); it was also questioned whether the level of commitment pledged from citizen scientist would be sufficient to ensure the sustainability of the project.

Interest of the wider public into the project was high during the whole duration of the project. However response to engage people with active involvement particularly the monitoring of earwig population densities failed despite a range of activities to get volunteers joining in such as leaflets, distributed monitoring protocols and the distribution of free monitoring equipment at all stakeholder meetings and the advertisement that equipment could be picked up for free at the FIG planning department. It became clear that the major problem was not unwillingness of the public to join in rather the need to deal with high workloads during the summer season, when everybody on the Falklands is extremely busy. As a solution to this and based on an offer by SAERI it was decided to transfer any monitoring activities into the hands of scientific staff at SAERI who will continue to monitor both earwig densities and the establishment of the control agents after the termination of the project. As a result of this we were able to get a monitoring scheme off the ground using 27 monitoring stations, partially installed in remote locations all over East Falkland. This in effect is much larger in scope what the team had hoped for to achieve through citizen science and will in the end be a better way forward to ensure a sustainable legacy of the project.

- It was asked to what degree residents, farmer, horticultural growers and pest controllers have been involved in stakeholder consultations and whether they had provided inputs into any publications; It was also asked whether citizen scientists were likely to be trained in pest management activities by the end of the project

Residents were given many opportunities to engage with the project. These included farmers, although they were not specifically consulted because earwigs generally don't pose such a large problem compared to residents of Stanley. Stakeholder consultations were more intensive during the first half of the project. This was based on the realisation that further regular consultation became somewhat repetitive and it was therefore decided to provide only regular updates on the progress of the project all stakeholder groups during the second year of the project. There is only one commercial horticultural grower in Stanley (Stanley Growers - Market Garden) and its staff had been consulted frequently and was indeed actively involved during all stages of the project (site of one monitoring station, providing earwigs for release trials, offering release of agents on their premises). Staff of Stanley Growers also took part in the two day workshop on PRA, primarily as an important stakeholder involved in the importation of biological material such as biological control agents for pest control within green houses.

There are two pest controllers in Stanley who offer a service to control earwigs, currently focused on the application of pesticides. Both are offering this service on top of full time employment and are very supportive of this project not least because a better control of earwigs would result in a reduced workload during a very busy time of the year. Both have been consulted several times during the course of the project and have provided valuable information on the spread and population levels of earwigs. The data provided is confidential as such, but in principle it is suitable to provide baseline information against which the future need for earwig control after the establishment of the control against can be measured against. In case the ongoing monitoring can demonstrate such an establishment, this may well turn out to be information worthwhile to be analysed as part of a future publication.

- The review endorsed in particular the steps undertaken to ensure a more successful second year.

Methods for the release of the parasitoids have been adapted as suggested in the annual report and described above. This has led to a successful release of both control agents. We are therefore optimistic to have also achieved establishment of one or both parasitoid species by the end of the project. However, as is the nature of a biological control programme, success cannot be taken for granted. There is a continued possibility that establishment might fail as the consequences of unpredictable events (e.g. local climate not allowing long term establishment; starter population too small). Only the coming years, when fly populations have increased beyond a threshold, where they can be detected inside the installed monitoring stations, will show if the establishment has been fully successful.

## **5 Darwin Identity**

At all stakeholder engagements it was pointed out that the funding for the release is being conducted with the support of the Darwin Initiative. The decision makers and residents of Stanley alike are aware of the Darwin Initiative not only through this projects but also through previous and ongoing other projects. There is also a strong positive identification of all residents and conservationists on the FI with the Darwin Initiative not least because of the extensive visits by Darwin himself to the islands, which is widely publicised in Stanley. Darwin funding opportunities are always discussed with regards to the future funding of activities building on this project or with regards to finding solutions to problems of a similar nature to this project.

The Darwin Initiative will be further publicised and its logo displayed during a presentation, which has been submitted for the upcoming 'Island Conference 2017' held in Dundee in July 2017. This will also lead into a publication of outcomes and of the project in the peer-reviewed proceedings of this conference.

Modern biological control programmes are usually funded by multiple donors and require a phased approach starting covering a range of work packages such as suitability assessment, survey for agents in the country of origin, host range testing, risk assessments, release and post release monitoring stretching over comparably long time periods. Equally this project is part of a longer string of individual projects on CBC on the Falklands and specifically the control of introduced earwigs.

## 6 Finance and administration

### 6.1 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			- 5.9	
Consultancy costs				
Overhead Costs			+ 3.7	
Travel and subsistence			+ 4.5	Budget increased from 5600 by 3905 after agreed change request to carry over unspent funds after year 1
Operating Costs			+ 2.8	
Capital items				
Others			+ 50	auditing fees higher than originally budgeted
<b>TOTAL</b>	59,348	58,679		

Staff employed (Name and position)	Cost (£)
Norbert Maczey – senior ecologist CABI	
Nick Rendell – officer planning department FIG	
Ross James – biosecurity officer, DoA, FIG	
Stephen McLean – technician biosecurity, DoA, FIG	
Pablo Gonzalez – ecologist CABI	
Nikolai Thom – technician CABI	
Corin Pratt – entomologist CABI	
Tomek Seier – technical assistant CABI	
<b>TOTAL</b>	

Other items – description	Other items – cost (£)
Auditing fees	
<b>TOTAL</b>	1,500

### 6.2 Additional funds or in-kind contributions secured

Please confirm the additional funds raised for this project. This will include funds indicated at application stage as confirmed or unconfirmed, as well as additional funds raised during the project lifetime. Please include all funds relevant to running the project as well as levered funds for additional work after the project ends. NB: the total of both these sections is the figure required for Annex I, Q23.



## Were any additional in-kind contributions secured during the project?

Source of funding for project lifetime	Total (£)
FIG-environmental studies budget: Awareness raising activities in the FI during 2015: benefits and safety biologicakl control	
FIG-environmental studies budget: Collecting of parasitoid tachinid flies in the UK during 2015 for the control of earwigs	
FIG-environmental studies budget: Collecting of parasitoid tachinid flies in the UK during 2016 for the control of earwigs	
CABI waiver overheads	
FIG contribution to the full costs of six flights Brize Norton to Mount Pleasant airport	
<b>TOTAL</b>	<b>70,160</b>

Source of funding for additional work after project lifetime	Total (£)
<b>TOTAL</b>	

### 6.3 Value for Money

Although the cost implications of earwig damage are relatively small, these are significant in relation to the population of the FI, where fruit and vegetable consumption remains comparably low despite a fully developed high income economy. One reason for this is that perishable goods, which need to be transported over long distances, are prohibitively expensive. Local production, although steadily increasing, can't currently meet demand and the earwig invasion has significantly added to production costs and increased yield losses.

Initial data obtained from the earwig monitoring stations setup during this project (annex 9), indicates that earwigs can invade native ecosystems, but that the invasion is most likely still at an early stage. We regard early intervention with CBC as the only feasible control method outside settlements, and when successful, able to mitigate the potentially very negative impact on the native invertebrate fauna. Furthermore, successfully introducing biocontrol agents will reveal the potential for using this safe and cost effective method for controlling invasive species to the population, giving long term value for money.

In comparison to average CBC programmes this project was characterised by extremely low costs. This was possible through the following beneficial circumstances:

- CABI had already conducted major research establishing the biology of both control agents during projects working on the control of invasive earwigs in Canada during the 1980s. Without this knowledge bringing the control agents into culture would have been much more time consuming and costly, and would have also included considerably higher risks of failure.
- Culturing of earwigs and parasitoids in the UK did not require the expensive usage of high-tech quarantine facilities.
- The control agents are comparably large and robust species. In comparison to other species such as small hymenopteran parasitoids or small Hemiptera the likelihood of establishment after release of only low numbers is still comparably high. The release of higher number would have been desirable but would have immediately required much more resources. It is still possible that not both species of parasitoids have become

established at the end of this project and only the monitoring set in place will reveal if further importations and releases will be required.

- Level of matched funding by FIG was very high considering that the whole economy of the FI is very small scale based on the income of less than 4,000 residents. This included not only the work funded to CABI for UK based research, listed in detail in the project application, but also any research funded in the years prior to this project. FIG also allowed CABI staff to visit on heavily subsidised flights. In addition, CABI contributed matched funding by reducing its normal rate of overheads.
- Good and regular communication between CABI and the partners in the host country allowed keeping direct supervision in the FI to a minimum.
- Through the remote participation of biosecurity officers from South Georgia and St Helena at the PRA workshop considerable value was added to the project without any additional costs.

## Annex 1 Standard Measures

The Standard Measures represent a 20+ year dataset of brief statistics of Darwin Projects. They largely comprise a series of inputs, activities and outputs or deliverables. Projects are not evaluated according to quantity of Standard Measures and completing Annex I is optional, but collecting information on these Measures are still useful. 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	Totals (plus additional detail as required)
<b>Training Measures</b>		
1	Number of (i) students from the UKOTs; and (ii) other students to receive training (including PhD, masters and other training and receiving a qualification or certificate)	0
2	Number of (i) people in UKOTs; and (ii) other people receiving other forms of long-term (>1yr) training not leading to formal qualification	(i) 1: Jeremy Poncet, Stanley; training in running basic quarantine procedures, maintaining insect cultures, controlled release of biological control agents over the course of 2 years
3a	Number of (i) people in UKOTs; and (ii) other people receiving other forms of short-term education/training (i.e. not categories 1-5 above)	(i) 7: training of biosecurity officers Falklands, South Georgia, St Helena and staff at the FIG planning department in understanding and usage of pest risk assessments (PRA)  (ii): training of 2 internships, 1 MSc student and 1 post doc scientist in setup parasitoid collecting programs and maintaining insect and parasitoid cultures
3b	Number of training weeks (i) in UKOTs; (ii) outside UKOTs not leading to formal qualification	(i) 1 (workshop on PRA); (ii): on the job training of people from 3a over course of 20 weeks
4	Number of types of training materials produced. Were these materials made available for use by UKOTs?	PRA template; and fully developed PRA case study
5	Number of UKOT citizens who have increased capacity to manage natural resources as a result of the project	9 biosecurity officers Falklands, South Georgia, St Helena and staff at the FIG planning department
<b>Research Measures</b>		

<b>Code</b>	<b>Description</b>	<b>Totals (plus additional detail as required)</b>
9	Number of species/habitat management plans/ strategies (or action plans) produced for/by Governments, public authorities or other implementing agencies in the UKOTs	0
10	Number of formal documents produced to assist work in UKOTs related to species identification, classification and recording.	0
11a	Number of papers published or accepted for publication in peer reviewed journals written by (i) UKOT authors; and (ii) other authors	(i) 2; (ii) 2 (one only submitted as conference proceeding so far)
11b	Number of papers published or accepted for publication elsewhere written by (i) UKOT authors; and (ii) other authors	0
12b	Number of computer-based databases enhanced (containing species/genetic information). Were these databases made available for use by UKOTs?	Database for earwig monitoring developed; handover of data and further management to SAERI at end of project
13a	Number of species reference collections established. Were these collections handed over to UKOTs?	Equipment and training provided to DoA, Falkland Islands to establish reference collection invasive and native arthropods
13b	Number of species reference collections enhanced. Were these collections handed over to UKOTs?	0
<b>Dissemination Measures</b>		
14a	Number of conferences/seminars/workshops/stakeholder meetings organised to present/disseminate findings from UKOT's Darwin project work	Numerous stakeholder meeting held as listed further above; one workshop on PRA held in Stanley September 2016
14b	Number of conferences/seminars/workshops/stakeholder meetings attended at which findings from the Darwin Plus project work will be presented/ disseminated	Outcomes of the project will be presented at the Island conference Durham, July 2017
<b>Physical Measures</b>		
20	Estimated value (£s) of physical assets handed over to UKOT(s)	~ £ 1,000 (equipment and material to build quarantine facilities; equipment to maintain and release insect cultures; equipment and consumable to establish invertebrate collection at DoA)
21	Number of permanent educational/training/research facilities or organisation established in UKOTs	2 quarantine facilities established in Stanley, Falkland Islands
22	Number of permanent field plots established in UKOTs	0

<b>Code</b>	<b>Description</b>	<b>Totals (plus additional detail as required)</b>
23	Value of resources raised from other sources (e.g., in addition to Darwin funding) for project work	

## Annex 2 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 *	Detail (title, author, year)	Nationality of lead author	Nationality of institution of lead author	Gender of lead author	Publishers (name, city)	Available from (e.g. weblink, contact address, annex etc)
journal	Norbert Maczey, Steve Edgington, Dave Moore & Tim Haye (2016)  Biology and host range testing of <i>Triarthria setipennis</i> and <i>Ocytata pallipes</i> (Diptera: Tachinidae) for the control of the European earwig ( <i>Forficula auricularia</i> ), <i>Biocontrol Science and Technology</i> , 26:4, 447-461	German	UK	m	Taylor & Francis	<a href="http://dx.doi.org/10.1080/09583157.2015.1123675">http://dx.doi.org/10.1080/09583157.2015.1123675</a>
blog	Controlling the European earwig on the Falklands,	German	UK	m		<a href="https://cabiinvasives.wordpress.com/2017/05/05/controlling-the-european-earwig-on-the-falklands/#more-1509">https://cabiinvasives.wordpress.com/2017/05/05/controlling-the-european-earwig-on-the-falklands/#more-1509</a>

	Norbert Maczey, 2016					
video	Earwigs in the Falklands, Norbert Maczey, 2016	German	UK	m		<a href="https://www.youtube.com/watch?v=fHZ0c0py4YY&amp;feature=youtu.be">https://www.youtube.com/watch?v=fHZ0c0py4YY&amp;feature=youtu.be</a>
presentation	Introduction to the benefits, safety and risks of classical biocontrol, Norbert Maczey, 2016	German	UK	m		<a href="http://staging-umbraco-b1/projects/project/32771">http://staging-umbraco-b1/projects/project/32771</a>
presentation	Introduction to pest risk assessment, Pablo Gonzalez-Moreno, 2016	Spanish	UK	m		<a href="http://staging-umbraco-b1/projects/project/32771">http://staging-umbraco-b1/projects/project/32771</a>

## Annex 3 Darwin Contacts

To assist us with future evaluation work and feedback on your report, please provide details for the main project contacts below. Please add new sections to the table if you are able to provide contact information for more people than there are sections below.

<b>Ref No</b>	DPLUS033
<b>Project Title</b>	Enhancing biosecurity and biological control capacity in the Falkland Islands
<b>Project Leader Details</b>	
Name	Norbert Maczey
Role within Darwin Project	Project manager; biocontrol specialist
Address	CABI, Bakeham Lane, Egham, TW20 9TY, UK
Phone	
Fax/Skype	
Email	
<b>Partner 1</b>	
Name	Nick Rendell
Organisation	FIG, Environmental Planning Department
Role within Darwin Project	Coordinator of project team based in the Falkland Islands
Address	PO Box 611, Stanley, Falkland Islands, FIQQ 1ZZ
Fax/Skype	
Email	
<b>Partner 2 etc.</b>	
Name	
Organisation	
Role within Darwin Project	
Address	
Fax/Skype	
Email	