Decision Support System for Prioritising and Implementing Biosecurity on Western Australia's Islands Project

Annual Report

1 July 2014 - June 2015

James Cook University (ARC Centre of Excellence for Coral Reef Studies),

Department of Parks and Wildlife, WA

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1. Executive Summary

This annual report is for the Project on Decision Support System for Prioritising and Implementing Biosecurity on Western Australia's Islands, covering the period 1 July 2014 to 30 June 2015.

A total of $707,815 was expended against the project on Decision Support System for Prioritising and Implementing Biosecurity on Western Australia's Islands for the period 1 July 2014 to 30 June 2015, including $551,581 of NCB funds and $156,234 of in-kind funds.

After some delays on earlier milestones, mainly related to delays in appointment of the software developer, the Project is now making strong progress. Milestones with completion dates in the reporting year, or not completed in the previous year are summarised here (Table 6 gives full details):

Planning and preparation
2.1: Completed
3.1: Completed
4.1: Revised to 31.10.2015 (revision of Work Plan)
Implementation
1.7: Completed
1.8: Partially completed; revised to 30.11.15 (submission of peer-reviewed paper)
2.2: Completed
2.3: Completed
2.6: Revised to 31.03.2016 (acceptance of peer-reviewed paper)
3.2: Completed
3.3: Revised to 31.03.2016 (second demonstration and testing)
3.4: Completed
3.5: Completed
Communications
1.9: Completed
External collaborations:
1.11: Completed
Reporting
2.8: Completed
3.6: Completed
3.7: Completed

Delays in the implementation milestones (manuscripts to journals on decision-support tool, second demonstration and testing with managers) do not indicate problems with the project. They reflect the one-year delay in appointing the JCU programmer for the project, explained in previous reports. The programmer has made strong progress on all aspects of the decision tool, including collaborations with other IT and computing groups, so all related tasks are now progressing well. The delays will not slow the project because data compilation and elicitation are proceeding unhindered.

The focus in 2014/15 has been on data compilation, introductory meetings to prepare for elicitation of data, habitat mapping, development of the Bayesian models of likelihood of invasive species establishing, formulation and coding of the decision-support tool, and liaison with managers.

In 2015/16 the focus will be on continued refinement of the decision tool and its graphical user interface, completion of the habitat mapping and Bayesian models, and publishing results.

1. Introduction

This report fulfils the annual reporting requirements for the year July 2014 - June 2015.

Table 1: Project elements implemented over 2014/15 (see detail in Table 6)

Project Element	Comments
Completion of initial model formulation and application to subset of islands	Completed
Finalisation of details for formulation and approach of the decision-support tool for publication in an international peer-reviewed scientific journal	Partially completed. One paper published in a peer-reviewed conference proceedings. Another to be submitted to a peer-reviewed conference proceedings in September. A third paper to be submitted to a conservation journal in November.
Update of Communications Plan	Completed
Preparation of a memorandum of understanding between JCU and DPaW	Completed
Annual revision of Detailed Work Plan 2013-2014	Completed
Demonstration and testing of initial model formulation with managers	Completed
Development of full threat sub-model	Completed
Acceptance of paper on the decision model in peer-reviewed journal	Delayed as for submission, above
Preparation of 2013-2014 annual report	Completed
Annual revision of Detailed Work Plan 2014-2015	Completed
Development of full sub-model for contributions of management actions	Completed
Second demonstration and testing of refined decision model with managers	Delayed until March 2016 to allow time for substantial improvement over previous demonstration
Mid-term peer review of decision model	Completed
Compilation of data from literature and data bases	Completed
Six-monthly update at December 2014	Completed

2014-2015 annual report	Completed
Annual revision of Detailed Work Plan for 2015-2016	Scheduled for October 2015

2. Commentary

2.1. Financial performance 2014-15

Summary

Table 2: Summary of the Operating Account Activity 2014-15

	Income (2014/15)	Expenditure (2014/15)	Closing balance (30 June 15)
Installments	$428,396		
Interest			
Expenditure		$551,581	
Total			**($123,185)**

3.2.1. NCB detailed expenditure

A spreadsheet of detailed expenditure for the project accompanies this report

Table 3: Summary of expenditure

Island prioritisation project, spending item	NCB actual expenditure July 2014 to June 2015
Salaries, JCU	$289,919
Salaries, DEC	$155,475
Consultants	$51,665
Travel	$45,424
Workshops, including travel and local costs	$9,099
Total	**$551,581**

3.2.2. In-kind expenditure (if relevant)

Table 4: Summary of in-kind expenditure

In-kind contribution	Value July 2014 to June 2015
JCU: Salary for Bob Pressey, JCU	$51,584
DPaW: Salary for Keith Morris	$21,800
DPaW: Salary for Lesley Gibson	$28,600
DPaW: Salary for managers and scientists in meetings	$54,250
Total	**$156,234**

Table 5: 2012/13 to 2016/17 NCB budget

JCU Finance Created	2012/13	2013/14	2014/15	2015/16	2016/17	Total
Instalments per contract	$462,827	$403,272	$428,396	$422,984	$321,852	$2,039,331
Expenditure	$337,302	$416,250	551,581			$1,305,133
Surplus/(Deficit) Balance	$125,525	$112,547	$(10,638)			$734,198

Table 6 Milestone performance 1 July 2014 to 30 June 2015

Table 6: Summary of milestone performance during twelve months from 1 July 2014 to 30 June 2015, by project element (left column indicates year and number of milestone). Shading indicates milestones completed before this reporting period. List includes milestones with due dates before reporting period but not completed beforehand.

Four milestones are overdue at the time of reporting, but none of these delays present problems for the project, as explained in the table:

1.8 (due 30 June 2013): Submission of decision model to international journal delayed, but well underway

2.6 (due 30 June 2014): Acceptance of article in international journal delayed as for 1.8

3.3 (due 30 June 2015): Decision taken to delay demonstration to managers of refined decision model until February or March 2016. The reason is to have made substantial progress following the initial (successful) demonstration to managers in Perth and Karratha (delayed to March 2015)

4.1 (due 31 May 2015): Previous Work Plan delayed to October 2014, so annual update planned for October 2015.

No.	Category	Description	Due date	Comments
1.1	PLANNING & PREPARATION	Preparation of detailed Work Plan for 2012-2013 in consultation with the Project Steering Committee (Outcome and Output 1)	31 December 2012	**Completed**
1.2	PLANNING & PREPARATION	Formation and meeting of a Project Steering Committee for Project planning and co-ordination (Outcome and Output 1)	31 October 2012	**Completed**
1.3	PLANNING & PREPARATION	Holding of a design meeting between the Parties and other stakeholders (Outcome and Output 1)	31 October 2012	**Completed**

1.4	IMPLEMENTATION	Holding of an initial scoping and peer review workshop to identify suitable islands, data sources, refine approach to eliciting model parameters from managers, and design details of Project methods. The results shall be documented (Outcome and Output 2)	31 October 2012	**Completed**
1.5	IMPLEMENTATION	Completion of an initial field data collection on subset of islands: distribution, abundance and population trends of species of concern (Outcome and Output 2)	30 April 2013	**Completed**
1.6	IMPLEMENTATION	Holding of the first workshop with field managers to review approach and obtain preliminary parameters for model formulation, including definition of quantitative goals for biosecurity (Outcome and Output 2)	28 February 2013	**Completed**
1.7	IMPLEMENTATION	Completion of initial model formulation and application to subset of islands (Outcome and Output 2)	30 June 2013	This milestone was delayed by the late appointment of JCU programmer, as described in minutes of the Steering Committee and previous progress reports. Formulation and development of the prototype code is now complete, with collaboration from programmers and operations researchers at Griffith University, Bond University, Charles University in the Czech Republic, JCU's eResearch group, and NICTA (National Information Communications Technology Australia).

Completed: 30 January 2015

1.8	IMPLEMENTATION	Finalisation of details for formulation and approach of the decision-support tool for publication in an international peer-reviewed scientific journal (Outcome and Output 3)	30 June 2013	Delayed for the same reasons as 1.7. One publication on the decision-support tool is published as a peer-reviewed conference paper: Brotánková, J., Randall, M., Lewis, A., Pressey, B. and Wenger, A. (2015). A genetic algorithm solver for pest management control in island systems. In: Artificial Life and Computational Intelligence: Proceedings of the First Australasian Conference, Newcastle, New South Wales, 5-7 February 2015. Eds. S.K. Chalup, A.D. Blair and M. Randall. Pp. 273-285.

A second paper will be submitted in September 2015 to the prestigious peer-reviewed proceedings of the February 2016 annual conference of the Association for the Advancement of Artificial Intelligence: "Habitat restoration planning under uncertainty with constraint programming", with authors J. Brotánková, P. Kilby, P. Van Hentenryck and T. Urli. The co-authors are from National Information Communications Technology Australia.

A third paper for a conservation science journal is being drafted, with expected submission date November 2015.

Partially completed (conference proceedings, not journal): **28 February 2015**
Full completion (submission to journal): **30 November 2015**

NOTE that several other manuscripts are being laid out to describe parts of the project, including the data compilation and habitat mapping (3.5 below), elicitation of data, and sub-models for the software.

1.9*	COMMUNICATIONS	Preparation of a Communication Plan for the Project addressing communication opportunities to assist in knowledge transfer (Outcome and Output 4); due date for initial Communication Plan	30 September 2012	Initial Communication Plan appended to first progress report. No update for September 2013. Update for September 2014 completed. Further update completed January 2015 to list recent activities for Steering Committee meeting in early March 2015.

		*Funding Agreement calls for an annual update of the Communication Plan for the Project	*September 2014 (second annual update)	**Completed: 10 October 2014**
1.10	HUMAN RESOURCE MANAGEMENT	Employment of three staff to the Project with each being managed using the respective organisation's human resource management system (Outcome and Output 5)	1 December 2012	**Completed**
1.11	EXTERNAL COLLABORATIONS	Preparation of a memorandum of understanding between the Parties for ongoing collaboration beyond the duration of the Project (Outcome and Output 6)	30 August 2012	**Completed: 20 February 2015**
1.12	REPORTING	Preparation and submission of a six-monthly update to the Project Steering Committee and the NCB Advisory Board addressing agreed items (Outcome and Output 7)	31 January 2013	**Completed**
1.13	REPORTING	Preparation and submission of the 2012-2013 Annual Report to the Project Steering Committee, the		

		State and the NCB Advisory Board (Outcome and Output 7)	31 August 2013	**Completed**
2.1	PLANNING & PREPARATION	Annual revision of Detailed Work Plan for 2013-2014 in consultation with the Project Steering Committee (Outcome and Output 1)	31 May 2013	No update for 2013-2014, but rolled into subsequent annual update (3.1 below), providing details on completed or planned activities for two financial years (2013-2015). **Completed: 8 October 2014**
2.2	IMPLEMENTATION	Completion and testing with managers of initial model formulation with subset of islands (Outcome and Output 2)	31 August 2013	Progressed at the general level (discussion with both WA and GBR managers about data and refinement of methods) in preparation for a working prototype of the software applied to a substantial trial data set (1.7, above). Delay related to late appointment of positions, as described for 1.7. The prototype software linked to a graphical user interface was demonstrated and discussed in March 2015 at meetings between the project team and managers in Perth and Karratha. **Completed: 26 March 2015**
2.3	IMPLEMENTATION	Development of full threat sub-model (Outcome and Output 2)	30 June 2014	Concepts and operational requirements for the sub-model have been extensively discussed within the Project team, with managers, and during conference presentations. Delays due to late appointment of programmer (see 1.7), but also setting of unrealistic date for completion given the scale of the problem to be addressed. Models for temporal responses of threats to actions (reductions), to cessation of actions before eradication (increases), and to arrival and establishment of new threats (increases) are now complete. The modelling is generic and can be adjusted to varying input parameters (e.g. annual rate of increase of an invasive species, temporal trends in reduction with management actions). Refinement of parameters will be ongoing. **Completed: 30 January 2015.** NOTE that two other aspects of modeling threats, not envisaged at the commencement of the Project, will also be developed: • Design of Bayesian Belief Networks to predict probability (spatially

explicit, so varying between islands) of arrival of invasive species not currently present on islands, considering present or potential sources of invasives on the mainland and other islands (planning for this aspect of the project is well advanced, with a workshop planned in Perth in late March 2015)

- Design of an approach to balance investment in quarantine, surveillance and control.

2.4	IMPLEMENTATION	Completion of field visits to fill data gaps on subset of islands (Outcome and Output 2)	31 October 2013	**Completed**
2.5	IMPLEMENTATION	Holding of second workshop with managers to review approach and refine parameters for model formulation for subset of islands, including uncertainties (Outcome and Output 2)	30 November 2013	**Completed**
2.6	IMPLEMENTATION	Acceptance of paper for publication in an international peer-reviewed scientific journal describing the formulation and approach of the decision support tool (Outcome and Output 3)	30 June 2014	Delayed as for 1.8, above, but one paper is now published in a national peer-reviewed conference proceedings. A second paper will be submitted to an international peer-reviewed conference proceedings in September, and a third will be submitted to an international conservation journal in November. **Expected completion date: March 2016**
2.7	REPORTING	Preparation and submission of a six-monthly update to the Project Steering		

		Committee and the NCB Advisory Board addressing agreed items (Outcome and Output 7)	31 January 2014	**Completed**
2.8	REPORTING	Preparation and submission of the 2013-2014 Annual Report to the Project Steering Committee, the State and the NCB Advisory Board (Outcome and Output 7)	31 August 2014	**Completed: 10 October 2014.**
3.1	PLANNING & PREPARATION	Annual revision of a Detailed Work Plan for 2014-2015 in consultation with the Project Steering Committee (Outcome and Output 1)	31 May 2014	Rolled into completion of 2.1, above. **Completed: 8 October 2014**
3.2	IMPLEMENTATION	Development of a full sub-model for contributions of management actions (Outcome and Output 2)	30 June 2015	This sub-model is closely linked to the threat sub-model. Concepts and operational requirements for the sub-model have been extensively discussed within the Project team, with managers, and during conference presentations. Models for temporal responses of threats to actions (reductions) and cessation of actions before eradication (increases) are now complete. The modelling is generic and can be adjusted to varying input parameters (e.g. varying intensity of management actions, temporal trends in reduction of pest species with management actions). **Completed: 30 January 2015.** Refinement of parameters will be ongoing.
3.3	IMPLEMENTATION	Completion of testing with managers of refined model formulation with subset of islands (Outcome and		Decision taken by the project team to delay demonstration and testing of the refined software until February or March 2016. The rationale for this delay was to present substantial progress to managers following the initial demonstration in March 2015 (2.2, above). A demonstration in mid-late 2015 will not involve a

| | | Output 2) | 30 June 2015 | large improvement in the software or the graphical user interface. **Expected completion date: 31 March 2016.** |

3.4	IMPLEMENTATION	Holding of a mid-term peer review workshop to ensure world's best practice (Outcome and Output 2)	31 March 2015	Four approaches taken in lieu of a formal peer-review workshop:

1. Extensive collaboration with software developers at other research institutions.
2. Presentation of the model at numerous conferences, involving discussions with people working on related research:
    a. 27th International Congress for Conservation Biology (and 4th European Congress for Conservation Biology), Montpellier, August 2015
    b. Australasian Conference on Artificial Life and Computational Intelligence, Newcastle, New South Wales, February 2015
    c. Association for Tropical Biology and Conservation 51st Annual Meeting, Cairns, July 2014
    d. Society for Conservation Biology Oceania Conference, Suva, July 2014
    e. International Conference on Computational Science, Cairns, June 2014
    f. Island Arks Symposium III, Hobart, February 2014
    g. Queensland Coastal Conference, Townsville, October 2013
    h. Annual symposium of the ARC Centre of Excellence for Coral Reef Studies, Townsville, October 2013.
3. Presentation of the model for critical discussion at two expert workshops, one on estimating and modelling costs of management actions and one on modelling populations of native and pest species. Each workshop has led to refinement of the approach.
4. Invited written review of the formulation by two experts in modelling for island management: Michael Bode (University of Melbourne); and Stephanie Borrelle (AUT University, Auckland). Both reviews were positive and suggested improvements, which are being pursued.

Completed: 4 August 2015

3.5	IMPLEMENTATION	Completion of search of published literature and other existing data (e.g. museum and herbarium		All published and accessible unpublished data have been obtained and compiled for all the islands covered by the project.

		records) for all islands covered by the Project (Outcome and Output 2)	30 June 2015	**Completed: 30 June 2015** NOTE that one aspect of data collection – remote-sensing to produce detailed maps of "habitats" (broad vegetation types, types of non-vegetated surfaces) on all study islands, not envisaged at the commencement of the Project, is well underway with maps being generated by October 2015. Map validation and publication to occur by October 2016.
3.6	REPORTING	Preparation and submission of a six-monthly update to the Project Steering Committee and the NCB Advisory Board addressing agreed items (Outcome and Output 7)	31 January 2015	**Completed: 9 February 2015.**
3.7	REPORTING	Preparation and submission of the 2014-2015 Annual Report to the Project Steering Committee, the State, and the NCB Advisory Board (Outcome and Output 7)	31 August 2015	Milestone achieved with this annual report. **Completed 26 August 2015**
4.1	PLANNING & PREPARATION	Annual revision of a Detailed Work Plan with the Project Steering Committee (Outcome and Output 1)	31 May 2015	Previous Work Plan delayed to 8 October 2014. Next update of Work Plan scheduled for October this year. **To be completed by 31 October 2015**

2.2.   Media achievement 2014/15

Cheryl Lohr discussed the project during an interview with ABC Pilbara radio. Andrew Burbidge discussed the project in a newspaper article. Publications and conference presentations are described below.

2.3.   Outputs reporting 2014/15 (based on milestones)

Major outputs and outcomes achieved for the period 1 July 2014 to 30 June 2015 include:

a.   Planning and preparation

Three members of the Project Steering Committee remain the same as for the last reporting period, but a JCU replacement for Prof Sean Connolly (who has taken on additional administrative responsibilities) is being sought:

- Prof Morgan Pratchett JCU (now Chair)
- Mr Allisdair MacDonald DPaW (Pilbara Regional Manager)
- Dr Colin Yates (Assistant Director, Science and Conservation Division)

The Steering Committee met on the 29th of July 2014 and 12th March 2015. The sixth meeting of the Project Steering Committee will be in September or October 2015. All meetings are attended by Bob Pressey and Keith Morris.

A detailed Work Plan was updated in October 2014 and circulated to the Steering Committee. A further update will be provided for the next meeting.

b.   Implementation

Field work: Field work for ground-truthing of vegetation condition is largely complete. A major field trip was completed in May 2015 for ground-truthing and additional records of native and introduced species. Opportunistic field work, in conjunction with ongoing species recording on islands by DPaW, will also be used to validate the habitat classification (below).

Subcontracts: Four subcontracts have been let for components of the project that were not envisaged when the project commenced:
- Provision of species data held by consultants (approx. $50,000)
- Assistance with Bayesian modelling of invasive species (approx. $20,000)
- Programming for graphical user interface (approx. $20,000)
- Imagery, interpretation, and ground-truthing for habitat mapping (approx. $70,000)

Reconnaissance trips and expert workshops: Amelia Wenger met with regional managers, Perth DPaW officers, and expert consultants in November 2014 to elicit occurrences of native and invasive species, relationships among species, and habitat preferences of native and invasive species. Ian Craigie met with regional staff in Exmouth in June 2015 for a two-day workshop to elicit information

on management costs. Cheryl Lohr has been in regular contact with Karratha and Exmouth staff to compile data and organise field work. Expert elicitation workshops were conducted in March 2015 (Perth) for the Bayesian models of probabilities of establishment of invasive species on islands (below). The project team spent time in Perth and Karratha in March 2015 to demonstrate the software and discuss refinements.

Data compilation: The database on biological records for the Pilbara islands, extracted from literature, reports, herbarium and unpublished data is complete. There will be ongoing additions from records held by researchers in personal databases and notebooks. A gap analysis of the data is underway.

Remote sensing: Mapping of "habitats" (types of substratum and vegetation distinguishable from high-resolution satellite imagery) for the Pilbara islands is proceeding well. This project is in collaboration with DPaW GIS Section and will improve the ability to predict occurrences of native and invasive species on the islands, as well as identifying ecosystems that are of conservation interest in their own right. Cheryl Lohr and Amelia Wenger collaborated with DPaW Marine Science Program and Animal Science researchers to arrange field work to ground-truth the habitat mapping.

Bayesian modelling: Amelia Wenger developed Bayesian models of probability of arrival and establishment of invasive species on islands in collaboration with Owen Woodberry (Monash University's Bayesian Intelligence group). Models include characteristics of islands (e.g. habitat, distance to source, so allow spatially explicit prediction). The models were parameterized in March 2015 with a workshop in Perth.

Formulation and programming: Strong progress has been made on formulation and coding of the decision-support system in the last year. The overall formulation is now complete, as is the threat sub-model and sub-model for contributions of actions. The software has been extensively discussed and exposed to peer-review (see milestone 3.4, above). The first round of work has been completed on a sophisticated graphical user interface for the software to allow interactive use with managers. The prototype system was demonstrated to DPaW managers in Perth and Karratha in March 2015.

c. Publications

Two publications have been accepted for publication. One is a journal paper: "Remotely monitoring change in vegetation cover on the Montebello islands, Western Australia, in response to introduced rodent eradication", by Lohr, Van Dongen, Huntley, Gibson, and Morris. The other is a peer-reviewed conference paper: Brotánková, J., Randall, M., Lewis, A., Pressey, B. and Wenger, A. (2015). A genetic algorithm solver for pest management control in island systems. In: Artificial Life and Computational Intelligence: Proceedings of the First Australasian Conference, Newcastle, New South Wales, 5-7 February 2015. Eds. S.K. Chalup, A.D. Blair and M. Randall. Pp. 273-285.

Another paper will be submitted in September 2015 to the prestigious peer-reviewed proceedings of the February 2016 annual conference of the Association for the Advancement of Artificial Intelligence: "Habitat restoration planning under uncertainty with constraint programming", with authors J. Brotánková, P. Kilby, P. Van Hentenryck and T. Urli.

Two journal articles describing the probability of arrival and establishment of invasive flora and fauna will be submitted in December 2015.

A journal article exploring the reliability of expert opinion and habitat mapping for predicting species distributions will also be submitted in December 2015.

A journal paper describing the overall rationale and approach for the decision model is being developed. A literature review of multiple-action conservation planning is in progress. The review will identify the requirements of multiple-action planning methods and identify limitations to be filled for this project. Work has commenced on a journal paper describing the cost sub-model.

d. Communications

The Communications Plan was updated twice in this reporting period – October 2014 and January 2015 – and submitted to the Steering Committee meeting in March 2015. A further update will be provided for the next meeting.

The project has been featured at several national and international conferences in the last year:
- Three oral presentations at the Society for Conservation Biology's Oceania Section meeting in Suva, July 2014 (in a symposium on island conservation organised by the project team)
- One oral presentation at the Association for Tropical Biology and Conservation meeting in Cairns, July 2014
- One oral presentation at the National Environmental Research Program Tropical Ecosystems Hub conference in Cairns, November 2014
- One oral presentation at the Australasian Conference on Artificial Life and Computational Intelligence, Newcastle, New South Wales, February 2015.

e. Human Resource Management

All three project staff members have been appointed and are well established in their roles. There has been active collaboration between the JCU and DPaW teams, including face-to-face meetings and joint participation in workshops with managers.

f. External collaborations

The project team has been collaborating with Ricky van Dongen, from the Department of Parks and Wildlife GIS Section who is conducting research into the use of remote sensing to determine vegetation condition on the Western Australian islands. This collaboration has been extended to include Katherine Zdunic (also DPaW GIS Section) to map "habitats" (identifiable types of substratum and vegetation) on the Pilbara islands, as a basis for predicting the occurrence of native and introduced species. Field work for habitat mapping was completed in the Dampier Archipelago in May 2015. This involved collaboration between Parks and Wildlife Animal Science Program, GIS Section, Marine Science Program, JCU researchers, and volunteers. The collaboration with GIS Section will continue into 2016 as additional field data are collected to validate maps.

A new collaboration with the University of Melbourne involves Dr Michael Bode who is working on control of invasives on southern Australian islands. The new joint research will contribute to understanding temporal trends in abundance or extent of invasives, with and without management actions, and the responses of native species.

A new collaboration with the University of Queensland involves Dr Vanessa Adams and Dr Gwen Iacona, who are working on costs in conservation. This collaboration will clarify the ways in which data on conservation costs should be incorporated into the decision model.

Collaborations continue with the parallel JCU project on prioritization of management actions on islands in the Great Barrier Reef. Both the GBR and Pilbara projects are benefiting from exchange of information and ideas between managers and the science teams.

Collaboration continues with Monash University to draw on the expertise of Professor Anne Nicholson and Dr Owen Woodberry who are experts in the development of Bayesian Belief Network models for diverse applications. The Monash team are helping to develop the Bayesian models of the probability of arrival and establishment of key invasive species on each of the islands. Owen Woodberry joined the project team in Perth and Karratha in March 2015.

Several continuing collaborations are contributing to the formulation of the decision problem and the development of solvers. The collaborating institutions are Griffith University, Bond University, Charles University in the Czech Republic, JCU's eResearch group, and the Optimization group of NICTA (National Information Communications Technology Australia).

g. Reporting

Five previous reports – three progress reports and two annual reports - have been submitted.

2.4.   Planned activities 2015/16

The activities proposed for 2015/16 include:

- Update of Detailed Work Plan and Communications Plan for 2015-2016, in consultation with the Project Steering Committee

- Second round of development of the graphical user interface by JCU's eResearch group

- Second round of demonstration and testing of software following further development of formulation, solver, and user interface. Planned for February or March 2016 in Perth and Karratha. More detailed feedback is expected during this round because managers will have more opportunity to interact with and explore the software.

- Further elicitation of management costs from experts working on control and eradication of invasive plants and animals

- Papers submitted to peer-reviewed journals, including description of the decision model, application of Bayesian models to predict likelihood of establishment of invasive species, and habitat mapping.

- Two specialist workshops to bring in experts on management costs and population modelling to work with the project team for refinement of sub-models.

- Conference presentations at:
  - Island Arks IV, February 2016
  - Society for Conservation Biology meeting, June 2016

- Liaison with island managers in Hobart around the ARC Centre's annual symposium

- Preparation and submission of a six-monthly update to the Project Steering Committee and the NCB Advisory Board addressing agreed items

- Preparation and submission of the 2015-2016 Annual Report to the Project Steering Committee, the State and the NCB Advisory Board

3. Conclusion

A total of $707,815 was expended against the project on Decision Support System for Prioritising and Implementing Biosecurity on Western Australia's Islands for the period 1 July 2014 to 30 June 2015, including $551,581 of NCB funds and $156,234 of in-kind funds.

After some delays on earlier milestones, mainly related to delays in appointment of the software developer, the Project is now making strong progress on all fronts. The decision tool is operational with a graphical user interface, data collection and elicitation are proceeding as planned, and there has been extensive consultation between the project team and field managers.

In 2015/16 the focus will be on continued refinement of the decision tool and its graphical user interface, completion of the habitat mapping and Bayesian models, and publishing results.