Evaluation of Doctoral and Postdoctoral Fellowships offered through the Australian Museum's Lizard Island Research Station

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LIZARD ISLAND REEF RESEARCH FOUNDATION

HUMANCAPITAL Alliance

Creating workforce solutions

Report preparation

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Photographs

Cover photograph of Lizard Island Research Station by Mr Charles Shuetrim AM. The photograph on page 4 of the reef at Lizard Island is provided by Anne Hoggett and Lyle Vail.

Photographs of Dr Sterling Tebbett, Dr Steph Gardner, Dr Sue-Ann Watson and Professor Redouan Bshary were provided by them.

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List of abbreviations

AM	Australian Museum
DFAT	Department of Foreign Affairs and Trade
HCA	Human Capital Alliance
IPF	The Ian Potter Foundation
LIRRF	Lizard Island Reef Research Foundation
LIRS	Lizard Island Research Station

Glossary

Co-Director LIRS	One of two expert scientists resident on-site at Lizard Island Research Station, overseeing strategic, operational and educational aspects of the Station
Doctoral Fellowship	A grant to fund a research project that is being conducted as part of a PhD or other doctoral degree at a university, under the supervision of a university academic, funding at least 100 person days per year on-site at Lizard Island Research Station over one, two or three years
Fellowship	A grant to fund a research project, obtained through a competitive process that includes review by an expert scientific panel
Fellowships Program	Provides funding for researchers (Fellows) to conduct fieldwork at the LIRS. Funding is available each year and is allocated through a competitive application process. The funding is made available by The Ian Potter Foundation and other donors
Postdoctoral Fellowship	A grant to fund a research project that is being conducted by an early career researcher who has completed a PhD within the last five years and is working independently, funding approximately 60 person days per year on-site at LIRS over one or two years
Supervisor	An academic scientist who is overseeing a research project being conducted by a university student as part of a PhD or other doctoral degree

Executive Summary

Background

The Australian Museum's Lizard Island Research Station (LIRS) is the most northly research station on the Great Barrier Reef. It is regarded by experienced marine science researchers around the world as one of the best, if not the best place, to undertake coral reef research. It is an especially good place for early career researchers to develop field research capabilities.

The Doctoral and Postdoctoral Fellowships Program provides grants to early career researchers to undertake field-intensive research at LIRS. It represents a unique, longstanding investment in building research capacity in coral reef research. The current and next generation of marine scientists and managers are being fostered through this program. The Program also makes a vital contribution to the generation of research informing evidence based decision making for the management of coral reef systems in Australia and internationally.

The aims of this evaluation are to describe the outcomes of the Doctoral and Postdoctoral Fellowships Program, create a comprehensive view of the contribution of the Program, make recommendations as to how the Program might be strengthened and inform the data infrastructure required to continue monitoring outcomes. The intent of the evaluation is to assist decision making by the LIRRF, the AM and the donors, particularly The Ian Potter Foundation, who support the Fellowships Program and the Research Station. The evaluation was undertaken by Human Capital Alliance assisted by a Working Group.

Method

The evaluation findings were based on the analysis of three major sources:

1. A database, constructed for this evaluation, describing applicants for the years 2006-2020
2. Semi-structured qualitative interviews conducted with fellows, supervisors and other key informants, and
3. A management audit.

Findings

There were 420 ***applications*** during 2006-2020, of which 89 (21.2%) were successful. This reflected 302 ***applicants*** who submitted at least one application, of which 78 (25.8%) were successful. Some applicants who were successful in achieving a doctoral fellowship were also subsequently successful in achieving a postdoctoral fellowship.

Two thirds of the fellowships awarded (62.6%) were to applicants from Australia however the success rate was the same for Australian and international applicants. Throughout the study period there were more female applicants and more female fellows. Three factors were related to a successful application: previous experience of LIRS; having a supervisor familiar with LIRS; and being enrolled at an institute geographically close to Lizard Island. All 89 fellowships were completed.

Fellows enjoy significant personal growth, developing increased independence and capacity as a researcher. In addition to research grant management experience, they learn to work under water and engage with the complexity of conducting research in the marine environment. Attaining a

prestigious fellowship and their enhanced publication and productivity strengthens their CV and their capacity to apply for future jobs and grants. They experience the international, collegial coral reef research environment fostered at LIRS. This enables the formation of lifelong collaborative research relationships. Completing the fellowship confers recognition as a coral reef researcher and sustained career benefits.

The academic institutions and supervisors with whom the fellows are affiliated also experience benefits. Having a fellow within the institution: increases the field work capacity within the unit; develops the grant management and leadership skills within teams; enhances the academic networking and international connections of the unit; increases productivity as measured by publications; and provides a pool of skilled researchers with enhanced field research capacity (a competency under threat at the moment) from which to recruit.

While at LIRS fellows are supported to be highly productive. The geographical isolation enables immersion, longitudinal data is available, there are excellent facilities (such as laboratories, boats and the continuous flow aquarium) and the knowledgeable oversight by the co-directors enables rapid problem solving ensuring that time in the field is efficiently and effectively used. Research goals are reached and, in many cases, extended. This is reflected in publication outputs. Since 2006 there have been 1,594 publications related to research at LIRS, of which 261 (16.4%) have been by fellows. Given that fellows' efforts at LIRS makeup only 9% of the total research person days spent on the island, fellow output is considerable.

The Fellowships Program continues to build and maintain a field research capacity within the marine research community. This in turn is building understanding about the complexity of marine ecosystems and of coral reef systems in particular at a critical time when these ecosystems are experiencing a variety of threats. Fellows are contributing to the evidence-base supporting further research and decision making. The evaluation highlighted the original thinking enabled by being on the island and how this is expanding the field of marine research. There were examples of fellows communicating their research to the community in innovative ways to increase awareness of what we stand to lose when this biodiversity is threatened. Fellows are also using other vehicles for knowledge translation such as providing evidence-based advocacy to decision makers about the Great Barrier Reef.

The evaluation has demonstrated that the Program is successfully developing both national and international capacity for marine science research. This provides a clear endorsement of the Program which has been offered by the Lizard Island Reef Research Foundation (LIRRF) for 40 years.

Recommendation

Funding issues

(1) Continue the highly successful Fellowships Program at least at the current level.

(2) Consider the relative number of Doctoral and Postdoctoral Fellowships offered each year. Consideration could be given to providing more Doctoral Fellowships over Postdoctoral Fellowships given the apparent greater demand for Doctoral Fellowships.

(3) Continue to build links with The IPF and other donors with the possibility of either increasing the number of fellowships (including specifically targeted opportunities, see below) or be able to sustain the current number. Consider allowing more flexible fellowship funding arrangements. While the current fellowship duration and level of funding seems to strike a good balance between research resources requirements and facilitating researcher independence, greater flexibility in the grant amount and the way it can be spent might be appropriate. This would potentially allow more overseas applicants the capacity to cover their greater travel costs.

Database of applicants

(4) Explore ways of automating capture of information from applications to build on the database created for this evaluation. (the online application form that is currently used allows download to spreadsheet format).

(5) Capture and retain additional relevant information about applicants, including gender and Aboriginal or Torres Strait Islander background.

Application and Selection processes

(6) For the doctoral fellowships, review selection criterion 4 with a view to reducing any unintended bias.

(7) Strongly encourage applicants to communicate with the LIRS Co-Directors before applying, to discuss the feasibility of their plans, especially if they have no history of engagement with LIRS.

(8) Explore avenues other than those already used to promote the Fellowship Programs into non-mainstream research communication channels.

Communicating outcomes with donors

(9) Consider implementing a standard questionnaire to be completed at the end of all fellowships as an exit evaluation tool.

(10) Investigate the feasibility (cost, level of interest) in developing and maintaining a community of practice from fellowship alumni.

Background

The Australian Museum's Lizard Island Research Station (LIRS) is the most northerly coral reef research station on the Great Barrier Reef. Part of the Australian Museum Research Institute, it is a world leading coral reef research facility, its location enabling ready access to a variety of reef ecosystems. LIRS is supported by the Lizard Island Reef Research Foundation (LIRRF) and its donors. Funds are provided for:

1. the infrastructure to deliver high quality research
2. maintenance of infrastructure
3. the Fellowships Program, for research and its dissemination (see **Appendix A** for more details).

This evaluation reviews the progress and outcomes of the Fellowships offered through the Fellowships Program which has been in operation since 1984. The review is intended to inform the Australian Museum, the LIRS, the LIRRF and its Science Committee, The Ian Potter Foundation (The IPF, a major donor to the Fellowships Program) and other donors of the value of the program and to guide developments to strengthen its delivery.

The Fellowships Program supports early career researchers and it accounts for approximately 9% (640) of the 7000 person/days of the research activity on Lizard Island annually. The distribution of days between fellowship types is:

- Doctoral Fellowships: up to 4 per year, each for approximately 100 days of research
- Postdoctoral Fellowships: up to 4 per year, each for approximately 60 days of research

Another way of looking at the relative activity at LIRS of fellows is by publication volume. An analysis of all publications that have collected primary data from the LIRS shows that since 2006 16.4% of all publications have been by fellows, which includes all LIRRF-supported publications, grants as well as fellowships.

The review was initially conceived in 2019. Unfortunately, the COVID-19 pandemic in 2020 disrupted the initial phases of the review and work was unable to properly begin until late 2022. Funded by The IPF, the protocol for the evaluation was reviewed in December 2022 and submitted for ethics approval in January 2023. Subsequently, Lee Ridoutt of Human Capital Alliance (HCA) was appointed in February 2023 to undertake data collection and analysis, and to provide a final report. A working group was then formed to support the study. The aims of the evaluation were to:

1. describe the outcomes of the LIRS Doctoral and Postdoctoral Fellowships Program, including the contribution to the research field (relative to the objective of the program), the impact on researchers' careers, both in the short and long-term, and, on the organisations where the researchers are employed/enrolled.
2. recommend how the Fellowships Program can be strengthened, including the appropriate length and breadth of fellowships for fostering ongoing career options for fellows, research outputs and building a community of practice.
3. inform data infrastructure that will be required to continue tracking participant progress and research outcomes for ongoing monitoring of outcomes.
4. create a comprehensive view of the contribution of the Fellowships Program since its inception to inform donors of the outcomes.

Method

Working Group

The evaluation review (study) was guided by a Working Group who provided both advice and supported the evaluation. The Working Group met on four occasions throughout 2023. The members of the Working Group were:

Person	Role
Kate Hayward	Chair LIRRF
Charlie Shuetrim AM	Treasurer LIRRF Member of the LIRRF Science Committee
Professor Lynne Madden	Trustee LIRRF Member of the LIRRF Science Committee Lead for the evaluation study
Dr Anne Hoggett AM	Co-Director LIRS
Dr Lyle Vail AM	Co-Director LIRS
A/Professor Meagan Brennan	Member of the evaluation team
Adj A/Professor Lee Ridoutt	Principle Human Capital Alliance

Ethics

Ethics approval was obtained from The University of Notre Dame Australia Human Research Ethics Committee (Reference 2023-101S). This included approval of the study protocol and information/consent documents for interview participants.

Data Collection approach

The study used a mixed methods approach. Three sources of data were used to gather information to support the aims of the review:

- an administrative database containing the applications for Fellowships for the period 2006-2020
- semi-structured interviews with a cross section of Fellowship recipients and selected supervisors of successful doctoral fellows
- a management audit.

The relationship between the data collection methods above and the evaluation aims (that is what research activities satisfy which aims) is described in Figure 1.

Figure 1: Relationship between research activities & evaluation aims

Evaluation aims	Administrat-ive Database	Inter-views	M'ment Audit
Describe the outcomes of the LIRS Doctoral and Postdoctoral Fellowships Program and the impact	X	X	
Recommend how the Fellowship Program can be strengthened		X	X
Inform data infrastructure that will be required to continue tracking participant progress and research outcomes for ongoing monitoring of outcomes	X		X
View of the contribution of the Fellowships Program since its inception	X	X	X

The data collection methods are briefly described in the following sections.

Administrative database

The initial plan was to undertake an online survey of all applicants to the Fellowships Program, successful and unsuccessful. To facilitate the survey a database was created from data extracted from all submitted application forms for doctoral and postdoctoral fellowships for the period from 2006 to 2020 inclusive. Data contained on the application form included name and contact details, university/institution, current (at the time of application) residential location, and in the case of doctoral fellowships, details of the supervisor.

However, there were doubts about the capacity of an online survey to deliver sound data because of expected poor response rates due to the lack of currency of contact information for all past applicants, in particular for those who were unsuccessful. Consequently, the study design was amended, and more time was invested in the development of the database to be used as a target of analysis.

The value of the database was therefore strengthened through adding current (2023) data describing all historical applicants. This was obtained through extensive web searches for all applicants in the database. In most cases this was relatively simple as most applicants had remained in academia and therefore it was easy to find academic profiles (Google Scholar, ResearchGate) or university/institution profiles. In other cases, it proved difficult as some fellowship applicants had since left academia or were unable to be located through social media, although LinkedIn proved to be quite helpful. Additional information that was extracted included recent work area, whether the applicant was still operating within marine science research, position, level of position and links to social media. This was done to create a more dynamic database and to aid data analysis. In some instances, the contact information remained incorrect, and the Station Director Dr Lyle Vail AM sourced a current email contact through his personal networks.

To facilitate analysis, all applicants were allocated a single unique identifier number. The numbers commenced with the oldest applications in the database at LI001. Duplicates were identified once all the data had been inputted and identifier numbers changed so that individual applicants would have only a single identifier. This allowed analysis of individuals who applied on multiple occasions.

Qualitative Interviews

Semi-structured qualitative interviews were conducted by the evaluators. This included ten each for successful doctoral and postdoctoral fellowship recipients, five for supervisors of successful doctoral applicants, and several additional interviews for other stakeholders (see Appendix B for a listing of the fellows and supervisors interviewed). The interviews were guided by separate interview schedules for fellows (Appendix C), supervisors (Appendix D) and other stakeholders (Appendix E). The schedules were pilot tested with four fellows before being used with other interview subjects. Only minor adjustments were required.

Fellows were selected on a stratified random sampling basis from the database (see above) but were chosen evenly from the years between 2006 to 2020. This was with a view to understand how completing a fellowship had affected recipients at different stages of their careers. Most interviews were undertaken through Microsoft Teams, as interview subjects were from many different geographical locations. A small number of interviews were conducted face to face.

The fellows selected for interview were contacted initially through an email request sent by one of the LIRS Directors and Professor Madden, providing a 'Participant Information Sheet' that described the project and seeking the subject's participation in the evaluation. Should they be willing to participate in the evaluation they were asked to respond, and Professor Madden then provided them with a copy of the consent form to consider and return signed if they agreed to proceed. Once this step was completed the fellow was introduced to A/Professor Ridoutt to arrange an interview time.

A total of 30 fellows (12 Doctoral Fellows, 14 Postdoctoral Fellows, and four individuals who had completed both a Doctoral and a Postdoctoral Fellowship) were contacted in this way and of these 27 (90%) were willing to participate in the evaluation[1]. Seven of these fellows (23.3%) were not able to participate in an interview within an acceptable time period or for some other reason it was not possible to confirm an arrangement for an interview. Consequently, twenty Fellows were interviewed (67% of those requested).

Management Audit

Background information was obtained about the strategic research priorities of the Doctoral and Postdoctoral Fellowships Program and operations from as far back as possible. This was obtained through:

- Interviews with the Directors of the LIRS, who are the administrators of the Fellowships Program.
- Interviews with selected members of the LIRRF Trustees
- Observations of the infrastructure and resources for the fellowship program in operation at the LIRS
- Data held by LIRS on research completed at the station by fellows (and others).

Data Analysis

Descriptive statistics were developed (frequency distributions and cross tabulations) on a range of applicant variables such as location of applicant, gender of application, year of application, place of supervisor and applicant institution. Fellowship outcomes were explored by examining differences

[1] One of those emailed could not be contacted and two declined to participate.

between successful and unsuccessful applicants in career paths and progression, areas of research interest and research productivity.

Analysis of qualitative (interview) data used a thematic approach (Braun, V. & Clarke, 2006) with themes being developed a priori (and reflected in the interview schedule) and also deduced from the interview notes text. Themes were identified by interviewers then discussed and refined in consultation with the working group.

Workshop

A workshop was held by the research group and members of the Advisory Group once preliminary data collection / analysis and a draft report created. This facilitated reflection by the research team on the findings from the different sources of data and how to best interpret any inconsistency of findings from different data sources. It also assisted in the development of recommendations.

Results

Description of the Fellowship Applicant Population

Total Applicants and Applications

The total number of applications for Fellowships between 2006 and 2020 inclusive was 420. **Applications** are made online into a pre-set form[2] that captures researcher information and a research proposal. There are no limitations on the number of applications that any researcher can make for a particular type of fellowship until an application is successful. Obtaining a doctoral fellowship does not preclude application for a postdoctoral fellowship. Postdoctoral Fellowships were first offered in 2008.

Almost two thirds of applications were for a Doctoral Fellowship (63%) and the rest (37%) for a Postdoctoral Fellowship. The number of applications each year since 2006 varied from 14 (in 2007) to a high of 38 (in 2016). There were no applications accepted in 2021 due to the COVID pandemic, and some of the successful applicants from 2020 were still conducting their research into 2023. The yearly applications by type of Fellowship (Doctoral or Postdoctoral) are provided in Table 1.

Table 1: Distribution of applications for Fellowships from 2006 to 2020 by type of Fellowship

Year of application	Number of Doctoral Fellowships	Number of Postdoctoral Fellowships
2006	21	0 (not offered)
2007	14	0 (not offered)
2008	7	11
2009	16	19
2010	16	6
2011	20	13
2012	23	12
2013	20	14
2014	23	11
2015	19	15
2016	22	16
2017	18	10
2018	18	11
2019	17	8
2020	9	11
Total	263	157

The total number of **applicants** for this period was 302. As there were 420 **applications**, this indicates that many applicants applied more than once.

[2] https://mc51n15iruy.typeform.com/to/r3Xygofn?typeform-source=australian.museum

Background characteristics of applicants

Country of application

Of the 420 applications for both types of Fellowship, 275, constituting 65.4% of the total applications, came from persons residing in Australia at the time. Note that country of application is not necessarily the applicant's country of birth or nationality. A number of applicants classified as 'Australian' were from other countries but were studying at an Australian university at the time of application. Similarly, some Australian national applicants were identified as being from other countries because at the time of the application they were resident overseas. This seems to be especially the case for the Postdoctoral Fellowship. As shown in Table 2, the proportion of applications from Australia is lower for the Postdoctoral Fellowship than the Doctoral Fellowship.

Table 2: Distribution of applications for Fellowships by country of application and type of Fellowship

Country of application	Number of Doctoral applications	% of Total Doctoral applications	Number of Postdoctoral applications	% of Total Postdoctoral applications
Australia	177	67.3	98	62.4
Canada	1	0.4	3	1.9
Germany	3	1.1	5	3.2
England	10	3.8	5	3.2
Israel	2	0.8	0	0
Italy	0	0	1	0.6
Netherlands	0	0	1	0.6
New Caledonia	0	0	1	0.6
New Zealand	6	2.3	4	2.5
Norway	0	0	2	1.3
Pakistan	0	0	1	0.6
Portugal	6	2.3	2	1.3
Saudi Arabia	1	0.4	0	0
Scotland	4	1.5	0	0
Singapore	1	0.4	1	0.6
Spain	1	0.4	0	0
Sweden	0	0	2	1.3
Switzerland	5	1.9	5	3.2
USA	46	17.5	26	16.6
Total	263	-	157	-

The country of applicants at the time of application for all Fellowships is similar to above, although the proportion of applicants from Australia is slightly lower (62.3%, see Table 3).

Table 3: Distribution of applicants by country of residence at the time of submission

Country at the time of application	Number of applicants	% of total applicants
Australia	200	62.3
USA	60	18.7
UK	15	4.7
Germany	8	2.5
Switzerland	7	2.2
New Zealand	6	1.9
Portugal	5	1.6
Others[3]	20	6.2
Total	321*	100

*Note: A number of applicants identified different countries of residence at the time of their different applications

Gender

The application forms did not ask for the gender of applicants (an element that could be reconsidered) so assumptions about gender were made based on applicant's name. These assumptions were made with as much sensitivity and caution as possible but will necessarily be less accurate than self-reporting.

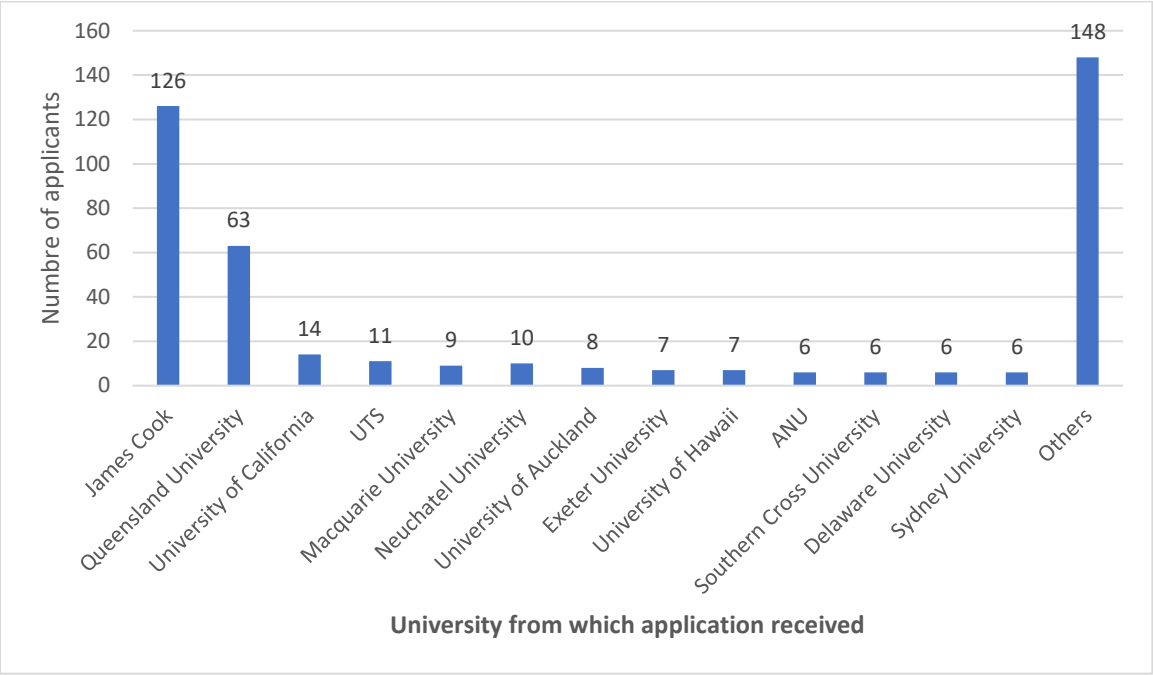
There is a slight overall majority of applications from females for the Fellowships (55.7%). The proportion of overall applicants who are female is similar but slightly higher (57.6%). For the Postdoctoral Fellowship, the proportion of female applicants (53.5%) is greater than that of male applicants.

University/Institution

The most prominent university as a source of applications for Fellowships (both types combined) is **James Cook University (JCU)**, which accounts for 30% of all applications. Following closely is the University of Queensland, constituting 15% of all applications. Other prominent universities (5 or more applications) include University of Technology Sydney (UTS), University of California, Macquarie University, University of Neuchâtel (Switzerland), University of Auckland (NZ), Australian National University (ANU), University of Exeter (UK), University of Delaware (USA), Southern Cross University, University of Hawaii (USA), University of Sydney, Georgia Institute of Technology (USA), Griffith University and the University of Lisbon (Portugal). The number of applications by university are shown in Figure 2. For the sake of brevity, universities with less than 5 applications were aggregated into an "other" category. Note that some applications listed more than one university/institution. In such cases, both universities were included in the count.

[3] Includes Canada, Israel, Italy, Netherlands, New Caledonia, Norway, Pakistan, Saudi Arabia, Scotland, Singapore, Spain and Sweden.

Figure 2: Distribution of applicants for Fellowships by the university / institute from which application made



Overall, a total of 111 separate academic institutions were nominated by applicants as the place from where they were making an application although some of these 111 represent different campuses of the same university. This suggests, along with the widespread number of countries from which applications were received (19), that the Fellowships are widely known at least within the tightly knit coral reef research community.

Overall rate of success of applications / applicants

Of the 420 total **applications** submitted, 89 (21.2%) were successful. Of the total number of 302 **applicants** who submitted at least one application, 78 (25.8%) were successful in achieving a Fellowship.

Eleven of the 78 successful applicants (3.6% of total applicants) obtained a Fellowship twice (Doctoral and Postdoctoral).

A total of 224 applicants (74.2%) were unsuccessful in obtaining any successful Fellowship outcome, even though some (47 or 15.6% of total applicants) submitted multiple applications (41 submitted twice, 5 submitted three times, and one submitted four times). Of the 25.8% who were successful in obtaining a Fellowship, just over half (53.9% or 13.9% of all applicants) were successful with their only application (this included 4 who were successful from single applications for both Doctoral and Postdoctoral Fellowships) and the rest (46.1% or 11.9% of total applicants) required more than one application (see Table 4).

Table 4: Distribution of applicants by outcomes (success or not) of their applications

Outcome for applicants	Number	% of total applicants
No success after one application	177	58.6%
No success after > one application	47	15.6%
Success after one application	42	13.9%
Success after > one application	36	11.9%

A higher proportion of postdoctoral fellowship applications are successful than doctoral fellowship applications (Table 5). This might have been anticipated as Postdoctoral applicants would be more experienced with application submission and possibly more familiar with the LIRS resources and how they could be employed for their research. Also, there are fewer applicants at the postdoctoral level and just as many scholarships offered in any year so the chance for success is higher.

Table 5: Distribution of applications by outcome and by type of Fellowship

Type of Fellowship	Successful applications	Unsuccessful applications	% of Fellowship applications successful
Applications for Doctoral Fellowship	44	219	17%
Applications for Postdoctoral Fellowship	45	112	29%

Findings

Overview

Analysis of the three data sources provided findings about the Fellowship Program in 8 main areas or 'themes'. Themes relate to characteristics of the program operations or outcomes and / or attributes of the LIRS where the fellowship activities are undertaken. An overview of these 8 themes is provided in Table 6 as well as the main sources for information for each.

Table 6: Overview of the themes identified within the evaluation findings

Theme	Source of findings	
	Qualitative data	*Quantitative (Database) data*
Management of the LIRS … management / administration … accessible and diverse reef environments … adequate lab resources for context … high quality researcher support with knowledge, resources and on-site problem-solving capacity.	☑	
Exposure to a collegiate environment … LIRS collegiate experience for early career scientists … benefits of the community of practice works … inclusive environment blind to status … source of life-long collaborations	☑	
LIRS Fellowships and field research capacity … decreasing amount of field research being undertaken … Fellows imbued at LIRS in real world observation … Fellows a source of increasingly scarce skills.	☑	
Fellowship enhances career prospects … A fellowship experience consolidates thinking on career direction … prestigious award in the reef research world … demonstrates able to get and use funding … body of research published.	☑	☑
Fellowship enhances personal growth … early career researchers develop critical professional skills at LIRS … remoteness fosters independence, managing a project / funds, managing 'staff' … all done with less close supervision.	☑	

Theme	Source of findings	
	Qualitative data	*Quantitative (Database) data*
Factors impacting on application success … Prior experience at LIRS or significant supervisor experience critical ... range of other factors seemingly important	☑	☑
Future in coral reef research not guaranteed … a majority of fellows stay in reef research but not much different to unsuccessful candidates … family reasons often identified as part of career diversion (travel, remuneration) … there is nevertheless enduring value.	☑	☑
Limited population to which Fellowship is promoted … comparatively small circle of prospective applicants to which Fellowship advertised … Selection criteria aim to ensure best use of LIRS facilities & resources … is there a desire to increase diversity (e.g. Western Pacific, Asia, Central America, Africa)?	☑	☑

In the subsequent sections of the report each of the above themes is discussed in detail.

Lizard Island Research Station

It was reported by a vast majority of interviewees that Lizard Island is arguably the best research station in the world for undertaking coral reef research. Some of the interviewee comments:

> *"It's the best that I've ever been to." – Postdoctoral Fellow*
>
> *"There was no better place to conduct field research than Lizard Island". – Doctoral Fellow*
>
> *"Lizard Island is a great place. I'll look back on it as the best place I ever worked." – Doctoral Fellow*
>
> *"I think it's the best station in the world… If I had a choice of working anywhere it would be Lizard." – Doctoral Fellow*

Most, if not all, of the interview subjects had been to multiple research stations in Australia and around the world and so were well placed to make an appropriate comparison and judgement. As one particularly well-placed interviewee remarked:

> *"I have toured a number of different research stations around the world, I think about 32, and Lizard is by far the best station I've ever worked on. This is why I keep going back there, and it still shines as the most professional and relevant. It's been consistently good for a long time."* – Supervisor

The research station's standing amongst researchers is not only the result of its natural assets which include access to both inshore and outer reef habitats; being a large island thus providing a sheltered

side in almost all wind conditions, and a wide variety of reef habitats within the easily-accessed Lizard Island Group. The island situated on the northern part of the Great Barrier Reef is, according to those best able to assess, comparatively difficult to get to and research projects require significant planning because 'forgotten' requirements can be difficult to overcome in the short term. In the following sections the factors that appear to make LIRS such a great research destination despite the difficulty in travelling to the Island are detailed.

Station management and administration

The most prevalent factor mentioned by researchers is the exceptional management of the station. The management at LIRS has been in the hands of two co-directors for 33 years, two people who are unwavering in their support of the researchers. For many research stations the positions of director (responsible for research oversight) and manager (responsible for the day-to-day smooth and safe operation of the research facility) are held by separate individuals with different skill sets, however for LIRS these roles are combined and shared by the two co-directors. It was noted by those who had insight into the history of the research station that the two co-directors were brilliant scientists in their own right and therefore, understood the importance of the collective contribution of the work undertaken at LIRS. As one such interviewer stated:

> *"Anne and Lyle are brilliant people, who sacrificed potentially brilliant careers for the sake of building other's."* – Supervisor

Many interviewers noted the capacity of the management team to balance providing ongoing support to researchers with sensitive administration:

> *"Compared to other research stations LIRS is very open and free in regard to how you manage your research time. Much less administration than other research stations ... but still extremely supportive ..."* – Doctoral Fellow

This does not mean that researchers are not supported to use their time optimally – on the contrary, management provides an environment where distractions from the task of conducting the research are reduced ("*… if you worked anywhere else you'd collect half the amount of data, because you'd be dealing with other issues*" – Doctoral Fellow) and delays to research effort from unexpected problems are minimised. Numerous interviewees identified problems they encountered ranging from the immediate (e.g., a strong wind preventing deployment of instruments) to longer term problems of finding specimens or overcoming a resource deficiency that LIRS co-directors were able to provide solutions for. For example:

> *"Fellows get to benefit from the … undeniable wisdom of the managers which has been built up over many years. [They are] … able to trouble shoot a myriad of technical and equipment issues and find a solution that makes fellows' studies invariably more productive. This LIRS capability is providing "freedom" to the fellows."* – Other stakeholder

Mentoring and on-site supervision

Many young researchers, in particular, noted not just the practical trouble-shooting type support from the directors but also the research support. This included sound advice and feedback when things started to go wrong with more fundamental issues such as the research question or the method approach. One doctoral fellow noted:

> *"[Management support is] …. Thorough without being over the top. Feedback is very reasonable, and you receive it when you need it."*

Another doctoral fellow noted:

> *" … that every time you fail there is feedback, and this was really important to correcting mistakes."*

Station resources

Over the years LIRS has built up high-quality laboratories and associated resources (including a highly valued library resource), which aids the researchers and provides the ability to enhance a project to greater levels. There is an acceptance that the resources at LIRS are not as comprehensive as some other stations but that they are highly appropriate for the type of research that is most suited to Lizard Island. As well, the available resources are extensive enough to accommodate changes (forced or unforced) in research direction:

> *"Best place to be a student. Lizard island is somewhere where you have the opportunity to make changes in what or how you're doing things, because the resources are all there."* – Doctoral Fellow

The administration of the facility resources allows for egalitarian access and flexibility. One supervisor felt it was critical that the co-directors management ensured that fellowship holders always get priority access to station resources. Another supervisor emphasised the flexibility noting:

> *"You get great access to environment and facilities. Everyone is helpful. You are able to store equipment and therefore to create research over many years … this is really important to be able to collect data long term."*

A little appreciated resource at LIRS is the historical data that people can draw upon for their projects. Another perhaps little mentioned but highly appreciated resource is the continuous flow aquarium that draws aquarium water from the surrounding environment. This means that animals can be returned to the sea when the experiments are completed. This supports the values of the researchers who are interested in protecting these animals and the environment.

Cost of research

Several interview subjects, especially the fellows, noted the cost structure for access to resources at LIRS. The cost of resources at LIRS are similar to comparative research facilities in the Great Barrier Reef, but they are considered to be more predictable:

> *"… the flat fee at LIRS is really important, especially compared to [another research station], where every little thing is tallied up and charged to you."* – Doctoral Fellow

The stability and knowledge of costs 'up front' was considered imperative on the small, fixed budgets available to Fellows and other young researchers, and allows much safer and reliable planning for the logistics of research. As will be discussed in a later section this is often an un-noticed positive outcome from the fellowships.

Reef access

While it was noted that Lizard Island is somewhat remote and time-consuming and somewhat costly to access, once there, access to field research environments was almost unparalleled. This is facilitated by two factors.

First, there are multiple, varied reef environments within easy reach of the shore with many sheltered areas to go to which are perfect for field research, regardless of the conditions. Second, the

LIRS has invested in, and maintained, a plentiful number of boats for researchers to access and use. Nearly all persons interviewed remarked on the availability of boats and compared this situation favourably with other research stations.

Collegiate Environment

Lizard Island fosters a collegiate environment and a friendly atmosphere in which researchers feel at home and able to bounce ideas off of one another.

Some of the interviewee comments are:

> *"You learn so much about different places and establish new connections and widen your network. It trains you how to communicate your science." - Doctoral and Postdoctoral Fellow*
>
> *"I met people from everywhere, absolutely everywhere". – Postdoctoral Fellow*
>
> *"There is almost limitless potential for collaboration, discussion, brainstorming sessions." – Supervisor and Postdoctoral Fellow*
>
> *"I went into academia wanting to experience collegiate practice that I had heard much about. It was not till I went to do my fellowship at Lizard Island, years after becoming an academic, that I first experienced true collegiate behaviour." – Postdoctoral Fellow*

In the following sections, some of the factors that facilitate and sustain the collegiate environment and some of the benefits of this environment are explored.

Supporting an inclusive, collegial culture

Researchers, young and old, early and late career, go to LIRS with a very specific project in mind and mostly with a strong focus on achieving clear outcomes in the shortest time possible. This is not necessarily conducive to interaction between researchers, especially when it is considered that the research efforts often have seemingly little in common in terms of content and methods. However, at the LIRS this is not the case, researchers are mutually supportive creating a rich, collegial environment.

Communication is fostered through:

- the accommodation (there is enough to allow considerable numbers of researchers, 20-30, on site at any one time and the accommodation is configured to 'force' some level of interaction in the eating of meals and other daily functions
- the proximity of researchers in the use of resources (especially the laboratory facilities)
- the social engagements.

Many interviewees remarked particularly on the seemingly simple but very important social structures that facilitated connection with their peers. A sample of commentary on these arrangements:

> *"There are also very nice networking opportunities, such as BBQs and sunset beers which really allow you to get to know the people you're around. These social occasions allow you to bounce ideas around with other researchers."* – Doctoral fellow
>
> *"They (LIRS management) make a point to enhance and facilitate networking and relationships. The BBQs, seminars and presentations are great."* – Postdoctoral fellow

> *"The best aspects are the sunset beers and Saturday BBQs, these informal social gatherings allow you to make connections and therefore facilitate collaborations. They are a chance for everyone to chat informally and build relationships."* – Postdoctoral fellow

The regular BBQ, each Saturday, has been a social arrangement at LIRS since the 1970s. The 'sunset beers' on the beach seem to be a more spontaneous arrangement, but no doubt facilitated by the broader culture established at the research station.

Egalitarian principles

Another characteristic of the "inclusive" culture of the research station appears to be the easy mixing of researchers not just across project team boundaries but also levels of researchers. Accordingly, early career researchers are able to comfortably mix and converse with very senior principal investigators at the highest levels of academic achievement. As one doctoral fellow noted:

> *"When people are on the island doing field work … this is a great equaliser with people of different levels of academic appointment all working together and sharing experiences. Encouraging the social aspect of research is another important contribution of time on the island."*

This level of mixing across researcher levels, that might not happen ordinarily except with immediate supervisors, is a 'hidden' learning experience for the early career researchers. Another doctoral fellow commented:

> *"The environment at Lizard Island is priceless, you're able to converse in very relaxed manner … the community at Lizard Island, it is emotional, like a family, you can forge lasting bonds. When you're a student it is a big impression. It is more like human-to-human interaction".*

A supervisor noted the benefits of this type of interaction:

> *"At LIRS, you can see accomplished Pis [principal investigators] brainstorming and working out the best ways to conduct an experiment, or the best way to answer a question. You can see how others approach grant writing, which as a PhD student you don't have many opportunities to learn about, and this helps you to learn."*

Outcomes from the collegiate environment

One immediate benefit from the heightened level of collegiate behaviour is that better scientific research is undertaken than if researchers were more isolated into separate research individuals or small teams. One postdoctoral fellow noted:

> *"At LIRS, you can brainstorm with others and come up with original questions that on your own you could never have dreamed of answering because you were never together at the same place at the same time. LIRS is a "hotspot" for good scientists and if you're a student spending a period of time there, what you will get is so much knowledge and wisdom from all the people you're around."*

Another fellow also commented on the learning outcomes:

> *"You can make significant progress in writing papers by collaborating with other more experienced authors. The sheer exposure to people critiquing your writing helps you to advance your writing capabilities."*

Case study: Shelby Temple, Postdoctoral Fellow

Shelby had travelled to Lizard Island when there was a group of researchers doing a similar type of research especially on Cephalopods. Shelby remarked that everyone would be there, living and breathing the research together.

"You can't get a better environment for cultivating ideas than that."

In fact, the initial technology in the device Shelby would later develop came about from a conversation at LIRS during his Fellowship. There was another group from the USA, and Shelby was trying to determine how to make a solid-state polarisation filter that would change the percentage of light that would be polarised but couldn't quite work out an efficient way. Someone from the group suggested using glue. The glue worked, and this was critical for the development of the instrument and obtaining effective data.

The thinking behind the instrument development was progressed when Shelby returned to Bristol:

"*Since then we have taken this crazy idea, generated from my research into cuttlefish and octopus vision, and translated it into a CE marked, Class 1 medical device (the MP-eye) that has been sold to optometrists and ophthalmologists in countries around the world*."

The MP-eye tool assesses macular pigment density. Low macular pigment as a strong risk factor for age-related macular degeneration, the leading cause of incurable blindness in the western world.

The environment at Lizard Island was in practice more like how Shelby imagined University to be. Lots of ideas being bounced around, people living and breathing their research, asking questions about why rather than how.

"*Lizard Island gives you the space and time to ponder and philosophise*."

On a longer-term basis, a majority of the persons interviewed identified lasting research collaborations as an important outcome from undertaking a fellowship at LIRS. One postdoctoral fellow noted:

> *"You learn so much about different places and establish new connections and widen your network. It trains you how to communicate your science."*

A supervisor echoed these collaboration benefits for fellows and noted that these 'community of practice' benefits were more likely to be achieved from time at LIRS than at the normal networking structures:

> *"Conferences are great for talking to and meeting people, but there are limitations in what you can talk about and how much time you can spend with other people. I went to LIRS every year for ten years and met someone of significance every time. There is almost limitless potential for collaboration, discussion, brainstorming sessions."*

Many interviewees noted that they had kept in touch with people they had met at Lizard Island and had maintained collaborations that they forged there throughout the years.

How to leverage the magic?

Discussion was undertaken with all interview subjects who had raised the community of practice issue (nearly all) to canvass ways that the bonds forged between alumni with LIRS experience could be used to leverage even greater outcomes in collaboration and scientific learnings. Most interview subjects thought the informal nature of the interactions was critical and difficult to replicate outside of the island. One supervisor comment typifies the general opinion:

> *"I think that this informal approach is the way to go for collaboration. People strike up conversations and will click, this is necessary to forming lasting collaborations."*

Some other interviewees mused on the idea of more structured ways of retaining and gaining from the unique bond between LIRS researcher alumni, for instance by maintaining a database and remaining in regular contact (for instance through newsletters), but wondered if the outcomes from such actions would justify the expense.

Field Research Capacity

LIRS provides an important capacity for field research to be undertaken in an academic world which is perceived to be providing diminishing opportunities. Some interviewee comments:

> *"You can do stuff so much quicker there than anywhere else."* – Doctoral Fellow

> *"It cemented my love of field work. There's nothing like being in the field."* – Doctoral Fellow

> *"The fellowships gave me more confidence in myself, and in my research… (they) provide you with all the tools so you have no excuse not to research."* – Postdoctoral Fellow

> *"You see so many things you wouldn't see if you were stuck behind your desk."* – Doctoral Fellow

The research station (and by implication the fellowships) firstly foster field research by their very nature as described by one doctoral fellow:

> *"… the necessity of spending time in the field, which is one of the caveats of the fellowship, definitely influenced some planning of field trips. It also opens up opportunities to spend more time doing longer experiments. I was influenced by having money to spend. It increases ambition for projects."*

Not only does the fellowship facilitate longer time in the field collecting data, but LIRS makes sure that the time spent collecting the data is both productive and a powerful learning experience.

> *"Lizard Island is the best place for field research. Having your own little lab, the resources at hand, access to the reef every day, it's really precious. I don't know any other place with the ease of access that Lizard Island has."* – Doctoral fellow

Extended time collecting data has implications for fellows' research / research paper output. Most fellows, but especially doctoral fellows, commented on the significantly increased output of research they were able to publish as a result of their extended period of data collection on Lizard Island.

> *It [the fellowship] allowed me to spend more time at LIRS, and allowed for more field experience, as I was able to go on 2 trips per year, which wouldn't have been possible without the fellowship. At Lizard Island I collected so much data that I am still using some of it today."* – Doctoral fellow

> *" … the fellowship allowed for more data collection, essentially allowing for two further chapters in the PhD which would have been otherwise impossible."* – Doctoral fellow

Several of the supervisors, especially those with a long history in coral reef research and also research at the LIRS, noted the significant changes in research approach that were occurring across the world since the fellowships had been initiated in science generally. Largely this change was characterised by a shift from field research to laboratory research or desk-based research mining data from past field research efforts. Funding was seen as a cause of this phenomenon since desk or laboratory research is less costly than field research. Diminishing skills (and motivation) to undertake field research is also perceived to be an issue along with increasing restrictions, especially because of safety regulations, and more paperwork.

One supervisor lamented this evolving situation with an impassioned opinion on the value of the fellowships and the type of researchers they produce:

> *"It has been important for my lab. It gives them [fellows] a chance to get the research, get the data and do the work. But the most important thing is what it's done to the people. It has transformed the kind of researchers I have. It's the independence and freedom from constraints of thought. And that's the thing that is strangling science at the moment. People telling you what to think and what to ask. And what Lizard Island does is give people freedom to ask their own questions, if it wasn't for this kind of thing, people wouldn't have realised the reef was bleaching. We only knew that the Great Barrier Reef was bleaching because one person went out and got the data …If it wasn't for Lizard Island and that opportunity and that one guy with the courage to go out and get the data it would have been covered up. …. That's the value of it [the fellowship]. It's not just in the money, or the data, it's in the minds and hearts of the people that are able to go out and see for themselves and understand what's going on. You can read a paper, you can see all the science and the data that comes back but actually being in the water and watching the coral bleach before your eyes, or regenerate is a whole different story."*

Many fellows echoed in their own way this sentiment about the importance of the fellowships for developing field work capability:

> *"LIRS has been very important to my career as it took me from desk study to field work." – Postdoctoral fellow*

One postdoctoral fellow remarked on the way studying animals in the wild is very different to studying them in a lab-controlled environment:

> *"… inevitably you learn much more from going and seeing your studied animals in the wild, and seeing them interact with other animals, so I think the fact that I was in the field collecting my own animals, doing my research in the field, it generates a lot of ideas about what sorts of interactions could be studied. I think that folks who buy animals and study them in a lab lack that experience. There's sort of a context that's missing."*

Some of the supervisors wanted to emphasise the wider significance of the LIRS Fellowships in the environment of decreasing grants for field work. One supervisor noted:

> *"The LIRS fellowship is a really important effort to address some of the key limitations to the development of early career scientists … There has been a reduction in the amount of capable field ecologists … and you aren't going to get any breakthroughs in coral reef science unless people understand the system."*

Another stakeholder noted in a similar vein:

> *"… [the fellowships] provide a place to ask blue sky questions. Universities are becoming less willing to fund field intensive study, which is an unfortunate trend that the fellowships can help to negate."*

This stakeholder feels strongly that the reef at Lizard Island is "the lab in a way", and pointed out that it takes a lot of experience to learn to work in the field. Therefore, the importance of the fellowships lies in its capacity for fellows to get out into the field and see things for themselves, and this fosters an environment in which one can really dig into their research and think outside of the box.

Case study: Time in the Field, Sterling Tebbett

For Sterling Tebbett, the Fellowship provided him extended time in the field. This in turn allowed him to develop mature insights into the way coral reef systems work, which in turn created new research questions. Sterling felt that the Fellowship allowed him to break free from the constraints imposed by only working at the university.

"You see so many things you wouldn't see if you were stuck behind your desk."

Sterling noted that there has been a narrative around coral reefs that when you lose corals the reef can become dominated by fleshy macroalgae. After the bleaching event at LIRS, it was expected that this could happen to the coral reefs, but Sterling observed that they weren't doing this around Lizard Island. Rather, in some cases the reefs became dominated by turfs, while in other cases, the coral was restoring itself. This begged the question of whether this was happening to other coral reefs around the world as well.

And so, during the COVID 19 enforced lockdown, Sterling collected as much data as he could from the internet and published studies to examine this. What he found was that the trajectory of coral cover turning to fleshy macroalgae generally only happened in the Caribbean and broader Western Atlantic, and did not happen as much in the Indian and Pacific regions.

"This was a good example of where research in the field allows you to question the prevailing paradigm through your own observations."

The same stakeholder noted that the fellows contribute to the LIRS's "huge body of work" in the broader coral reef research with the number of papers that come out of that one small facility being quite outstanding. An analysis of all publications that have collected primary data from the LIRS (a database which several fellows noted was almost unique to LIRS) shows since 2006 there has been 1,594 relevant publications, of which 261 (16.4%) have been by fellows. Fellows may have contributed to many of the other publications as part of another funded project. It is worth noting that Professor Merlin Crossley, when he was Dean of Science at UNSW, visited LIRS and commented that the research output was equivalent to that of a medium sized university school.

Career Prospects

Perceived benefits

None of the successful fellowship applicants interviewed were in any doubt that the LIRS fellowships had enhanced their career prospects. A sample of interviewee comments are :

"(The Fellowship) … helped sell myself as a researcher in the field. The University was very pleased for getting that international recognition… [Fellowship] is extremely prestigious, not just in Australia but all over the world." – Postdoctoral Fellow

"Obtaining the Fellowship itself was a boost to an early postdoctoral career because (a) it demonstrates that you can bid for and attain funding and (b) it shows that you can do work in a prestigious setting and be selected by a body with a great reputation." – Postdoctoral Fellow

"I think having that on my CV has helped me to get jobs, has potentially helped to get funding, so I think it has been very helpful just in the recognition of Lizard Island Research Station." – Doctoral Fellow

"It would be good, if I applied for a grant, to be able to show that I secured Australian funds." – Postdoctoral Fellow

Fellows interviewed identified three main areas where the fellowship, doctoral or postdoctoral, can help progress career prospects:

- Being able to write an application that can successfully attain a grant is a highly prized skill in academia. The LIRS fellowship is evidence of such capability.

"… the Lizard Island fellowship was a "big tick mark". It proves that you can get money and manage it well and apply for competitive fellowships successfully. This is especially important for a researcher early in their career. It is also quite prestigious and comes with high regard." – Postdoctoral fellow

- Unlike many other grants and scholarships, the LIRS Fellowships are of sufficient size to allow the recipients to operate independently from their academic institution, including to some extent their supervisor. With this independence comes responsibility, for the logistics of setting up the research and getting to Lizard Island, recruiting and managing workers (research assistants and volunteers), managing data collection problems as they arise, and of course managing a quite tight budget. This is another highly valued skill in academia.

"Yes, it [the fellowship] did look impressive on the CV. Yes, it did help form important network connections. Yes, it did build confidence in being part of unique community of practice. Yes, it did help build competence in important areas, especially it helped me to develop project management skills and provided a very clear insight into who you need to build a field research team." – Postdoctoral fellow

- Delivers a number of publications. For early career researchers in some countries this is critical because the opportunities in later study periods (for example honours years) is not possible. Publishing means potentially attending and presenting at conferences which can provide additional means of networking and help "sell oneself as a researcher in the field".

"Just last week the Fellowship covered the costs of travelling to and taking part in an international conference to present work I'd done at Lizard. I was blown away with how many

new collaborations (I've) struck up and by how much value other people saw in my work." - Doctoral fellow

For one postdoctoral fellow the LIRS funding meant he could keep going and get results and publications even though he had missed out on significantly more funding through an ARC grant application. It was helpful in getting a start in the field as it was a sizeable grant and led to a publication, none of which would have happened if he had relied on the other grant.

Objective evidence

Most of the people who receive fellowship funding appear to go on to have solid careers in academic marine science research. This suggests that the fellowship is giving them a good foundation, although, as several supervisors pointed out, they are the cream of the crop, so they would likely have had a successful career even without the fellowship.

The database was interrogated to test the potential effect of being a fellow on career outcome. A job level (according to academic position ratings) was allocated on the basis of a job title interpretation and so would not always have been precise. And of course, where the job was not in academia, then the 'job level' was even harder to establish. Analysis of this data, while providing some support for a positive career outcome from receiving a fellowship, was not conclusive.

Personal Growth

In conjunction with enhancing career prospects, the Fellowships are important in contributing to the personal growth of fellows. Lizard Island is a place where researchers can become better scientists, learning critical skills, and gaining important insights and maturity. Some interviewee comments:

"It's really where I cut my teeth" – Doctoral Fellow

"So much maturity you gain when you don't need to go to your supervisor" – Doctoral Fellow

"You do research on the questions that interest you, not someone else's." – Postdoctoral Fellow

"Fellowship played an immense role in making the person that I am today, shaping the interests that I have, opening up opportunities and pathways that I would not have had otherwise." – Postdoctoral Fellow

For doctoral fellows, and sometimes even for postdoctoral fellows, the fellowship funding represents the first time in their career (maybe their life) where they are being invited to act independently. They are given what must seem like a significant pot of money and general guidance but, and especially because of the remoteness of Lizard Island, a high level of responsibility to use the money wisely and efficiently. As one doctoral fellow observed:

" … it allows students to be independent and conduct research that differs from their supervisors' interests. This provides experience at being independent early on, and that ability to be independent allows a certain maturity to be nurtured for a young researcher. Which is very much a benefit of LIRS."

A postdoctoral fellow pointed out that:

" … the research work one generally does is already established and you merely walk into things and aren't allowed much autonomy … the fellowship afforded me greater autonomy and allowed me to bring my own questions to the table in support of the project. I could build upon

the project and have experience in leadership, and it cultivated ideas and opportunities that I wouldn't have had otherwise."

This is indicative of an important aspect of the Lizard Island fellowship in that it liberates the receiver to do research on their own. As one supervisor framed it:

"It [the fellowship] gives them that level of independence to make their own decisions and to think. It takes away the dependence on other people and lets them take risks. It lets them flap their wings, they can go and do things and it makes a difference to the way that they think about themselves. The value is more in the independence and creativity rather than the money. It's a psychological boost as much as it's a financial boost."

Case study: Ownership of Research, Steph Gardner

Steph Gardner's research investigates how climate change impacts marine ecosystems. Tropical water species are increasingly moving polewards (away from the equator) to escape warmer ocean temperatures that are outside their preferred thermal limits. This mass movement of marine life is a global phenomenon called 'tropicalisation', and leads to multiple consequences for ecosystems and biodiversity.

At the time of her LIRS application, Steph was a Postdoctoral Researcher in a team that was funded by an Australian Research Council (ARC) Discovery Project led by a senior academic, investigating tropicalisation of temperate reefs. Steph's proposal for the LIRS fellowship built upon the ARC project she was employed on by expanding study sites to include a tropical coral reef ecosystem which had been heavily impacted by coral bleaching and cyclones. These environmental impacts had led to increased growth and dominance of turfing algae (the focus for the fellowship), which is expected to become a dominant feature of tropicalised reef systems, as reefs shift from coral/algal dominated to turf dominated as seawater temperatures increase. The proposed Lizard Island project provided a tropical comparison to the southern temperate reefs (in the Solitary Islands and Batemans Bay) to study tropicalisation over a latitudinal gradient along the east coast of Australia to further understand what we expect reefs to look like into the future.

The benefit of the LIRS Fellowship was that it enabled Steph to lead a research project that added value to the existing ARC project. Project goals and deliverables are typically already established on successfully funded projects, meaning there isn't always room to change or incorporate new research ideas within the project constraints (aims, budget etc). However, obtaining additional funds to build upon research outputs provides many benefits to early-career researchers (< 5 years post PhD) by allowing them to develop skills in leading and managing projects and research funding, as well as cultivating ideas and opportunities that otherwise might not have occurred. An additional benefit of the LIRS Fellowship for early career researchers is that evidence for previously successful grants is a requirement for future grant applications to secure research funding.

A number of fellows interviewed echoed this sentiment, claiming that the fellowship, because of the independence factor, made people more confident in their abilities if they came out the other side with a good result and acknowledgement from people who they respected. One postdoctoral fellow's growth is reflected in the following:

"… looking back to then, I was 27 at the time, I remember I was so uncertain about my future and felt intimidated when I first arrived at Lizard Island. Now I feel very proud and that I have grown a lot. I feel I belong in the field."

Another postdoctoral fellow noted:

"The fellowship was the biggest confidence boost. It was also very important for personal development. It's prestigious and is good for your CV. But as a young researcher finding your feet it's so important to feel like you're trusted to do your research and that people believe in you and your project. It demonstrates that you're capable of conducting research at a bigger scale."

One specific additional piece of personal growth noted by a supervisor was that it allows fellows to learn to work underwater, "which is no trivial thing". They observed that you don't learn how to work underwater when you dive, you have to learn it through field work. There is a quantum leap from being able to dive and being able to dive and work. In the supervisor's opinion, this is something that isn't recognised enough, especially in light of increasing cuts to field research by organisations.

Factors impacting on application success

As noted previously, of the total of 420 ***applications*** submitted (between 2006 and 2020), 89 (21.2%) were successful. Of the total number of 302 ***applicants*** who submitted at least one application, 78 (25.8%) were successful in achieving a Fellowship.

A range of factors were explored to identify which were more influential in making one in four applicants successful in gaining a fellowship. Three factors, somewhat inter-related, were found to be important:

- previous experience of LIRS
- a supervisor familiar with LIRS
- being at an institute close to Lizard Island.

Each of these factors is discussed in some detail below.

Previous experience at LIRS

Nearly all of the fellows interviewed had been to Lizard Island before crafting their application for a fellowship, sometimes quite a few times. One doctoral fellow described their pre-application journey thus:

"I worked in the laboratory at JCU [James Cook University] with (well known supervisor). I had already undertaken volunteer work at several research stations including Lizard Island ... had done many trips in fact. As the PhD evolved it became clear that it would benefit from a field work element and because I knew the facilities at LIRS well I knew it had the best."

Another doctoral fellow remembered:

" … that I first travelled to Lizard Island in 2015 during my Honours. I then made subsequent visits as [supervisor's] research assistant, and likely made half a dozen trips before applying for my Fellowship."

A postdoctoral fellow had a very similar experience:

"I volunteered for a PhD student …. In 2013. She had successfully received a Lizard Island fellowship, and so I was able to travel there for a couple of weeks to help with her research. While I was there I met Anne and Lyle and became acquainted with the reef and the facilities and quickly planned to come back for my own research."

One supervisor insisted that candidates must have a high level of pre-existing knowledge to make LIRS visits worthwhile. She noted that it is such a complex system and there is so much to think about. Another supervisor felt that the applications that are most likely to be successful include a good alignment with what is possible at Lizard Island. Some projects require very broad, large-scale surveys, and these don't necessarily have sufficient focus on Lizard Island and the immediate area. The type of research funded through the fellowships is generally for research that builds from the existing research base, but others are 'blue sky' research.

The supervisor influence

Supervisors are primarily connected with Doctoral Fellowship applicants but the interviews of postdoctoral fellows indicates that supervisors can often still be important, either directly (they are the director for instance of a research centre or laboratory where the post doctorate is employed) or indirectly (they have had a strong influence on the research direction). Supervisors are only identified on the doctoral fellowship application.

Bearing this in mind, data for the association of supervisors could only be assessed for the doctoral fellowships. Some supervisors of doctoral fellow applicants seem to be associated with a higher rate of successful applications than others. Of a total of 67 supervisors identified with doctoral fellow applications, 16 (23.9%) supported successful applications from the PhD students they were supervising. Several of these supervisors have had multiple successful applicants over many years.

A key characteristic of the supervisors, based on the data collected from fellow interviews, is that they have extensive knowledge of and experience at LIRS. Most, including several from overseas, have been going to LIRS annually for a decade or more. Thus, in lieu of fellowship applicants gaining their own experience of LIRS (for instance if they are an overseas student), the experience of the supervisor can help to overcome this crucial deficit.

"I was first introduced to Lizard Island during my master's degree in [European city] – my supervisor was a member of a team at [another European university]. The Director there knows about Lizard Island and the fellowships program and has been involved with a number of successful applications." – Postdoctoral fellow

Proximity to Lizard Island

While the state of Queensland makes up the most significant portion of geographic origin of applications (a total of 194 [46.2% of total applications], 123 from Townsville, 66 from Brisbane, 3 from Cairns, 2 from Maroochydore), it is the application locations in closest proximity to Lizard Island (North Queensland including the two campus sites of James Cook University, Townsville and Cairns) that have the most success in number of Fellowships and success rate as shown below:

	Total applications	Successful	Unsuccessful	Success Rate
North Queensland	126	35	91	28%
Other	276	50	226	18%

The success rate between North Queensland and other areas is notably different (28% compared to 18%). Given the importance of previous experience at LIRS, one can expect proximity to LIRS to be a highly correlated factor.

One might argue that this outcome is likely less a question of proximity and more the relative expertise and reputation of James Cook University in the area of coral reef research. As one doctoral fellow put it:

> *" … everyone from JCU knows about the Fellowship."*

As noted previously, applications from several universities make up a significant proportion of total applications (see Figure 2). James Cook University is at the head of this list accounting for 30% of total applications (for both types of Fellowship) followed by the University of Queensland (15%).

In Table 7 the top ten universities / institutes by number of applications are compared by rate of success of applications. James Cook University (main campuses are located in Townsville and Cairns) accounts for over 40% of all successful applications with both the highest number of applications and one of the highest success rates (28.6%, compared with an average success rate of 17% for all applications). Only the University of Neuchatel and ANU have higher success rates but with much lower numbers of applications. Applications from these two institutions are more efficient - i.e. 50% success rates which is extremely good for any research application process.

Table 7: Distribution of applications for Fellowships by university of applicant and by application outcome (success or non-success)

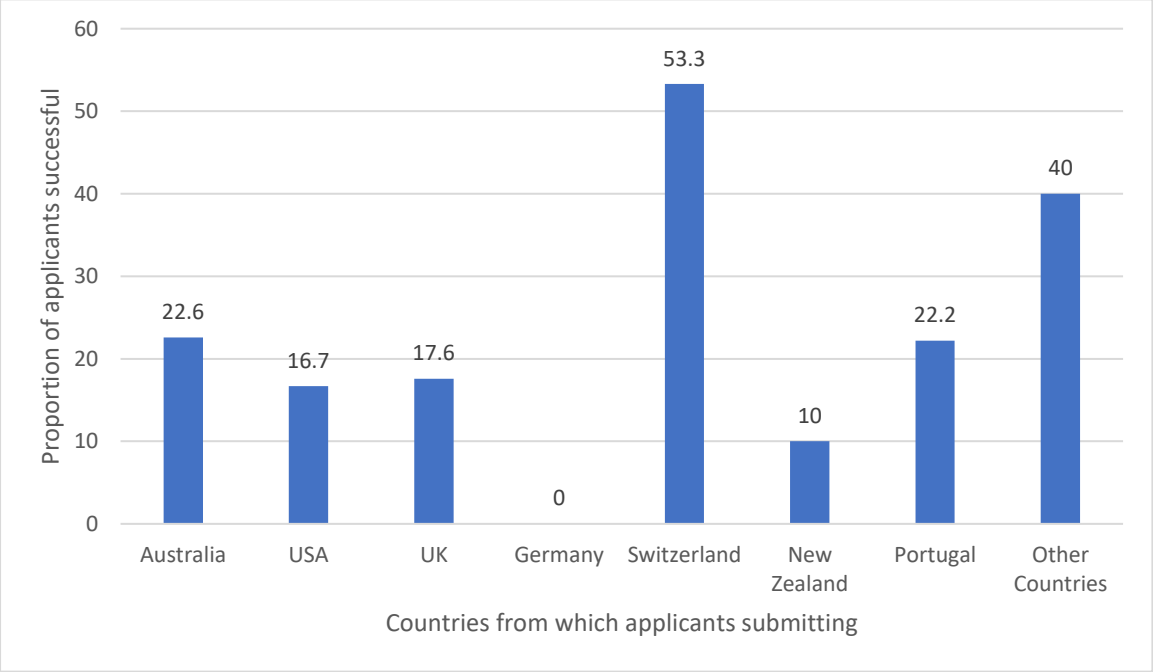
Application Time University/ Institution	Total applications	Successful applications	Success Rate (Successful / Total for University)	% of total successful applications (n = 89)
James Cook University	126	36	28.6	40.4
University of Queensland	63	5	7.9	5.5
University of California	14	3	21.4	3.4
University of Technology	11	3	27.3	3.4
University of Neuchâtel	10	5	50.0	5.6
Macquarie University	9	1	11.1	1.1
University of Exeter	8	1	12.5	1.1
Southern Cross University	6	1	16.7	1.1
Australian National University	6	3	50.5	3.4
University of Sydney	6	1	17%	1.1

Influence of country of application

Applicants from Australia accounted for nearly two thirds of total Fellowships (62.6%). That proportion was a little higher for the Doctoral Fellowships (67.3%) and conversely a little lower for the Postdoctoral Fellowships (58.2%).

The success rate of Australian applicants across all Fellowships, calculated as the number of successful applicants divided by total applicants by country, was 22.6%, higher than most other countries but still lower than the average success rate of 25.8% (see Figure 3). This would suggest a more or less unbiased selection process in terms of country from which application was made.

Figure 3: Proportional distribution (%) of successful applicants by the country from which an application was submitted



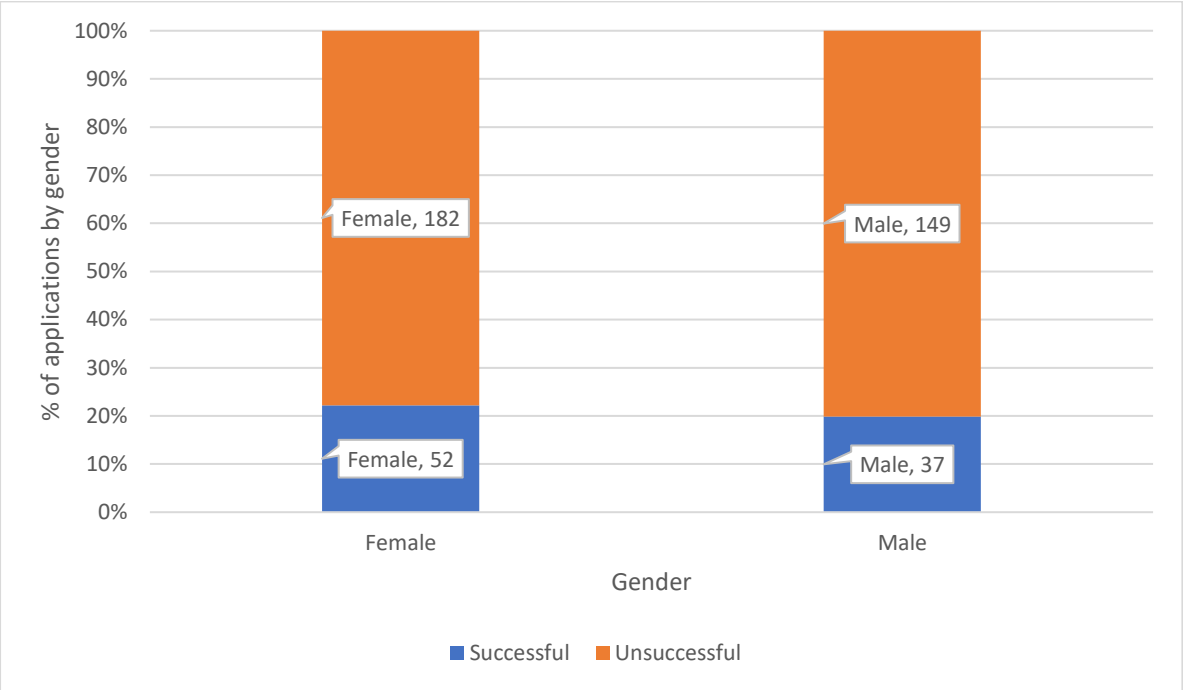
Influence of gender of applicant

There are more applications from females (55.7%) than males for fellowships which is contrary to the proportion of females working in the marine biology area in Australia (40%[4]) although more consistent with other similar countries (e.g., the USA, 52%[5]). Several authors have reflected on a gender imbalance in coral reef research (e.g., Ahmadia, et.al., 2021) and in marine biology more generally (Giakoumi, et.al., 2021), the latter identifying a consistent pattern of relatively balanced representation of men and women in early career stages but women being under-represented in later stages, with women occupying only 13% to 24% of senior positions.

While there are more female applicants than males successfully obtaining a fellowship, a more telling statistic is the relative success of male and female application submissions. This shows slightly more success for female applications (see Figure 4). Female applications are successful 22.2% of the time while male applications are successful 19.9% of the time, suggesting there the success rate between genders is more or less equal.

[4] https://labourmarketinsights.gov.au/occupation-profile/marine-biologists?occupationCode=234516
[5] https://www.zippia.com/marine-scientist-jobs/demographics/

Figure 4: Proportional distribution of applications for Fellowships by gender and by a successful or unsuccessful outcome



There is no discernible trend in applications by gender, with the proportion of female applications over the years 2006 to 2020 varying from as low as 29% (2012) to as high as 76% (2019). Most years the proportion of female applicants is greater than 50%.

Future in Coral Reef Research

The majority of fellows who were interviewed still work in coral reef research. Analysis of the database confirms that 82.1% of fellows are still working in coral reef research. One of the supervisors noted:

> *"All I can say is that when you look at the names on the honours board [at LIRS], there is an extremely high success rate of people who stay on and work in the field."*

The proportion of applicants that were not successful but are still working in coral reef research is also high (75%, see Table 8), suggesting that anyone working in this niche area of research at the PhD level (or later) is generally unlikely to move out of the field. Statistical analysis of the numbers using a 2x2 Contingency Table provides a Chi square of 1.615 (1 degree of freedom) meaning that successfully attaining a Fellowship does not statistically improve the likelihood of working in coral reef research.

Those fellows who have continued in coral reef research, the great majority, cover many different areas of research interest. When fellows do leave coral reef research it seems mostly for family reasons. Coral reef research, especially field research, can be taxing and require long periods away from the family unless they can be taken along.

Table 8: Distribution of applicants for Fellowship by current area of work and outcome of application for Fellowship

Current research activity in coral reef / Marine Science	Number of Successful applicants	Number of Unsuccessful applicants
Not current working in the research field	14 (17.9%)	56 (25.0%)
Yes, currently working in a relevant research field	64 (82.1%)	168 (75.0%)
	78	224

One postdoctoral fellow had been able to take her children to LIRS on several trips, especially for the longer stays. This had been immensely helpful to her personal situation and for which she was very grateful to the LIRS management. She claimed this had prolonged her field research career and hoped that this option could be more widely promoted / provided.

Some fellows had also changed research direction or had shifted into meta research or science communication because they wanted to see more impact being obtained from research in areas like climate change because of the threat that this poses to the Reef. Some Fellows mentioned that their increased understanding of the Reef and the immediate and long-term threats to it enabled them to work through organisations and events such as Science meets Parliament to provide bi-partisan briefings to alert politicians to the situation.

Limited pool of successful applicants

In an earlier section it was noted that applications for the LIRS fellowships originate from a limited number of countries. The top ten countries by applications, for both types of fellowships, is shown in Table 9.

Table 9: Top sources of LIRS Fellowship applications by country of application

Country of application	Total number of Fellowship applications
Australia	275
USA	72
UK	15
New Zealand	10
Switzerland	10
Portugal	8
Germany	8
Canada	4
Scotland	4
Israel	2
Singapore	2
Sweden	2
Norway	2

One of the other stakeholders interviewed was concerned that applicants (including successful fellows) represented a very "limited universe" of people … a known pool that more or less reflects the broader composition of the scientific community. The stakeholder felt that, like in most other areas of endeavour:

> *" … there is value in enhancing the diversity of people accessing and then obtaining fellowships … this could bring new ways of thinking about, and addressing, coral reef issues of concern."*

This view is largely substantiated by the data in Table 9 and supported by research by Ahmadia, et.al. (2021) who in a review of 1,677 articles published over the years 2003–2018 found:

> *"OECD nations … continue to dominate authorship contributions in coral reef science (89%), in research conducted in both OECD (63%) and non-OECD nations (68%)."*

There is a notable absence of applicants from many countries where coral reefs are important features of the economy and on which the diet of local communities are dependent including in many Western Pacific countries, Asia and Africa. However, accommodating such applicants through having different selection criteria was questioned by the vast majority of stakeholders (fellows, supervisors, others) as it could undermine the culture of excellence in research currently supported through the fellowships. Instead, different pathways of engagement were suggested as described below in Possible Options.

A number of fellows interviewed have worked in the Western Pacific countries including Cook Islands, Fiji, French Polynesia, Tahiti and Solomon Islands. They note that often in these countries, local people have very strong ties to, and are very proud of their reefs, but research is limited and is much more adaptive and local. One senior researcher described it thus:

> *"They [Pacific Islanders] have knowledge of their reefs which differs from [ours], it is less academic but much more natural historic. It would be great to encourage more people from developing countries, but it would be difficult to do."*

One postdoctoral fellow opined that it would be ideal to have people from more diverse places working in coral reef research, especially where the research might impact them directly:

> *"It is critical that these people have their voices heard."*

Promotion of the Fellowships

The current marketing of the Fellowships attracts a field of candidates with appropriate qualities.

Those stakeholders with an overview of the Program, including past Fellows and their supervisors, noted that there was potential to widen the promotion of the fellowships. Currently a select few mailing lists are used (e.g., Australian Coral Reef Society, Australian Marine Sciences Association, and the international coral-list run by US-based NOAA) that target the mainstream coral reef research community and flow on from that audience relies on word-of-mouth. It was noted that other possibly appropriate lists (e.g., different Australian Museum databases and mailing lists) could be used. There is also the potential to use social media more where young people increasing get much of their communication.

Selection processes

The selection process is undertaken by a small group of highly qualified research proposal assessors from the Australian Museum (including LIRS) and the LIRRF Science Committee. For some applications, external reviewers with specific expertise may be consulted.

The review and assessment process are informed by a set of objective criteria which are similar for both fellowships. The selection criteria for the doctoral fellowship, taken from the LIRS website, are provided below.

1. The applicant meets the eligibility criteria.
2. The application is of high quality, including spelling, grammar, meets word restrictions, provides information in the required manner, the funding request is consistent with the remaining duration of the PhD, and similar considerations.
3. The applicant has an excellent academic record.
4. The applicant has high research output in relation to career stage.
5. The project makes good use of LIRS facilities, requiring an average of at least 100 person nights (for non-diving projects) or 130 person nights (for diving projects that require a 3-person team) at LIRS per year of funding to conduct field-intensive research, which may include aquarium-based research. Applications for the Joint Fellowship must demonstrate a similarly high level of usage of MERL.
6. Projects for which LIRS is the primary research base will be given preference, except applications for the Joint Fellowship, in which case LIRS and MERL should be the two primary research bases.
7. The applicant has relevant research and field work experience.
8. The significance and innovative approach of the project.
9. The project is feasible within the limitations of capability, time, budget and safety regulations.
10. Fellowship funds will be used efficiently (e.g., travel costs are minimised).
11. There is an actual or potential source of additional funding if the fellowship does not cover all planned costs, or there is a plan for amending the proposal if such additional funding doesn't become available.

Members of the review group interviewed noted that application culling is done independently (based on individual rankings) and is rigorous. There is reported to be a high level of consensus achieved on selections. These interviewees noted that selection criterion (4) can provide a barrier to some applicants (where published research output is generally not part of early career progress, for example in the USA) and an additional source of funding (criterion 11) could provide challenges for applicants from developing countries.

Most persons interviewed, fellows, supervisors and other stakeholders, believe that the selection process is objective and that, with a high degree of success, offers fellowships to appropriate researchers and research projects. Finding a way to maintain the research standards that the Fellowships currently support while diversifying the fellow population is acknowledged as a great challenge.

Possible options for inclusion of applicants from developing countries

Most persons offering suggestions noted the lower academic qualifications of prospective fellowship applicants from developing countries and the low value in bringing someone to LIRS who was not

able to take advantage of the facilities. Several supervisors and others argued that the process of support would need to start earlier. One supervisor noted:

> *"JCU used to have AusAid scholarships [now Australian Award or DFAT], but you have to look after the recipients for several years to give them a chance. They need a lot more training compared to local students. You need to get there early, you need to give them support and it will take years. You also need good supervisors, and these are rare (and getting rarer)."*

Other stakeholders agreed with this idea but said that some countries / institutions could be targeted that might allow some truncation of the very long path that starts with undergraduate training. For instance, the University of South Pacific, because they're a multinational university with a good calibre of academics, some French speaking pacific island countries (although then there might be a language barrier), could be targeted.

Some fellows noted the cost of travel to Lizard Island could be an issue especially from countries far away or where it might be costly to travel. These fellows suggested there could perhaps be an adjusted travel budget, and the foundation could provide more money for travel so that a recipient would not be disadvantaged by 'losing' significant budget to travel.

Discussion

In an earlier section of this report the aims of the evaluation were presented as follows:

1. To describe the outcomes of the LIRS Doctoral and Postdoctoral Fellowships Program, including the contribution to the research field (relative to the objective of the program), the impact on researcher's careers, both in the short and long-term, and, on the organisations where the researchers are employed/enrolled.
2. To create a comprehensive view of the contribution of the Fellowships Program since its inception to inform donors of the outcomes.
3. To recommend how the Fellowships Program can be strengthened, including the appropriate length and breadth of fellowships for fostering ongoing career options for fellows, research outputs and building a community of practice.
4. To inform data infrastructure that will be required to continue tracking participant progress and research outcomes for ongoing monitoring of outcomes.

In the following sections a response to each of these aims is provided.

Outcomes of the Fellowships Program

LIRS is regarded around the world as one of the best, if not the best, place to undertake coral reef research. This is especially so for early career researchers. Much of this status owes to the quality and stability of the research station's management and, the research resources and facilities that the LIRS has developed and maintains with the support of the AM and the LIRRF. This model of research support enables researchers to be both highly productive and creative. There are also unique and valuable attributes of the location of the LIRS and the access to inner and outer reef research sites as well as to highly varied reef environments close to the island.

LIRRF Fellowships to undertake research in this environment are prestigious and are internationally recognised. The competitive nature of the application and selection process, along with the high standards required to obtain a Fellowship, further contribute to the prestige of the Fellowships. While the Fellowship application process favours Australian applicants, because of their, and their supervisors' capacity to gain a more intimate understanding of the LIRS context and research possibilities, there have still been applications from over 18 other countries and successful applicants from 14 different countries.

The contribution of the Fellowships Program

Fellows contribute to the LIRS's "huge body of work" in coral reef research. As noted by a stakeholder the number of published peer-reviewed papers that emerge from LIRS is outstanding. As described in the Background, LIRS maintains a database of all publications that have collected primary data at the station. Several fellows noted that this database was almost unique to LIRS. Since 2006 there has been 1,594 related publications, of which 261 (16.4%) have been by fellows who make up 9% of the person days spent on the island.

Peer-reviewed publication is an established metric of success in academia however fellows are also using other forms of communication to apply their research. The Great Barrier Reef is currently under threat, in particular from the effects of climate change. The Fellows increased understanding of the Reef and these immediate and long-term threats, empowers them to be evidenced based advocates. Working through organisations and events they are communicating these threats in

forums, such as Science meets Parliament to provide bi-partisan briefings to alert politicians to the situation.

Case study: Cone shells and jumping snails, Sue-Ann Watson

Sue-Ann's post-doctoral research was in the area of ocean acidification and how this affects the behaviour of invertebrates.

'*Without going to Lizard Island, I would not have done such an extensive research project which opened a new field of research and has attracted international interest'*.

Invertebrates face dual threats from ocean acidification, it weakens their exoskeleton and secondly it affects their physiology and behaviour. As oceans warm up this is a global issue. Her Post-Doctoral Fellowship allowed her to focus on this topic and to devote an extended period to field research. Consequently, rather than studying a few animals she studied lots of different animals and examined how they are responding.

There was great media interest in her research in cone shell behaviour. Cone shells predate on snails and snails have evolved a behaviour to 'jump' out of harm's way when they detect a cone shell. This research was featured three times by the New York Times with footage available on YouTube[6]

Subsequently Sue-Ann was contacted by a global film crew from the USA who had heard about her cone shell research and in early 2022 they came and filmed her about this. This is currently in production; with an expected audience of 300-400 million viewers across 100 countries demonstrating the potential impact of research done on the island. This was a direct result of her research showing what we stand to lose through both acidification and warming of sea temperatures.

'*Fellowships enable very interesting and impactful research which is possible to complete in a relatively short time at LIRS*'. https://www.nytimes.com/2015/10/12/science/a-snail-that-has-a-jump-on-climate-change.html

The Fellowships Program is enabling the expansion of areas of coral reef research with many fellows noting that that the time and the freedom to concentrate on their research resulted in new areas of research being opened.

Short and long-term impact on researchers' careers

The outcomes for fellows are overwhelmingly positive. Not only does the fellowship facilitate longer time in the field collecting data, but LIRS makes sure that the time spent collecting the data is both productive and a powerful learning experience.

Fellows enjoy significant personal growth through implementing their fellowship research. One specific additional piece of personal growth noted by a supervisor was that it allows fellows to learn practical competence to work underwater. For most it is the first time they have been responsible for managing a research grant, for recruiting and managing research assistants, for arranging travel and

[6] https://www.youtube.com/watch?v=VAE3rN-1i-o

the many logistical requirements of undertaking research at LIRS. They complete their fellowship with not just publications but with practical field research capabilities, a capacity to undertake research work independently, to begin to assume some leadership capacity, and with significantly greater confidence. The extremely egalitarian and collegiate environment at the LIRS also helps them begin to feel an integral part of the body of coral reef research scientists.

Field research exposes fellows to the complexity of environmental systems and conducting robust research to answer questions within this environment. This requires learning the skills to problem solve while in the field to recognise these complexities and address them when they influence the research process or outcomes. There is a recognised need in government for an increased capacity in systems thinking across the sectors as society grapples with issues such as climate change.

Although not able to be statistically proven, there appears fellows have a slightly higher chance of achieving academic career advancement and of continuing to undertake a career in coral reef research or a related field (including more applied research in the climate change area). A fellowship, and particularly the extended periods of time at LIRS, provides Fellows the opportunity to develop greater clarity about their research interests and future directions. In many cases Fellows describe how this time allowed them to extend their current research area. They achieve an enhanced competitiveness for future applications through obtaining and undertaking such a prestigious grant. Also on a longer-term basis, a majority of the Fellows interviewed identified networking and lasting research collaborations as an important outcome from undertaking a fellowship at LIRS.

There are numerous examples of Fellows becoming supervisors and bringing their own students to LIRS thus perpetuating a 'generational' relationship with LIRS. They also encourage these students to apply for Fellowships – are testament to the career outcomes of LIRS and the Fellowship Programs.

Impact on the organisations where the researchers are employed/enrolled

The supervisors described the impact on their organisations where fellows are located when they apply. The prestigious nature of the Fellowships reflects upon the Fellow's home institution and on their supervisor. The personal growth of the fellow is also a contribution to the institution's leadership capacity.

> *"It has been important for my lab. It gives them [fellows] a chance to get the research, get the data and do the work. But the most important thing is what it's done to the people. It has transformed the kind of researchers I have. It's the independence and freedom from constraints of thought."*

A comprehensive view of the contribution of the Fellowships Program

While enhancing the overall research capacity in marine science, the Fellowship Program is particularly recognised by the 'elders' of the coral reef research community for the important contribution made to the on-going development of field research skills and knowledge. Many senior coral reef researchers are concerned about the decreasing amount of field research underpinning published research papers with an increasing proportion of total research effort being undertaken in the laboratory or by analysing existing data. The LIRRF Fellowships remain a bastion for maintenance of field research capability within the broader coral reef research community and thus the continued attainment of the unique understanding of how reefs work. Some research community elders argue

that this perspective is critical to obtaining breakthroughs in coral reef science and to understand the coral reef system.

Another perhaps unrecognised outcome of the Fellowship Program is the gender equity of successful fellowship applications and applicant outcomes. There are more female applications and more female fellows, with general parity between the genders in rate of success. This outcome appears to have been achieved without any specific strategies to encourage it other than a strict selection approach based on merit. Given the impact the fellowships can have on career and personal growth (see above), the fellowships may be playing a small part in addressing some of the broader research population inequities relating to women in marine science identified by Giakoumi, et.al. (2021). The Foundation could therefore consider continuing to monitor the gender distribution of fellows.

Recommendations for the Program

This evaluation has demonstrated the effectiveness of the current model of delivery of the Fellowship Programs. The length and breadth of the fellowships is appropriate for fostering the ongoing career options of fellows.

All fellows and supervisors commented on the value and the extent of the networking opportunities developed through time spent on the island. These networks appeared to have the greatest value at the individual personal level and there were mixed views on the value of establishing and maintaining a more formal community of practice.

Nearly all successful applicants come from high income countries with little representation from many low and middle-income countries that also have prominent coral reef environments. This also reflects that the current composition of the coral reef researcher population is skewed towards OECD country representation (Ahmadia, et.al., 2021). The need to maintain the selection standards for the Fellowships and thus sustain their prestige, works against applicants from developing countries. This is discussed further in Other Considerations below.

Many insights about the outcomes of the fellowships were gained through the analysis of the database of the applications for fellowships. Maintaining this database would allow the ready monitoring of outcomes such as gender parity and facilitate efficient periodic evaluations of the Fellowship Programs. The recommendations below also inform the data infrastructure that will be required to continue tracking participant progress and research outcomes for ongoing monitoring of outcomes.

Specific recommendations, drafted in collaboration with the evaluation study working group, are provided below:

Funding issues

(11) Continue the highly successful Fellowships Program at least at the current level.
(12) Consider the relative number of Doctoral and Postdoctoral Fellowships offered each year. Consideration could be given to providing more Doctoral Fellowships over Postdoctoral Fellowships given the apparent greater demand for Doctoral Fellowships.
(13) Continue to build links with The IPF and other donors with the possibility of either increasing the number of fellowships (including specifically targeted opportunities, see below) or be able to sustain the current number. Consider allowing more flexible funding arrangements. While the current fellowship duration and level of funding seems to strike a

good balance between research resources requirements and facilitating researcher independence, greater flexibility in the grant amount and the way it can be spent might be appropriate. This would potentially allow more overseas applicants the capacity to cover their greater travel costs.

Database of applicants

(14) Explore ways of automating capture of information from applications to build on the database created for this evaluation (the online application form that is currently used allows download to spreadsheet format).
(15) Capture and retain additional relevant information about applicants, including gender and Aboriginal or Torres Strait Islander background.

Application and Selection processes

(16) For the doctoral fellowships, review selection criterion 4 with a view to reducing any unintended bias.
(17) Strongly encourage applicants to communicate with the LIRS Co-Directors before applying, to discuss the feasibility of their plans, especially if they have no history of engagement with LIRS.
(18) Explore avenues other than those already used to promote the Fellowship Programs into non-mainstream research communication channels.

Communicating outcomes with donors

(19) Consider implementing a standard questionnaire to be completed at the end of all fellowships as an exit evaluation tool.
(20) Investigate the feasibility (cost, level of interest) in developing and maintaining a community of practice from fellowship alumni.

Other Considerations

The Fellowships Program currently does a comprehensive job of providing early career development opportunities for Australian based coral reef researchers and for many similar level researchers from other economically advanced countries. The Foundation, and the donors it represents, can continue on this path and continue to have a significant impact on coral reef research capability in Australia and other countries with substantial investment in coral reef research.

However, it is worth raising questions about the breadth of impact that the LIRRF wants to achieve. Is diversity of applicant country of origin desirable? Is it desirable to want to influence research capability in lower income countries where coral reefs are also a major part of their culture and economies? Are fellowships the best the way to support that development? Does the AM and the LIRS have an ethical obligation to include programs to develop Australian Indigenous and Pacific Island Country researchers?

A likely majority of stakeholders (fellows, supervisors, managers) recognised and wanted to wrestle with these questions but not at the risk of even slightly undermining the integrity and prestige of the current Fellowship Program. It became clear that anything the Foundation might attempt in this regard would likely need to be supplemental to the current Program approach.

There was less agreement on just how that could be done.

If thinking was limited to the current Program parameters, very long term 'scholarship' type interventions were primarily suggested that started with supported access to undergraduate level training as a necessary prelude to relevant postgraduate and fellowship possibilities.

Outside of the constraints of the current Program parameters, thinking was focused more on what might be achieved with people at their current level of understanding and capacity for research. Several fellows who have worked in low-income countries and other stakeholders noted that people from these countries have knowledge and an understanding of their reefs which is different, less academic but much more natural and organic. Rather than a research-based fellowship, people from these countries might benefit more from an exchange of perspectives, an assessment of where and what type of research could be done, and development of plans back in their own country.

These might be more like the study tours that are provided through the School for International Training[7] (with which some past fellows are involved) which provide "Experiential Learning for Tomorrow's Leaders". The question would be, should this be picked up by LIRRF or rather seen as a Department of Foreign Affairs and Trade (DFAT) funding responsibility? As well, there is the question of capacity to support such study tours within the already full schedule for LIRS.

Whatever approach is adopted for Pacific Island Countries (PIC) would be potentially appropriate for Australian First Nations people, with whom LIRS has already begun to develop some expertise.

These are all considerations that LIRRF can approach after determining the vectors of the direction the Foundation wants to travel.

[7] https://www.sit.edu/

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Photograph of Professor Redouan Bshary at work in the continuous flow aquarium at Lizard Island Research Station in 2023, provided by Redouan Bshary - Professor in Behavioural Ecology, University of Neuchâtel, Switzerland.

Appendix A: Fellowships Program Description

Current Fellowships Program

The Fellowships Program currently offers:

1. Doctoral Fellowships
2. Postdoctoral Fellowships.

Doctoral Fellowships Program

The Doctoral Fellowships Program has operated continuously since 1984. It supports field-based research at LIRS by excellent PhD students, many of whom have gone on to be leaders in their field. Since inception to 2023, 78 doctoral fellowships have been awarded.

Doctoral fellowships are offered every year (except 2021 due to COVID-19) and may run for one, two or (rarely) three years. Funding can cover field research expenses at LIRS, travel, minor equipment and some other incidentals but not salaries. The maximum value of each year of a fellowship in 2023 (ex GST) is $13,000 (for projects that require scuba diving) or $11,000 (for those that don't), with up to an additional $4,000, which may be awarded for travel in the second or third year of a fellowship, to present at an international conference. Additional funds of $1000 each year may be provided for international recipients to contribute to travel costs.

There were four named fellowships in the 2023 Doctoral Fellowships Program (a fifth is offered for 2024):

1. **The Lizard Island Doctoral Fellowship** which is funded by LIRRF and its donors. These fellowships have been awarded since 1984.

2. **The Ian Potter Doctoral Fellowship**, funded by The Ian Potter Foundation. These fellowships have been awarded annually since 2006.

3. The **Raymond E. Purves Foundation Doctoral Fellowship,** funded by the eponymous foundation. This fellowship was offered in 2019 for the first time. This fellowship is directed to research related to climate change or effects of plastics pollution on reefs.

4. The **Gough Family Doctoral Fellowship,** funded by the Gough family based in Victoria. This fellowship was offered for the first time in 2020.

Apart from the new Purves Doctoral Fellowship, the area of research focus for the Doctoral Fellowship Program is deliberately broad.

Selection for Doctoral Fellowships

Doctoral Fellowships are awarded annually by the Australian Museum following a competitive two-stage application process. An applicant, who must be enrolled in a PhD program to undertake field-based coral reef research and have a stipend that covers their living costs for the duration of the fellowship, prepares a preliminary application for assessment. These applications are assessed by the

Selection Committee and highly ranked applicants are invited to submit a full application. Full applications are also assessed by the Selection Committee, but up to 2020, they were assisted by evaluations from two external experts for each application. Following the COVID-19 hiatus in 2021, full applications are not routinely sent for external review. Now, full applications are only sent for external review if the Selection Committee considers that it does not have the expertise to assess a particular application fairly. The Selection Committee comprises Australian Museum scientists and some members of the LIRRF Science Committee. The Science Committee is a committee of the LIRRF and currently comprises the Directors of the LIRS (Dr Anne Hoggett & Dr Lyle Vail), the Director of AMRI (Prof Kristofer Helgen) and Trustees of the LIRRF Dr Penny Berents as Chair, Prof Lynne Madden and Charlie Shuetrim AM.

Postdoctoral Fellowships Program

The Postdoctoral Fellowships Program has operated since 2008 with 49 awarded since inception to 2023. These fellowships support field-intensive research at LIRS by scientists whose PhD degree was awarded fewer than five years before the application date. These fellowships are intended to stimulate scientific benefits in addition to the research outcomes, through collaboration, research training, and contributing to larger projects. Fellows are expected to make substantial original contributions to science.

Postdoctoral Fellowships in 2023 were valued at $18,000 per annum excluding GST (for projects that require scuba diving), and $15,000 per annum (for those that don't), and they may be awarded for either one or two years. Expenses covered are the same as for Doctoral Fellowships except there is no additional funding to attend an international conference.

In 2023, there were four named fellowships within the Postdoctoral Fellowships Program.

1. **The Isobel Bennett Marine Biology Fellowship** is named in recognition of the late Dr Isobel Bennett who was one of Australia's eminent marine biologists. The Hermon Slade Raiatea Foundation has provided funding to the LIRRF to enable this fellowship. These have been offered in most years since 2008.

2. **The John and Laurine Proud Fellowship is** named in recognition of the late Sir John Proud and his late wife, Lady Laurine Proud. Sir John was the founder of LIRRF and a long-term passionate supporter of the LIRS. Their estate now supports this fellowship through the LIRRF. These fellowships have been offered in most years since 2008.

3. **The LIRRF Fellowship** which is funded by the LIRRF and its donors. These have been offered in most years since 2015.

4. **The Chris Joscelyne Fellowship** is funded by a bequest from former LIRRF Trustee Chris Joscelyne. The first was awarded in 2022 and the second and final award was made in 2023.

Since 2018, applications have been sought in two areas of research that are assessed separately:
1. Projects that develop understanding of the biology, ecology or processes of coral reefs.
2. Taxonomic projects that examine little-known marine or terrestrial faunal groups and utilise and/or contribute to the collections of the Australian Museum.

Selection for Postdoctoral Fellowships

Postdoctoral Fellowships are awarded annually by the Australian Museum following a competitive application process. There are selection criteria that the applicant and their project must meet.

Applicants must have been awarded a PhD within the previous 5 years, be employed by a research institution for the duration of their fellowship and have an excellent academic record. Their project must significantly advance knowledge in one of the two areas described above and be capable of creating scientific leverage. Taxonomic projects are required to utilise the collections of the Australian Museum and/or contribute to those collections. Selection is made by a Selection Committee described under the Doctoral Fellowships Program.

Appendix B: List of fellows and supervisors interviewed

Many thanks go to the interviewees for their participation and insightful contributions to the evaluation. The following fellow and supervisor interviewees have provided their permission to be recognised here.

Robert Streit

Steve Doo

Zegni Triki

Christopher Goatley

Catheline Froehlich

Lauren Nadler

Adam Crane

Sterling Tebbett

Chiara Pisapia

Tyler Cyronak

José Paula

Sue-Ann Watson

Jairo Rivera Posada

Dominique Roche

Vanessa Messmer

Ashley Frisch

Shelby Temple

Joseph Pollock

Stephanie Gardner

Darko Cotoras

David Bellwood

Morgan Pratchett

Redouan Bshary

Steve Simpson

Appendix C: Interview Questions for Fellowship Recipients

Thank you for agreeing to participate in this study.

This research project will investigate the outcomes of the LIRS Doctoral and Postdoctoral Fellowship Programs for Fellowship recipients. The study aims to identify recommendations about how the Fellowships Programs can be strengthened, including the appropriate length and breadth of Fellowships for fostering ongoing career options for fellows, research outputs and building a community of practice.

Name	
Place of employment	
Year of Fellowship	

1. Since completing your LIRS fellowship we believe your employment, research experience and publications is .... Can you confirm our research and fill in some blanks?

   Pre-interview research: interrogate database for interview subject

   Prompt: Explore further education, recent university employment, research experience, publications, current role and position)

2. How did you find out about the Fellowship at Lizard Island?

   Prompt: From your supervisor? Another PhD colleague?

   What influenced you to apply for this Fellowship in particular? What additional value did you hope to gain from it, over and above what undertaking your PhD or postdoctoral studies would have obtained anyway?

3. Did the requirements of the Fellowship influence/shape your research in any way?

4. Can you please tell us a bit about your Fellowship at Lizard Island?

   Pre-interview research: When was the fellowship undertaken? Fellowship studies completed? Number of applications. Any unsuccessful applications?

   Prompt: Did it facilitate the completion of your academic achievement? What was enjoyable / challenging what did you get from the experience that you hadn't anticipated?) If appropriate ... being unsuccessful the first time, did you take anything from this to help with subsequent applications?

5. What was your first big career decision after completing your fellowship at Lizard Island? **Prompt** – after completing the PhD? When seeking next appointment after the postdoctoral research?) Did the Fellowship have an impact on your decision making in that career move? What was your next big career move? Did the fellowship experience influence at all this next career move? If yes, in what way? (… keep going until all career moves up to current time

covered). Overall, how big an impact has the fellowship had on your career and research direction choices?

6. Did attaining and completing the fellowship help you achieve your career / research direction choices?

   Prompt – it looked impressive in the CV? Formed important network connections? Built competence in important areas? Built confidence in being a part of a unique community of practice?

7. Are you aware of any impact/outcomes that your Fellowship had on the organization/s where you are/were employed/enrolled for the period of your Fellowship?

   Prompt –contribution to the research field? Change in research direction? Creation of important contacts?

8. What was useful/helpful with your Fellowship to support the dissemination of your research?

9. We have been able to find some of the research you have undertaken since completing the fellowship. It seems that you are still actively researching coral reef/marine science ... or ... you are not still actively researching coral reef/marine science. Is this correct?

   Prompt – why / why not? How important was the LIRS experience in shaping your research interests?

10. Have you applied for/received a Fellowship at another marine science institution/coral reef station? (If yes, type of Fellowship and research topic)

11. Do you have any thoughts about how the practical aspects of the Fellowships, advertising and delivery of the Fellowships could be improved?

    Prompt - optimal grant period, amount of support, selection process, administration, community of practice, promoting awareness about the Fellowships, timing, reminders, how it fitted in with your other university requirements.

12. Is there anything else that you want to say about the Lizard Island Fellowships Programs?

Thank you for your time. We will advise you when a report from this data collection is published and where you can obtain a copy of the report.

Appendix D: Interview Questions for Supervisors

Thank you for agreeing to participate in this study.

This research project will investigate the outcomes of the LIRS Doctoral and Postdoctoral Fellowship Programs from the perspective of those who have applied for a Fellowship and for the organisations with whom they were employed at the time of their Fellowship. The study aims to develop recommendations about how the Fellowships Programs can be strengthened, including the appropriate length and breadth of Fellowships for fostering ongoing career options for fellows, research outputs and building a community of practice. It also hopes to gain an insight into the contribution of the Fellowship program long-term to coral reef research and marine science in general.

NAME	
ORGANISATION	
POSITION	

1. Firstly, our research indicates that your role and position within your organisation is ..... and your current area of research interest is ..... Is that correct?

   Pre-Interview research: Search database for details on current role and research interests. Make link to fellows supervised.

   Prompt: Can you elaborate on our research in terms of your role?

2. How did you become aware of the facilities offered by the LI Research Station - what is your personal history with Lizard Island? Did it begin before you heard of the Fellowships?

   Prompt: Have you completed research on the island? If so, did this experience influence your subsequent approach to the scholarships? If not, what other ways did you find out?

3. What role do you as a supervisor have in the selection of fellowships / grants / scholarships that students are exposed to or determining the scholarships that a student may apply for?

   Prompt: Are there many scholarship options around for marine researchers to support field work? What is your role at the contemplation phase? How are doctoral/postdoctoral research students most likely to be connected with knowing about the LIRS scholarships? Would you recommend these to all of your marine research students or only some?

4. As a supervisor of student/s who have applied for a Fellowship at Lizard Island we are interested in your views as to what factors influence the application success.

   Pre-Interview: Search database and find all links to any fellow they have supervised

   Prompt: Could the application process, application process promotion, assessment process … be changed / strengthened? Based on your experience are there any ways that the application process could be opened up to a broader range of applicants or is it reaching the appropriate group? Based on your experience, what are the characteristics of an application that mean that it is more likely to be successful? (last probe only of the successful

5. As a supervisor of student/s who has/have received a Fellowship at Lizard Island how has the Fellowship impacted their doctoral/Postdoctoral studies?

   Prompt: What does the field work opportunities on Lizard offer a student and their research? Was the research outcome strengthened in any way? Were they able to complete their studies earlier?

   Do these opportunities differ to those offered by other coral reef research stations on the GBR? Were they able to network with other researchers through the experience/ community of practice? In your experience do the fellowships add anything to a student's development as a researcher/academic? Are you aware of whether the Fellowship had an impact on the student's career opportunities both immediately on completion of the Fellowship and subsequently? Is being a part of the fellowship alumni likely to influence the opportunities that a student may subsequently have? What was the impact on research direction?

6. Did the Fellowship/s have outcomes for your organization during and after the Fellowship?

7. What was useful about the Fellowship to support the dissemination of the research?

8. Do you have any thoughts about how the advertising and delivery of the Fellowships could be optimised?

9. Do you have any overall thoughts about how the LIRS Doctoral and Postdoctoral Fellowship Programs could be improved?
   Prompt – timing of the release, optimal grant period, amount of support, selection process, administration, community of practice, promoting awareness about the Fellowships, reminders

10. Students who receive a Fellowship are required to produce a short final report. One purpose of these is to inform the Trustees of the Foundation about the outcomes of the research that has been supported. With the permission of the Fellow these reports are sometimes also used to communicate with our donors who support the Fellowships through their philanthropy. From your experience do you have any thoughts about how this reporting process might be strengthened e.g. the timing and the nature of the report or the style of the communication?

11. Is there anything else that you want to say about the Lizard Island Fellowships Programs or about their contribution to the capacity building in marine research?

Thank you for your time. We will advise you when a report from this data collection is published and where you can obtain a copy of the report.

Appendix E: Interview Questions for Other Stakeholders

Thank you for agreeing to participate in this study.

This research project will investigate the outcomes of the LIRS Doctoral and Postdoctoral Fellowship Programs. The study aims to develop recommendations about how the Fellowships Programs can be strengthened, including the appropriate length and breadth of Fellowships for fostering ongoing career options for fellows, research outputs and building a community of practice. It also hopes to gain an insight into the contribution of the Fellowship program long-term to coral reef research and marine science in general.

NAME	
ORGANISATION	
POSITION	

1. Based on your experience and understanding of the Fellowship Program, what do you consider to be the main objectives and benefits for marine research and for the Australian Museum Research Institute?
   Probes:
   - For Fellows?
   - For the institution where the Fellow is supported?
   - For the Australian Museum?
   - For coral reef research

2. Do you have any thoughts about how the promotion of the Fellowships could be optimised?
   Probes:
   - Timing of advertising?
   - Where the Fellowship is advertised?
   - The reach of the promotion … especially prospective applicants from non-traditional institutions in high-income countries

3. Based on your experience are there any ways that the selection process could be improved?
   Probes:
   - More fair and transparent?
   - Better able to capture the right type of candidates?

4. Do you have any overall thoughts about how the LIRS Doctoral and Postdoctoral Fellowship Programs could be improved?
   Probes:
   - Optimal grant period
   - Amount of support
   - Administration

- Community of practice

5. Students who receive a Fellowship are required to produce a short final report. One purpose of these is to inform the Trustees of the Foundation about the outcomes of the research that has been supported. With the permission of the Fellow these reports are sometimes also used to communicate with the donors who support the Fellowships through their philanthropy. From your experience **do you have any thoughts about how this reporting process might be strengthened** e.g. the timing and the nature of the report or the style of the communication?

6. Is there anything else that you want to say about the Lizard Island Fellowships Programs or about their contribution to the development of individual marine researchers or other researchers and similarly would you like to comment about how the Fellowships are supporting building the capacity in marine and other forms of research in general?

THANK YOU