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# RAPID: Natural Laboratories in the Chilean Fjords: Studying Reproduction and Development in Emergent Deep-Sea Corals

Rhian G. Waller

*Principal Investigator; University of Maine, Orono, [rhian.waller@maine.edu](mailto:rhian.waller@maine.edu)*

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## Preview of Award 1219554 - Final Project Report

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### Cover

Federal Agency and Organization Element to Which Report is Submitted:	4900
Federal Grant or Other Identifying Number Assigned by Agency:	1219554
Project Title:	RAPID: Natural Laboratories in the Chilean Fjords: Studying Reproduction and Development in Emergent Deep-Sea Corals
PD/PI Name:	Rhian G Waller, Principal Investigator
Recipient Organization:	University of Maine
Project/Grant Period:	02/01/2012 - 01/31/2014
Reporting Period:	02/01/2013 - 01/31/2014
Submitting Official (if other than PD\PI):	Rhian G Waller Principal Investigator
Submission Date:	07/11/2014
Signature of Submitting Official (signature shall be submitted in accordance with agency specific instructions)	Rhian G Waller

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## Accomplishments

### \* What are the major goals of the project?

The northern Patagonian fjords lie on the interface between the high Andes Mountains in the east and the South Pacific Ocean, formed thousands of years ago through erosive glacial activity and tectonic sinking (Borgel, 1970). Around 12,000 years ago the icefields in the Chiloé Interior Sea began to open, leaving behind over 15,000km<sup>2</sup> of fjords, channels and gulfs (Clapperton, 1994). The waters within the fjords are influenced by strong tides, large volumes of freshwater runoff, and upwelling of deep-ocean waters as well as steep climatic gradients from north to south (observed in parameters such as temperature, wind intensity and precipitation; Silva et al., 1997; Leth et al., 2004). This dynamic environment has resulted in an extremely high biodiversity and endemism (Smith-Ramirez, 2004), yet this region is one of the least studied areas of the world. Both oceanographic (Arntz & Rios, 1999; Fernandez et al., 2000; Försterra et al., 2005) and biological data are scarce (Arntz & Rios, 1999; Häussermann & Försterra 2009) and only recently was it discovered that these fjords are one of the few areas in the world where deep-water fauna can survive in shallow-water habitats (Försterra & Häussermann, 2003; Häussermann & Försterra 2007).

The specific goals of this project were -

#### 1. Establish a year-long monitoring site at three populations of *Desmophyllum dianthus* in the Comau fjord in Northern Patagonia

Two populations will be in areas unaffected with runoff, one population will be directly downstream of encroaching salmon farms

These populations will have samples for histological analysis (see Waller et al., 2002 for methods) collected every 3 months, with samples for genetics (see Morrison et al., 2011 for methods) and TEM/SEM analysis (see Pradilla-Gamino et al., 2011 for methods) taken by the PI at the beginning and end of the project

**2. Examine for recruitment at these three populations by placing recruitment panels both within and surrounding populations**

**3. Monitor environmental variables at each site**

Salinity, Temperature and Light monitors will be deployed at each sample site. Every three months data will be downloaded, sensors cleaned and redeployed to give a full year of data at each site.

**4. Record general biodiversity and habitat characteristics of each population**

Each population will be photographed using scales to estimate age of population and number of corals and associated fauna. Benthic habitat will also be classified, as will areas surrounding the main population.

**5. Examine other areas in the fjords to aid in our Chilean collaborators mission of adequately documenting locations of these fragile populations**

For initial and final field seasons, once samples from all sites for the main project have been obtained, remaining dive days will be used to pair with station divers to catalogue areas of coral abundance and enter data onto a GIS database of cold-water corals in South America.

**\* What was accomplished under these goals (you must provide information for at least one of the 4 categories below)?**

Major Activities: - August 2012 - PI and Dive safety Officer (University of Maine) deployed to the Huinay Scientific Field Station.

- Three major sites were identified - Lilihuape, Pt Huinay and Pt Mammuro - loggers deployed and samples collected

- Collaborators at the Huinay Scientific Field Station collected corals from these three sites every three months, ending in September 2013

- September 2013 - PI and collaborator Laura Grange (UK) deployed to Huinay Scientific Field Station - collected final samples, loggers and examined additional areas within the fjords.

- Photographs of each area taken with scaleable quadrat to examine for other fauna in the area.

- Masters level graduate student taken on (Keri Feehan) in January 2014 to work up the reproductive and environmental data for this project.

Specific Objectives: Scientific results will be worked up by masters level student (expected graduation/publication of results - December 2016).

Significant Results: Located heavily damaged areas of cold-water corals and extensive photographs taken - photographs being used in large publication led by Chilean colleagues.

Key outcomes or Other achievements: - Located three large populations of *D. dianthus* to monitor for a year

- Samples taken for genetics (sent to Germany to collaborators for analysis) and reproductive ecology and seasonality
- Located areas within the fjords with heavy damage from over-silting (hypothesized from salmon farms)
- Samples returned to University of Maine (with CITES licenses) and will shortly begin to be worked up by masters level student.

**\* What opportunities for training and professional development has the project provided?**

- Masters level student employed in January 2014, project has aided in increasing diving skills of PI

**\* How have the results been disseminated to communities of interest?**

A BCO-DMO site has been set up for this project - <http://www.bco-dmo.org/project/2215> - data will be entered once Master level student has analyzed data (approximately summer 2015).

- Data to be entered will include - 1) HOBO dataloggers (salinity, temperature, light) for two sites in Comau fjord, and one site in Renihue fjord. One year of data (possibly a second year - yet to be recovered); positional data for sampling efforts, along with number of samples recovered.

Several public outreach pieces have been published in the general media both in Chile and within the US.

- <http://www.latercera.com/noticia/tendencias/2013/11/659-550027-9-corales-de-agua-fria-la-desconocida-selva-bajo-el-mar-patagonico.shtml>

- <https://umainetoday.umaine.edu/archives/winter-2012/8244-2/>

Peer reviewed publications utilizing images or data from this project -

- Häussermann, V., Försterra, G., Melzer, R. R. & Meyer, R. 2013. Gradual changes of benthic biodiversity in Comau Fjord, Chilean Patagonia – lateral observations over a decade of taxonomic research. *Spixiana* 36 (2): 161-171.

## Products

### Books

### Book Chapters

### Conference Papers and Presentations

### Inventions

### Journals

Häussermann, V., Försterra, G., Melzer, R. R. & Meyer, R (2013). Gradual changes of benthic biodiversity in Comau Fjord, Chilean Patagonia – lateral observations over a decade of taxonomic research. *Spixiana*. 36 (2), . Status = PUBLISHED; Acknowledgment of Federal Support = No ; Peer Reviewed = Yes

### Licenses

### Other Products

*Audio or Video Products.*

<http://video.nationalgeographic.com/video/waller-deep-sea-coral>

Video of photographs taken in 2012 expedition

## Other Publications

## Patents

## Technologies or Techniques

## Thesis/Dissertations

## Websites

*National Geographic Newswatch*

<http://newswatch.nationalgeographic.com/author/rwaller/>

Blog kept on National Geographic Newswatch for both 2012 and 2013 expeditions

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## Participants/Organizations

### What individuals have worked on the project?

Name	Most Senior Project Role	Nearest Person Month Worked
Waller, Rhian	PD/PI	6
Grange, Laura	Faculty	1
Rigaud, Christopher	Other Professional	1
Feehan, Keri	Graduate Student (research assistant)	6
Rossin, Ashley	Undergraduate Student	2

### Full details of individuals who have worked on the project:

#### **Rhian G Waller**

**Email:** rhian.waller@maine.edu

**Most Senior Project Role:** PD/PI

**Nearest Person Month Worked:** 6

**Contribution to the Project:** PI of project - completed both expeditions, preserved samples, advising masters student

**Funding Support:** NSF RAPID - this grant

**International Collaboration:** No

**International Travel:** Yes, Chile - 0 years, 1 months, 0 days; Chile - 0 years, 1 months, 0 days

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#### **Laura Grange**

**Email:** laura.grange@nocs.soton.ac.uk

**Most Senior Project Role:** Faculty  
**Nearest Person Month Worked:** 1

**Contribution to the Project:** Diving support during 2013 field season

**Funding Support:** NSF RAPID and National Geographic

**International Collaboration:** No

**International Travel:** Yes, Chile - 0 years, 1 months, 0 days

**Christopher Rigaud**

**Email:** christopher.rigaud@maine.edu

**Most Senior Project Role:** Other Professional

**Nearest Person Month Worked:** 1

**Contribution to the Project:** Diving Safety Officer - completed 2012 field season with PI

**Funding Support:** NSF Rapid - this grant

**International Collaboration:** No

**International Travel:** Yes, Chile - 0 years, 1 months, 0 days

**Keri Feehan**

**Email:** keri.feehan@maine.edu

**Most Senior Project Role:** Graduate Student (research assistant)

**Nearest Person Month Worked:** 6

**Contribution to the Project:** Will be working on histology samples and environmental data

**Funding Support:** UMaine TA and RA fellowships

**International Collaboration:** No

**International Travel:** No

**Ashley Rossin**

**Email:** ashley.rossin@maine.edu

**Most Senior Project Role:** Undergraduate Student

**Nearest Person Month Worked:** 2

**Contribution to the Project:** Aiding in histological preparation

**Funding Support:** UMaine Dearborn Foundation grant

**International Collaboration:** No

**International Travel:** No

#### What other organizations have been involved as partners?

Name	Type of Partner Organization	Location
Huinay Scientific Field Station	Other Nonprofits	Comau Fjord, Chile

Name	Type of Partner Organization	Location
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**Full details of organizations that have been involved as partners:**

**Huinay Scientific Field Station**

**Organization Type:** Other Nonprofits

**Organization Location:** Comau Fjord, Chile

**Partner's Contribution to the Project:**

Financial support

Facilities

Collaborative Research

Personnel Exchanges

**More Detail on Partner and Contribution:** Technicians at the station collected 3 monthly samples; shared all data with Chileans (including photographs of newly explored areas).

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**Have other collaborators or contacts been involved? Yes**

**Impacts**

**What is the impact on the development of the principal discipline(s) of the project?**

Findings from this project will provide invaluable information on the reproduction, development and seasonality of one of the most ubiquitous cold water corals in the world. There is no other location in the world discovered to date where this study would be possible, and information gained will aid in the successful management and conservation of cold-water corals anywhere. This project also discovered areas where cold-water corals are being negatively impacted by salmon farming techniques ongoing in the fjords, documenting this evidence clearly through photographs and samples. We were fortunate to examine populations as yet unaffected by farming, thus preserving data from a pre-impacted state. To date there are now a dozen more salmon farms in the areas we sampled, thus gaining those samples in 2012 - 2013 was urgently needed and essential to gaining a baseline signature from one of our sites.

**What is the impact on other disciplines?**

Nothing to report.

**What is the impact on the development of human resources?**

Waller gained valuable skills in scuba diving, and has since used those skills on multiple other scientific projects and endeavors

One masters student (female) is currently being trained and her thesis will utilize these samples

One undergraduate (female) is gaining valuable experience this summer in the histology laboratory working on these samples alongside the masters level student.

**What is the impact on physical resources that form infrastructure?**

Utilizing the Huinay Scientific Field Station for this project aids in my collaborators being able to improve their facilities.

**What is the impact on institutional resources that form infrastructure?**

Nothing to report.

**What is the impact on information resources that form infrastructure?**

Nothing to report.

**What is the impact on technology transfer?**

Nothing to report.

**What is the impact on society beyond science and technology?**

The increasing prevalence of fisheries, tourism and intensified logging against a backdrop of climate change is leading to increased soil erosion, heavy metal pollution, and glacial retreat in this fragile fjord area. These are all potential threats to this delicate and unique coral-based ecosystem. This project has, and will continue, to provide an understanding of how anthropogenic influences are affecting basic life history processes in an important habitat forming species in the region and will springboard future, more intense study of the regions benthic resources.

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## Changes/Problems

**Changes in approach and reason for change**

- Settlement panels were not deployed - German scientists had just deployed panels at two locations we ended up sampling - scientists in Huinay were not keen for additional damage to the fjords, so we started a collaboration with the Germans to pool reproductive and settlement data once available

- Genetic material was sent to a collaborator in Germany who had gained funding specifically to look at the Comau fjord corals and had collected additional samples. This seemed the most efficient use of material.

**Actual or Anticipated problems or delays and actions or plans to resolve them**

Masters student was not hired until January 2014 - this will delay final analysis of data.

**Changes that have a significant impact on expenditures**

Nothing to report.

**Significant changes in use or care of human subjects**

Nothing to report.

**Significant changes in use or care of vertebrate animals**

Nothing to report.

**Significant changes in use or care of biohazards**

Nothing to report.