FINAL REPORT ON PROJECT SUPPORTED BY PADDY PALLIN SCIENCE GRANT

Instructions to Project Leaders for Completing This Form
Progress reports are required to be submitted 12 months after the start of the project, and then at 18-24 months as a final report. Grants usually begin on the 15TH September in the year in which the grant was awarded. Payment of the second grant installment is contingent upon the receipt of this material. Updates are to be provided during the tenure of the grant, and at the time the final report is submitted. Payment of the final grant installment is contingent upon receipt of the final summary, which is to summarize the outcomes of the project during the tenure of the grant.

1. PROJECT IDENTIFICATION

1.1 PROJECT
Conserving the fish of surf zones: how effective are small coastal reserves?

1.2 ADMINISTERING ORGANISATION
University of the Sunshine Coast

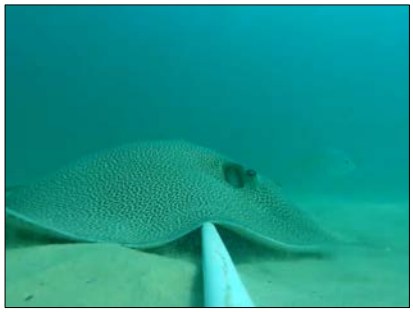
1.3 PROJECT LEADER AND PARTICPANTS
Dr Andrew Olds

2. PROJECT DESCRIPTION & OBJECTIVES

2.1 100- Word Project Summary
Surf beaches are prized by society for recreation, development, and fishing. They supply a substantial amount of global seafood, but we lack basic information on the ecology of fish that inhabit surf-zones. This means that we do not know how these assemblages are impacted by fishing, or how they respond to conservation. This project will quantify, for the first time, the effectiveness of coastal conservation initiatives for fish in Australian surf zones by contrasting assemblages across shorelines subjected to different management practices. The results of this study will help improve planning decisions concerning the management of the coastal zone.

2.2 Summary of original objectives (150 words max)
The chief objective of this project is to determine, for the first time, the effects of coastal conservation initiatives on the fish of Australia's surf beaches. In working towards this overall objective the project will also: (1) pioneer a new sampling methodology to overcome the limitations of traditional surf-fish research done with nets; (2) produce the first empirical dataset on the effects of conservation on the fish of Australian surf beaches; and (3) develop a framework to improve coastal zone management.





3. PROJECT OVER DURATION OF FOUNDATION GRANT

3.1 Have there been any changes to the project? If yes give details

This could include changes to the research Project resulting from funding from the Foundation being at a lower level than requested. By indicating changes to the budget, aims and research plan in the Report, you are requesting approval from the Foundation for a revision of the Project. A 'satisfactory' assessment of the Report and the Project by the Paddy Pallin Grants Committee means that the revision has been approved.

Field surveys were conducted at ocean beaches in Queensland and New South Wales between 2015 and 2016. Fieldwork was conducted as planned, however, the scope of this project was expanded in early 2016 to include marine parks in New South Wales. This was done because there are too few marine reserves in the surf zones of southern Queensland (the initial focal region for this project), and these do not appear to be particularly effective for fish. Field surveys in New South Wales marine parks were finished in winter 2016, and the analysis of video footage from our Baited Remote Underwater Video Stations (BRUVS) was completed earlier this year.

3.2 What were your research plans and objectives for the period covered by this report? (150 words max)*(The answer to this question should be consistent with the original Application or the preceding Progress Report).*

The chief objective of this project was to determine, for the first time, the effects of coastal conservation initiatives on the fish of Australia's surf beaches. In working towards this overall objective the project will also: pioneer a new sampling methodology to overcome the limitations of traditional surf-fish research done with nets; and produce the first empirical dataset on the effects of conservation on the fish of Australian surf beaches.

3.3 Did the research project proceed as planned? What have you achieved over this period? Outline the research findings to date (200 words max)

This project has: (1) pioneered a new methodology for surveying surf-fishes; (2) produced the first large dataset on Australian surf-fishes; and (3) quantified the effectiveness of coastal reserves for Australian surf-fish. It has, therefore, delivered against all three proposed objectives. A manuscript describing this study, and the key results of this work, was submitted to *Biological Conservation* for publication earlier this year (see abstract below, and manuscript attached). During this time, we have also published three other allied papers on the ecology of fish in the surf zones of ocean beaches (see publication summary in item 4.1 below).

Ortodossi NL, Gilby BL, Schlacher TA, Connolly RM, Yabsley NA, Olds AD (Under Review) Seascape connectivity shapes reserve performance on exposed coastlines. Biological Conservation.

Abstract

The spatial properties of landscapes influence numerous ecological attributes on land and in the sea, including the efficacy of nature reserves. In this context, connectivity has been shown to modify reserve performance in low-energy marine ecosystems (e.g. coral reefs, mangroves, seagrass), but it is not clear whether seascape linkages also shape reserve effectiveness on high-energy, exposed coastlines. We used the surf zones of ocean beaches in eastern Australia as a model system to test how seascape connectivity and reserve attributes combine to shape

and 15 fished beaches, across two thousand kilometers of exposed coastline, using baited remote underwater video stations. Reserve performance was shaped by both the characteristics of nature reserves, and the spatial properties of the coastal seascapes in which they were embedded. Effective reserves had three key attributes. They i) encompassed a sizeable area of surf-zone habitat (> 1.5km of coastline); ii) were located close (< 100m) to rocky headlands; and iii) included pocket beaches in a heterogeneous seascape. We suggest that conservation outcomes for exposed coastlines will be enhanced by prioritizing sufficiently large areas of seascapes, with strong ecological linkages to abutting complementary habitats. Our findings have broader implications for coastal conservation planning, by demonstrating that similar effects of connectivity on reserve performance can be applied to revere design in both sheltered and exposed seascapes.

3.4 Have you experienced any difficulties that have affected the progress of the research project? If yes give details (150 words max)

Yes, but the project is now complete. The scope of this project was expanded in early 2016 to include marine parks in New South Wales because there are too few marine reserves in the surf zones of southern Queensland (the initial focal region for this project), and these do not appear to be particularly effective for fish. Video footage took far longer to process than anticipated due to the unprecedented diversity of fish species that we recorded in the surf.

3.5 What are your research plans and objectives, including publication plans, for the coming year? (150 words max) *(Please note that in your next Report you should report progress against these plans and objectives)*

Research plan and objectives

NA - the project is now complete.

Publication summary

The manuscript arising from this project was submitted for publication earlier; three other papers that are linked to this project have already been published; four conference presentations have been delivered to help publicise this work to a wider scientific audience; and four student theses have been completed from project work directly aligned with this research (refer to detailed publication summary provided at item 4.1 below).

4. ACADEMIC OUTPUTS

4.1 Publications and other academic outputs directly related to this project. *(Please list all publications and those manuscripts accepted for publication, for the period covered by this report)*

The manuscript arising from this project was submitted for publication earlier; three other papers that are linked to this project have already been published; four conference presentations have been delivered to help publicise this work to a wider scientific audience; and four student theses have been completed from project work directly aligned with this research.

Publications

1. Ortodossi NL, Gilby BL, Schlacher TA, Connolly RM, Yabsley NA, Olds AD (Under Review) Seascape connectivity shapes reserve performance on exposed coastlines. *Biological*

2. Olds AD, Vargas-Fonseca E, Connolly RM, Gilby BL, Huijbers CM, Hyndes GA, Layman CA, Whitfield AK, Schlacher TA (2017) The ecology of fish in the surf zones of ocean beaches: a global review. *Fish and Fisheries*, doi:10.1111/faf.12237 (IF: 9.0).
3. Borland HP, Schlacher TA, Gilby BL, Connolly RM, Olds AD (2017) Habitat type and beach exposure shape fish assemblages in the surf zones of ocean beaches. *Marine Ecology Progress Series*, 570:203-211 (IF: 2.4).
4. Vargas-Fonseca EM, Olds AD, Gilby BL, Connolly RM, Schoeman DS, Hyndes GA & Schlacher TA (2016) Combined effects of urbanization and connectivity on iconic coastal fishes. *Diversity and Distributions*, 22:1328-1341 (IF: 4.6).

Conference presentations

1. Olds AD (2017) Effects of urbanization, conservation and connectivity on iconic coastal fishes. Coastal and Estuarine Research Federation conference, November 2017.
2. Olds AD (2017) The ecology and conservation of fish in the surf zones of ocean beaches. Indo-pacific fish conference, October 2017.
3. Borland HP, Schlacher TA, Gilby BL, Connolly RM, Olds AD (2017) Habitat type and beach exposure shape fish assemblages in the surf zones of ocean beaches. Australian Society for Fish Biology conference, July 2017.
4. Vargas-Fonseca EM, Olds AD, Gilby BL, Connolly RM, Schlacher TA (2015) Combined effects of urbanization and connectivity on iconic coastal fishes. Australian Marine Science Association conference, July 2015.

Student theses

1. Ortodossi NL (2017) Seascape connectivity shapes reserve performance on exposed coastlines. Honours Thesis, University of the Sunshine Coast.
2. Borland HP (2016) Habitat type and beach exposure shape fish assemblages in the surf zones of ocean beaches. Honours Thesis, University of the Sunshine Coast.
3. Vargas-Fonseca EM (2015) Ecology of surf-zone fishes in eastern Australia. Masters Thesis, University of the Sunshine Coast.
4. Franks IR (2015) Conservation of surf-zone fishes in southeast Queensland. Honours Thesis, University of the Sunshine Coast.

4.2 Evidence of scholarly impact and contribution. Is there evidence that this research project is having/has had an impact in the research field or the broader public domain? *Include examples of formal training (PhD /Masters) as well as other training.* **If yes, give details** *(For instance, standard citation data on articles published in ISI journals, citations to books, re-publication, translations, reviews, invited keynote addresses, other invitations, newspaper/media/expert commentary).*

Please refer to the detailed response provided at item 4.1 (above).

4.3 End-user interaction and other project outcomes If there are examples of the impact of this research Project not covered in item 4.2 above please provide details. *For example, introduction or modification of standards/protocols within an industry sector, preparation of proposals for funding from other agencies as a result of outcomes from this project.*

The results of this project will help to improve spatial conservation planning decisions for ocean beaches. We suggest that conservation outcomes for exposed coastlines will be enhanced by

strong ecological linkages to abutting complementary habitats (i.e. < 100m to rocky headlands). Our findings also have broader implications for coastal conservation planning, by demonstrating that similar effects of connectivity on reserve performance can be applied to revere design in both sheltered and exposed seascapes.

The method development component of this project has also been a huge success, and we can now survey the fish of surf zones with relative ease. Mobile baited remote underwater video (BRUV) apparati developed during this project are now a cornerstone of undergraduate field courses in the new Animal Ecology program at the University of the Sunshine Coast.

5. ATTACHMENTS & OTHER MATERIAL

Please provide, as separate files, any figures, graphs, images and other material that cannot be included in this form. Please also provide updated material (text and images) that can be used to revise your project summary on the Foundation's web site. Please provide text in Microsoft Word format and images in JPEG format with a minimum size of 600 x 400 pixels. If this is the final project report, the web page summary must be updated to reflect the outcomes of the project. Is any material being forwarded as additional attachments?

Attachments
I have attached the manuscript that describes this study, and the key results of this work, which was submitted to *Biological Conservation* for publication earlier this year. I have also attached the three other allied papers on the ecology of fish in the surf zones of ocean beaches.

Other material
The following text might be useful when updating the project summary text on the website:

This project used the surf zones of ocean beaches in eastern Australia as a model system to test how seascape connectivity and reserve attributes combine to shape conservation outcomes. Spatial patterns in fish assemblages were measured in 12 marine reserves and 15 fished beaches, across two thousand kilometers of exposed coastline, using baited remote underwater video stations. Reserve performance was shaped by both the characteristics of nature reserves, and the spatial properties of the coastal seascapes in which they were embedded. Effective reserves had three key attributes. They i) encompassed a sizeable area of surf-zone habitat (> 1.5km of coastline); ii) were located close (< 100m) to rocky headlands; and iii) included pocket beaches in a heterogeneous seascape. We suggest that conservation outcomes for exposed coastlines will be enhanced by prioritizing sufficiently large areas of seascapes, with strong ecological linkages to abutting complementary habitats. Our findings have broader implications for coastal conservation planning, by demonstrating that similar effects of connectivity on reserve performance can be applied to revere design in both sheltered and exposed seascapes.