Quantifying contributions of fish to coral reef carbonate cycling and modelled responses to environmental change

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We also expect that the student would spend approx. 2 months on fieldwork in Australia, and a period of 1-2 weeks over the duration of the project working with Co-supervisor Jennings at Cefas in Lowestoft on the fish population modelling aspects of the project.

Project description: Coral reef ecosystems globally have been subject to multiple disturbances over the last few decades. This has resulted in widespread loss of coral cover in many regions and associated changes in reef benthic community composition. Widely impacted by these changes have been coral reef fish – both directly as a result of increasing and unsustainable fishing practices, but also indirectly through disturbances that have changed the habitat complexity of reefs and consequently altered the abundance and diversity of reef fish assemblages. This is a critical issue, not only because fish are central to the provisioning of many key coral reef ecosystem services, but also because they play critical roles in influencing multiple aspects of coral reef geo-ecology and which ultimately underpin the production and cycling of carbonate in coral reef environments.

In the context of the latter, recent work lead by Exeter researchers, has significantly improved understanding of the role that coral reef fish play in coral reef carbonate budgets via physical erosion of coral skeletons (Perry et al. 2013 *Nature Comms*), and has provided ground-breaking insights into the production of intestinally precipitated carbonate by fish and its potential contributions to fine carbonate sediment production in the tropics (Perry et al. 2011 *PNAS*). Collectively this work, when combined with recent (currently unpublished) work on reef fish corallivory (undertaken as part of a UoE *Climate Change and Sustainable Futures* pump-priming project), demonstrates the wide-ranging and quantitatively important role that reef fish play in multiple aspects of coral reef carbonate framework and sediment production, and carbonate cycling.

However, to-date, there has been no attempts made to quantify, in an integrated way, the relative contributions made by fish to different facets of reef carbonate budgets and to carbonate production with single reef systems. There has also been no attempt to quantify how environmental disturbances, that are known to fundamental change reef fish assemblages, will alter their collective contributions to reef carbonate production. This project will build on our recent high profile research (above) and specially **aims** to: 1) develop the first integrated models that quantify the collective role of fish in carbonate production, across all the main functional fish groups and within different reef habitats (reef flat, crest, slope etc); and 2) model the impacts of different types of disturbance (selective overfishing, food chain disruption, habitat complexity loss due to coral bleaching etc) in order to quantify the impacts of changing assemblage composition on fish-associated reef carbonate production rates. This work will be undertaken at sites around Lizard Island, Australia (a near pristine, model system for examining fish carbonate production and cycling roles) and integrate with a recent NERC Standard project on the depositional fate of fish-derived sedimentary carbonates.

References

Perry C.T., Murphy G.N., Kench P.S., Smithers S.G., Edinger E.N., Steneck R.S. and Mumby P.J. (2013) Caribbean-wide decline in carbonate production threatens coral reef growth. *Nature Communications. doi: http://dx.doi.org/10.1038/ncomms2409*

Perry, C.T., Salter, M.A., Harborne, A.R., Crowley, S.F., Jelks H.J., Wilson, R.W., (2011) Fish as major carbonate mud producers and missing components of the tropical carbonate factory. Proceedings of the National Academy of Science 108: 3865-3869.

Training opportunities: The project will expose the student to a wide breadth of marine field data collection and monitoring techniques, and equip them with up to-date skills in the development and running of ecological computer-based models. The student will be supported in these tasks by a supervisory team with a wide range of relevant fieldwork and laboratory experience, in particular relating to quantifying carbonate production and erosion by reef fish, quantifying marine fish assemblages, and quantifying coral reef benthic ecology. External supervisor Simon Jennings is a world-renowned expert in modelling marine fish populations, and will contribute key expertise in this area.

More generally, Exeter Geography has a very strong PGR training environment, and the student will join the Environmental Change Research Group (comprising 13 academic staff). All Geography PGRs have dedicated workspaces and individual computing facilities, and are fully embedded within the everyday research culture of Geography via research group seminars and meetings. In addition to formal supervisors each student has a nominated research mentor. Each student completes a learning agreement in the first 8 weeks, has a review meeting at 6 months, and an MPhil-PhD upgrade (comprising a research presentation, written report and viva) at 12 months. Student progress is managed via the University online MyPGR software which documents supervisory meetings, as well as supplying a one-point source for official processes. Research training and career development is also provided via the University's Researcher Development Programme.