

Darwin Project 10-019

Mapping benthic biodiversity of the South Georgia continental shelf and slope

This project attempts to collate, check and database georeferenced species data of marine macro and megafauna around the island of South Georgia (Southern Ocean). Biodiversity is measured in terms of 'species richness' which refers to the total number of species (of macro and megafauna) present. 'Endemic' species are referred to in the context of only occurring at South Georgia unless otherwise specified. The continental shelf is typically 0-500 m water depth and the continental slope ~500-3000m depth.

Half-year Update Report November 2010

Personnel

Oliver Hogg was employed by the British Antarctic Survey (BAS) in July 2010 and has had a very productive start to his contract. Extra funding allowed us to fund Oliver on other sources of finance and so start him on Darwin Initiative money 3 months later than planned and so extend the project to 30 June 2012 (from the originally planned 1 April 2012).

Paul Brewin was employed by the Shallow Marine Surveys Group (SMSG) of the Falkland Islands in September 2010 and has also had a good start to his work.

David Barnes and Mark Belchier (BAS) and Martin Collins (Government of South Georgia and South Sandwich Islands – GSGSSI) have all begun work on cruise organization and data analysis.

Southern Ocean biodiversity context to the project

Previous attempts to frame Southern Ocean biodiversity within a global context have identified species richness as equivalent (or higher) to that reported from northern polar areas (Sirenko *et al* 2001), temperate shelves (Ugland *et al* 2003) and the equatorial tropics (Cruz *et al* 2003; Clarke *et al* 2004). Current species counts from the Southern Ocean however indicate that in terms of biological richness, by global standards it is relatively impoverished (Griffiths 2010). Accounting for the relatively low proportion of shelf area in the Southern Ocean (~8% of global shelf area) however, representation of global species across many taxa in the Southern Ocean is, at 8% fairly high (Barnes & Peck 2008). Furthermore, unlike many lower latitudinal realms, our knowledge of many of the Southern Ocean taxa is relatively poor (Clarke *et al* 2007). Our Darwin Initiative project focused on South Georgia biodiversity shows, by comparison a considerably better estimate of the marine biodiversity of a southern polar locality. As such this study (which represents the

first attempt to map the biogeography of an archipelago south of the Polar Front) provides a powerful tool by which to gain an understanding of the structure and function of biodiversity in this remote and poorly understood region.

Progress overview from April 2010-September 2010

The tailing off of the number of new literature records (of georeferenced species occurrences) now being identified by Oliver Hogg suggests that we have now identified the vast majority of validated records. Most of these have been checked and added to the South Georgia database. Already it is clear that South Georgia represents, by some margin, the most biodiverse locality currently known in the entire Southern Ocean. This is of considerable note given that the nearby archipelago of the South Orkney Islands was recently found to be considerably richer than expected (Barnes *et al* 2009). Oliver Hogg presented these preliminary findings at the European Marine Biology Symposium in Edinburgh in August 2010. We have started identifying the most poorly known areas of the South Georgia shelf and thus planning of where most sample time will be allocated during the research cruises. A cruise time slot has been provisionally allocated (January 2012) for the deeper water work using RRS James Clark Ross and some planning of personnel and equipment has begun. Overall progress is about where we hoped to be.

Progress overview from April 2010-September 2010

The South Orkney Islands (SOI) probably offers the best direct comparison with South Georgia as they are both relatively well sampled (see Barnes *et al* 2009) and have a shelf area of the same order of magnitude as South Georgia. The data from South Georgia which has been entered so far shows that it has 37% more species than in the SOI in only 75% of the area of the SOI. In addition, comparisons between species accumulation rates reveal known mega and macro-faunal richness at the SOI are unlikely to increase greatly with increased sampling (Barnes *et al* 2009). In contrast general trends across taxa on South Georgia's shelf are of continually high rates of novel species identification. We estimate that with increasing sampling effort, differences in marine biodiversity between the two archipelagoes should prove to be even more disparate than at present.

In a global context, the data collected from South Georgia supports inferences made by Barnes *et al.* (2009) that Scotia arc localities support equal or higher levels of biodiversity than equally well sampled sites at comparable northern latitudes (Sirenko *et al* 2001; Uglund *et al* 2003). Indeed such was the richness within certain phyla at South Georgia (notably

amongst bryozoans, sponges, nematodes and chelicerates) that when compared to locations such as Hawaii (Eldredge & Miller 1995) and the Baltic Sea (Ojaveer *et al* 2010) which have much larger shelf areas (over 13 x in the case of the Baltic) and a much higher degree of sampling effort, South Georgia still reported higher species numbers.

Taxonomic structure and spatial distribution of biodiversity

At South Georgia however the literature data we have processed to date shows that just a few taxa dominate the ecosystem. Though as with the Southern Ocean as a whole, crustaceans remain the richest phyla, this dominance was not as marked at South Georgia (~19% of species). Remaining species richness was also far more equally divided across remaining taxa resulting in some phyla deviating well above South Ocean averages. Examples of this were seen in phyla already known to be rich in the Southern Ocean such as bryozoans and sponges (Arntz *et al* 1994), which both constituted total species shares twice that of the Southern Ocean average.

Spatial distribution of species at South Georgia is proving harder to quantify. This was because despite South Georgia being relatively well sampled, this sampling effort has not occurred in a uniform way. This is not necessarily problematic when considering broad scale ecosystem level comparisons, such as between South Georgia and other polar archipelagos. It does however limit our understanding of how biodiversity is structured spatially across the South Georgia shelf itself. Across some phyla for example, large areas of continental shelf remain completely un-sampled and for most phyla, in the areas that have been sampled, there is a heavy bias towards the waters surrounding research bases such as at King Edward Point. Taking these biases into account we report that averaged across all taxa, biodiversity is far from uniform across the South Georgia shelf. Based on present data however there are no obvious biogeographic trends. Biodiversity did tend to be higher nearer inland, especially on the northern and western coasts but this broad trend did not show ubiquity across all phyla.

Endemic species

The Southern Ocean is well documented as having some of the highest levels of marine endemism on the planet (Arntz *et al* 1997). The ability to report the level of endemism from South Georgia however was constrained in some phyla by inadequate reference sampling throughout the rest of the Southern Ocean. With the exclusion of these phyla our data suggests that South Georgian endemism to be high amongst molluscs (gastropods and

bivalves), bryozoans, and cnidarians (46 -56%) with fish and sponges tending to be more ubiquitous (3-8%). The duration and degree of isolation from other biogeographic zones are often cited as major drivers behind high levels of island endemism (Arntz *et al* 1997). Geologically old, geographically remote, and endemically rich South Georgia certainly seems to support this paradigm.

Progress in the host location

The South Georgia Shallow Marine Programme is included within phase two of the Darwin project and is responsible for the collection of biodiversity data from shelf waters less than 20 m deep. The programme will be conducted by the Shallow Marine Surveys Group (SMSG) based in the Falkland Islands. The group was formed by a core group of experienced biologists and divers and assisted by volunteers from the community and they have been collecting, identifying and photographing marine animals since June 2006. The Shallow Marine Surveys Group exists to coordinate and conduct assessments of the status of inshore resources around the Falkland Islands. The scope of the work includes the splash zone, inter-tidal and sub tidal environments on sandy, pebble and rock beaches of Falkland Islands' shores. This makes SMSG ideally suited for similar work in South Georgia.

During May – June SMSG secured funds to enable a sponge taxonomist and an algal taxonomist to join the shallow marine survey of South Georgia planned for November 2010. Dr Claire Goodwin is a marine biologist/sponge taxonomist working with the National Museums of Northern Ireland. Claire has been on two surveys with SMSG in the Falkland Islands. The first survey included environs around Stanley and the Jason Islands and resulted in the descriptions of 12 new species of sponge, currently in press with the Journal of the Marine Biological Association of the UK. The second survey also yielded interesting results with many species new to science. Many of these samples are currently being worked up. Dr Emma Wells is an algal specialist sponsored by a grant from the JNCC. These two specialists will complement the team and will add to the overall quality of the shallow marine survey as the algae and sponges are important ecologically and difficult taxonomically.

The Shallow Marine Surveys Group has a set of safe diving regulations which has been updated to include specifics of diving around South Georgia (e.g. leopard seal watch, diver recall system etc). Diving will be restricted to 18m. All divers are fully trained, with a wealth of experience within the group with all members having done many cold water dives.

July saw the start of a recruitment process for the Shallow Marine Programme's Project Officer/Benthic Ecologist. Advertisements on list servers and University Departments

yielded eleven excellent candidates of which five were interviewed. Dr Paul Brewin was the successful candidate and comes from a strong benthic ecology background. Paul did his PhD at the University of Otago on local and regional patterns in benthic community structure in Doubtful Sound, Fiordland, New Zealand. Paul then completed a Post Doctoral Fellowship at the University of California, San Diego on the effects of oceanography on seamount community structure. Paul comes with a wealth of diving experience in the tropics, New Zealand and in the Antarctic. Paul arrived in the Falkland Islands on 22nd of October and did his first dive on the 24th. Paul is currently preparing for our survey on the 14th November, collecting literature on species that are likely to be encountered and also helping design a suitable survey methodology.

Given the large volume of biodiversity data collected from South Georgia the scope for future applications is broad. Identifying priority areas around South Georgia that are anomalously rich or important to investigate due to gaps in our knowledge must be viewed as a key priority. In so doing this dataset will act as an accurate baseline measure of South Georgian biodiversity. In turn this information can provide a framework from which to identify ecologically sensitive areas and species, identify conservation priorities and aid in the monitoring of future biogeographical changes.

Plans for the next six months

We plan to complete all literature data entry and begin analysis leading to a major scientific paper submission and also use the data to plan the detailed sample sites for the deep water science cruise. We will be sourcing and purchasing some of the equipment needed. We plan to finalise the personnel for the RRS James Clark Ross cruise and invite these participants. The shallow diving work cruise will be carried out around South Georgia and material collected will be distributed to taxonomists. The first new biodiversity data should go live on open access databases and we will start to categorise biodiversity by rarity, major threats and potential responses towards meeting criteria of the Convention on Biological Diversity.