

Understanding climate driven change in biodiversity and ecosystems: observations, modelling and experiments.

Professor S J Hawkins, Bangor University, School of Ocean Sciences (visit to Argentina 12 Feb to 9th March 2010)

Hosted by: Dr. Maria Gabriela Palomo. Senior Researcher National Commission for Research in Science and Technology (CONICET) Argentina. Museo Argentino de Ciencias Naturales Bernardino Rivadavia, Ciudad de Buenos Aires, Argentina.

Participation in fieldwork and seminar component in Quequen: Professor Juan Jose Cruz Motta, Universidad Simon Bolivar, Venezuela.

Course credit value and locations

The course was at PhD level and it qualified as a 2 credit (56 hour contact) course in the University of Buenos Aires. For the PhD title each student needs to obtain a total of 20 credits from courses, so this course allows them to obtain the 10 % of the total. The theoretical component (35 hours plus) was held in Buenos Aires in the Museo Argentino de Ciencias Naturales and the practical/discussion seminars component (21 hours plus) 500 km south of Buenos Aires at Estacion Hidrobiologica de Quequen on the rocky coast there.

Course Summary

The course provided an integrated combination of formal lectures, research seminars, discussion workshops and fieldwork to inform research and to provide training in the area of climate change responses of coastal and nearshore ecosystems. This was intended to inform and enable the establishment of broadscale observations and time series essential for separating climate change from local and regional scale impacts. Research underpinning adaptational responses to climate change was also outlined (work on impacts and design of sea defences).

The following NF-POGO priorities were explored in the context of climate change and the relationship between biodiversity and ecosystem functioning: fixed point time-series observations, large-scale observations of biodiversity, emerging approaches for ocean observations, data management, coastal observations, coastal zone management and modelling future states in the coastal zone.

Week 1 15th to 20th February: 9.30 to 6pm : Formal lectures and discussion seminars. Individual students were asked to prepare short presentations for the themed student discussion groups.

Each morning there was a three hour session consisting of lectures followed by discussion. In the afternoon there was a 2 hour session of student-led discussion, interspersed with shorter lectures/research seminars, each followed by discussion.

Students were asked to prepare 20 minute presentations (in English or Spanish or Portuguese) to kick-off discussion. Most chose to speak in Spanish/Portuguese but with English power point slides (sub-titles). Several talks were given in English. Discussion was in English and Spanish with translation to SJH to his enable input. They worked very well and complemented the lectures well – especially as the students were asked to draw on local examples. It was pleasing that the students drew on terrestrial and freshwater examples in addition to marine ones. Students selected topics for discussion and self organised the sessions which were of a very high standard.

The lectures in the morning covered general principles whilst those in the afternoon focussed on case studies based on the work of Professor Hawkins, colleagues and collaborators in most cases. Occasional research talks were given by the students to add variety in this first week.

Day 1: Global environmental change and the need for sustained observations.

Session 1 (am):

Course Introduction: SJH briefly introduced Bangor University and his past work including research based at the Marine Biological Association in Plymouth. The students introduced themselves briefly, stating their research interests.

Changing oceans and seas – a global overview.

The evidence for climate change was presented focusing on the oceans. Emphasis was given to demonstrating that climate has fluctuated since the last Ice Age but that recent rapid warming exceeds all previous instrumental records. This drew heavily on the IPCC 2007. Followed by discussion.

Session 2 (pm): Separation of climate driven change from regional and local scale impacts – the need for decadal scale observations.

Focusing on examples from the North East Atlantic fluctuations in climate over the last 120 years of instrumental recording were examined. The case for long term observations as an essential mechanism to separate climate driven change from regional (fishing, eutrophication) and local scale impacts (point source pollution, inappropriate coastal development) was made. Followed by discussion and questions.

Student led discussion seminars: The need for long-term monitoring.

The students were asked to bring examples from their own countries and regions of ongoing long-term work on climate change responses. The discussion focused on the challenge of separating climate driven change from regional and local impacts.

Final thoughts from SJH: is change faster than previously observed or reconstructed?

The recent geological history of glaciation and deglaciation was explored including examination of post-glacial colonisation processes. The extent and severity of impacts in various parts of the world including Latin America were outlined based on IPCC

Day 2: Time-series and observatory case studies

Colleagues at SAHFOS (Reid, Burkhill, Edwards, Richardson) kindly provided material which was used for this day.

Session 1 and 2: Broad-scale pelagic surveys – the work of the Continuous Plankton Recorder (CPR).

The continuous plankton recorder is towed behind ships of opportunity and enables broadscale monitoring of plankton in the surface layer of the ocean. Its use has made a major contribution to our understanding of climate change responses of marine ecosystems and the impacts of such changes on marine resources. The lectures in the morning and afternoon covered geographic shifts in zooplankton, phenological shifts in plankton and larval fish influencing recruitment and regime shifts of whole ecosystems. The main examples were from the North Atlantic and the North Sea.

Student led discussion seminar: Planktonic indicators of change.

Focusing on planktonic systems students were asked to find examples of change from South America and elsewhere for their presentations. The discussion focussed on the following questions: How representative are plankton of the whole ecosystem? What are the problems with using the CPR approach? Where would be the best place to establish CPR routes in South America?

Ocean acidification and plankton: short seminar by SJH on different views of jellyfish proliferation in the context of acidification. This emphasised that correlation does not equal cause and effect.

Day 3: Time-series case studies continued

Session 1: Coastal observatories – The Plymouth time series from 1888 onwards

Drawing on the work done at the Marine Biological Association by past MBA staff and more recently by Southward, Hawkins and collaborators (Sims, Genner, Jenkins, Mieszkowska et al) the major findings of the MBA Time Series were discussed. These show fluctuations in dominance by pelagic and demersal fish species, plankton and rocky shore species which are broadly linked to temperature fluctuations (the so called “Russell cycle”). The underlying causality of these changes was discussed. Continuation via the Western Channel Observatory (led by PML) was outlined.

Session 2: Other sustained time-series, including work by the Marine Environmental Change Network/Oceans 2025.

Drawing on the wider work of the Marine Environmental Change Network/ Oceans 2025 programme other time series were explored (Liverpool Bay Observatory, Port Erin time series), the latter covering changes in nutrients in the Irish Sea.

Student led discussion seminar: Integrating hydrographic and ecological observations

This focussed on the need to integrate oceanographic and ecological approaches in coastal waters. The students drew on South American examples wherever possible (e.g., time series off Mar del Plata, at Bahia Blanca, off Puerto Madryn).

Marine life of South-west England and its conservation

Introduction to southwest marine life, impacts and conservation. (Short general interest talk based on slides provided by Hiscock).

Day 4: Coastal biodiversity and ecosystem functioning

Session 1 (am): Introduction to Rocky shores of the North-east Atlantic and basic ecology of rocky shores.

Environmental gradients and patterns of horizontal, vertical and geographic distribution. Role of physical factors and biological interactions in setting distributions.

Role of grazing in setting distributions, structuring communities and mediating ecosystem functioning. Experiments on how grazing structures rocky shore communities were outlined emphasizing shifts along the wave exposure gradient and with latitude drawing on work of Hawkins, Coleman, Jenkins and co-workers as part of the EUROROCK project.

Session 2 (pm):

Student led discussion seminar: Biodiversity change and ecosystem functioning

Drawing on the international literature students were asked to prepare presentations on work underway on the relationship between biodiversity and ecosystem functioning.

Is species diversity too fine a scale to matter for functioning of open coastal ecosystems? Seminar by SJH

The role of habitat patch diversity for ecosystem functioning was outlined.

Day 5: Biodiversity and ecosystem functioning (Continued)

Broad-scale and long-term studies of coastal biodiversity – patterns of change.

The pioneering broadscale surveys of rocky shores in France, Spain, and the UK by Fischer-Piette, Southward, Crisp, and Lewis were reviewed. These base-lines from the 1940s and 50s have proved invaluable in measuring recent responses to climate change. The factors setting the biogeographic distribution of species were discussed in the light of recent range extensions found by Hawkins and co-workers as part of the MarClim project.

Processes driving change. The underlying mechanisms driving climate change responses, particularly reproduction and recruitment success were discussed. Hydrographic barriers to dispersal and the importance of connectivity were considered. The consequences of climate driven change for ecosystem processes will be outlined to inform the discussion below

Looking back for the future – Use of sustained observations to predict future states, integrating monitoring with experiments and modelling

How can sustained observations be used in combination with modelling to predict – or at least forecast future states? The need for in-parallel experimental work was emphasised.

Session 2 (am): Experimental studies of coastal biodiversity and ecosystem functioning

Current research on the relationship between biodiversity and ecosystem functioning in coastal ecosystems by Jenkins, Hawkins, Griffin, Thompson and co-workers was summarised in a research seminar.

Looking to the Future – adaptation to climate change and impacts of mitigation measures

Student led discussion seminar: Global Environmental Change – Drawing on the resources of IPCC 2007.

A series of presentations covered the following topics: adaptation to climate change in the coastal zone, non-native species and climate change, managing natural resources in a changing world.

Session 2 Climate change and coastal zone management

Climate change will prompt both adaptational responses and the need to mitigate greenhouse gas emissions. This means that sea defences will be built in response to rising and stormier seas and renewable energy will be increasingly extracted from coastal and near shore waters through wind, wave, and tidal power schemes. Examples were given of the impacts of coastal defences on marine habitats and how ecologically sensitive design can minimise impacts whilst maximising biodiversity. The impacts of offshore renewable energy installations were briefly considered (there is very little published on this area as it is such a new field).

Saturday 21st Day off

Sunday 22nd Course lunch (*assado* - barbecue) and social event hosted by Dr Palomo.

Week 2: February 23 - 25th. Fieldwork to provide training in monitoring techniques and establish time-series at Quequen. Student research seminars and methodological discussions (Estacion Hidrobiologica de Quequen)

A series of field exercises covered survey and experimental design, sampling protocols and techniques, data analysis and synthesis. The emphasis was placed on matching the appropriate scale of resolution of observation to the objectives of the study. Topics covered included broadscale semi-quantitative rapid assessment methods, quantitative sampling using different

survey designs, common statistical problems in dealing with broadscale and long-term survey data. This part of the course was curtailed by appalling weather including strong onshore winds and large waves rendering the intertidal inaccessible.

Between tides (early am and late pm) students gave 20 minute seminars on their Ph.D research.

TOTAL CONTACT HOURS: THEORY 35, PRACTICAL AND SEMINARS 21.

Table 1 Students taking course

Student	Home	Country	Topic of research	Stage of PhD/Master
Addino Mariana del Sol	Univ. de Mar del Plata	Mar del Plata, Argentina	Estuarine Ecology	3rd year (advanced)
Arribas Lorena	Museo Arg. Cienc. Nat	Buenos Aires, Argentina	Rocky intertidal Ecology	1 st year (early stage)
Avalos Cecilia	Cent Austral de Inv. Cientif.	Ushuaia, Argentina	Marine Physiology	4th year (last)
Bagur Maria	Museo Arg. Cienc. Nat	Buenos Aires, Argentina	Rocky intertidal ecology	1 st year (early stage)
Crisci Carolina	Univ. de la República	Montevideo, Uruguay	Marine ecology	3rd year (advanced)
Fueyo Sanchez Luciana	Univ. de Lujan	Lujan, Argentina	Rocky intertidal ecology	1 st year (early stage)
Garcia Patricia	Univ. de Comahue	Bariloche, Argentina	Freshwater Ecology	2 nd Year (mid stage)
Guinder Valeria	Inst. Arg. de Oceanografía	Bahia Blanca, Argentina	Estuarine ecology	4 th year (last stage)
Hernandez Alejandra	Univ. Simón Bolívar	Caracas, Venezuela	Marine Ecology	Research assistant
Herrera Cesar	Univ. Simón Bolívar	Caracas, Venezuela	Marine Ecology	Research assistant
Jorge Gabriela	Univ. de la Republica	Montevideo, Uruguay	Marine Biology	1st year (early stage)
Kasten Paula	Univ. de Sao Paulo	Sao Sebastiao, Brazil	Marine Ecology	Master level
Lauretta Daniel	Museo Arg. Cienc. Nat	Buenos Aires, Argentina	Taxonomy of Anemones	3rd year (advanced)
Lopez Abbate Celeste	Inst. Arg. de Oceanografía	Bahia Blanca, Argentina	Estuarine Ecology	1 st year(early stage)
Martinez Mariano	Museo Arg. Cienc. Nat	Buenos Aires, Argentina	Taxonomy of holoturidea	1 st year (early stage)
Menoret Adriana	Univ.de Buenos	Buenos Aires,	Parasitology	1 st year (early

	Aires	Argentina		stage)
Montemayor Diana	Univ. de Mar del Plata	Argentina	Estuarine Ecology	3rd year (advanced)
Silva Ricardo	Inst. Nac. Inv. Des. Pesq.	Mar del Plata, Argentina	Phytoplankton dynamics	3rd year (advanced)
Silveira Santiago	Dir Nac Rec Acuac (DINARA)	Canelones, Uruguay	Artisanal fisheries	1 st year (early stage)
Tarantelli Maria Soledad	Univer.de Córdoba	Córdoba, Argentina	Marine Biology	1 st year (early stage)
Torroglosa Maria Eugenia	Univ.de Buenos Aires	Buenos Aires, Argentina	Ecology of sandy shores	1 st year(early stage)
Urteaga Diego	Museo Arg. Cienc. Nat.	Buenos Aires, Argentina	Taxonomy of chitons	3rd year (advanced)

Post course fieldwork and training

22nd February: Trip to Quequén. (550 km from Buenos Aires). Arrival time 16 hs.

18:30 hs. Scoping visit to intertidal. Learning basic biodiversity.

23rd February: 7:00 Field work. MarClim sampling.

11:00 Lecture in the University of Quequén.

13:30 Lunch

14:30-17:00 Talks by students

Field excursion 1700 -1930. Curtailed by storms

24th February: Shore excursion 7.30.

9:00 to 13:00 and 14:00 to 17:00 Students talks, discussion on methods and end of the course.

25th February: Field trip to Puerto Madryn (1000 km). We met there with Dr. Gregorio Bigatti, a researcher from CONICET that works in the Patagonian Centre for research (CENPAT). He is the director of the Marine Invertebrates lab. He showed us the Centre and facilities. He also showed us the rocky intertidal near Puerto Madryn, Punta Este and Punta Gales. Broadscale surveys were made and techniques discussed to pave way for a broadscale monitoring programme in Argentina.

26th February: Sampling at Punta Este (Puerto Madryn) and Punta Gales (Peninsula de Valdes).

27th February: Sampling at Punta Delgada (Peninsula de Valdes)

28th February: Trip to Playas Doradas (Rio Negro Province, 180 km north from Puerto Madryn). Sampling was done in two different sites in this area.

1st March: Trip to Viedma (350 km north from Playas Doradas). Sampling in Playa el Espigón and Playa Bonita. Discussions with Ph.D students of Palomo (2) and Cruz Motta (2) and staff from Mar del Plata University.

2nd March: Sampling in Playa El Espigon. Trip to Mar del Plata (800 km north from Viedma)

3rd March: Trip to Buenos Aires (400 km). End of the trip.

5th March Seminar by SJH at University of Buenos Aires on “climate change responses of marine biodiversity and ecosystems: combining sustained observing, experiment and modeling”

During the field trip we collected data on presence and in some cases abundance of species in the rocky intertidal. We found 13 species of algae and 25 species of animals and have developed a checklist of species for future monitoring (see Appendix I for the complete checklist).

Future collaboration

During the field trip, we discussed about two main collaborations. One involves a biogeographical study of the rocky shores. The hypothesis to be tested is that there is an inverse latitudinal gradient on the coast of Argentina. For testing this hypothesis we plan to collect data from the collection of marine invertebrates of the Museo Argentino de Ciencias Naturales, Buenos Aires City and Museo de Ciencias Naturales de La Plata and from a field trip that involves the Argentinean coast (from Buenos Aires Province to Tierra del Fuego). This collaborative project will be coordinated by Dr. Gabriela Palomo, Dr. Gregorio Bigatti and Prof. Steve Hawkins. The second collaboration is to organize a workshop involving the experts on marine invertebrates and algae taxonomists of Argentina and other South American countries to generate a complete species list and a field guide from the Argentinian rocky intertidal zone. During the field trip that we did along 1700 km of coast we realized that there is an urgent need of aggregating all the information that there is in each lab. A field guide about species on the coast, is essential for marine ecologist working on assemblages. Most of the field guides are for molluscs or crustaceans. The workshop would produce a general field guide of the species that compose the rocky intertidal assemblages.

Appendix I: Checklist of the species found on the field trip (from Quequen to Puerto Madryn).

Phylum	Class	Cientific Name	Type	Author
Phaeophyta	Phaeophyceae	<i>Macrocystis pyrifera</i>	cold waters-indopacific	(L.) C. Agardh
Phaeophyta	Phaeophyceae	<i>Undaria pinnatifida</i>	invasor-indopacific	(Harvey) Suringar
Phaeophyta	Phaeophyceae	<i>Colpomenia sinuosa</i>	cosmopolitan	(Mertens) Derbés et Solier
Phaeophyta	Phaeophyceae	<i>Dictyota dichotoma</i>	cosmopolitan	(Hudson) Lamouroux
Phaeophyta	Phaeophyceae	<i>Ralfsia verrucosa</i>	cosmopolitan	(Areschoug) J. Agardh
Phaeophyta	Phaeophyceae	<i>Petalonia fascia</i>	cosmopolitan	(O.F.Müller) O.Kuntze
Rodophyta	Florideophyceae	<i>Corallina officinalis</i>	cosmopolitan	L.
Rodophyta	Florideophyceae	<i>Nemalion helminthoides</i>	cosmopolitan	(Vellej) Batters
Rodophyta	Florideophyceae	<i>Ceramium rubrum</i>	cosmopolitan	(Hudson) C. Agardh
Rodophyta	Florideophyceae	<i>Hildenbrandtia lecanellieri</i>	cosmopolitan	Hariot
Chlorophyta	Ulvophyceae	<i>Codium fragile</i>	invasor-Japan	(Suringar) Hariot
Chlorophyta	Ulvophyceae	<i>Ulva lactuca</i>	cosmopolitan	L.
Chlorophyta	Ulvophyceae	<i>Ulva rigida</i>	cosmopolitan	(C. Agardh) Thuret
Chlorophyta	Ulvophyceae	<i>Enteromorpha intestinalis</i>	cosmopolitan	(L.) Link
Chlorophyta	Ulvophyceae	<i>Enteromorpha linza</i>		(L.) J. Agardh
Mollusca	Bivalvia	<i>Perumytilus purpuratus</i>		Lamarck, 1819
Mollusca	Bivalvia	<i>Brachidontes rodriguezi</i>		(Orbigny, 1846)
Mollusca	Bivalvia	<i>Mytilus edulis platensis</i>		Linnaeus, 1758
Mollusca	Bivalvia	<i>Aulacomya atra atra</i>		Molina, 1782
Mollusca	Gastropoda	<i>Tegula patagonica</i>		(d'Orbigny, 1840)
Mollusca	Gastropoda	<i>Trophon geversianus</i>		(Pallas, 1774)
Mollusca	Gastropoda	<i>Siphonaria lessoni</i>		(Blainville, 1824)
Mollusca	Gastropoda	<i>Fissurella radiosa</i>		Lesson, 1830
Mollusca	Gastropoda	<i>Nacella magellanica</i>		(Gmelin, 1791)
Mollusca	Gastropoda	<i>Crepidula dilatata</i>		Lamarck, 1822
Mollusca	Polyplacophora	<i>Chaetopleura isabellei</i>		(d'Orbigny, 1839)
Mollusca	Polyplacophora	<i>Plaxiphora aurata aurata</i>		(Spalowsky, 1795)
Arthropoda	Malacostraca	<i>Cyrtograpsus angulatus</i>		Dana, 1851
Arthropoda	Malacostraca	<i>Cyrtograpsus altimanus</i>		Rathbun, 1914
Arthropoda	Maxillopoda	<i>Balanus glandula</i>	invasor	Darwin, 1854
Echinodermata	Asteroidea	<i>Allostichaster capensis</i>		(Perrier, 1875)
Echinodermata	Asteroidea	<i>Anasterias antarctica</i>		(Lütken, 1857)
Echinodermata	Echinoidea	<i>Arbacia dufresnii</i>		(Blainville, 1825)
Cnidaria	Anthozoa	<i>Antholoba achatas</i>		(Drayton in Dana, 1846)
Cnidaria	Anthozoa	<i>Anthothoe chilensis</i>		(Lesson, 1830)
Cnidaria	Anthozoa	<i>Parabunodactis imperfecta</i>		Zamponi & Acuña, 1992
Porifera		<i>Sponge purple</i>		
Porifera		<i>Sponge Orange</i>		