Marine Ecosystems Research Programme

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Kick off Meeting Report

4-6 June 2014

Marine Ecosystems Research Programme
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Project Office hosted by Plymouth Marine Laboratory
Funded by the Natural Environment Research Council and the Department for Environment, Food and Rural Affairs

NERC SCIENCE OF THE ENVIRONMENT

Department for Environment Food & Rural Affairs

Marine Ecosystems
Research Programme

Marine Ecosystem Research Programme Kick-off Meeting

Hosted by Plymouth Marine Laboratory, UK

4-6 June 2014

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Executive Summary

Human activities and environmental change that affect parts of the marine ecosystem can have much wider consequences for biodiversity and ecosystem services than previously thought, due to interactions through food webs. Research activity in the North-East Atlantic region has tended to be fragmented and focused on components of the system (e.g. specific habitats or issues such as fishery management or conservation), largely reflecting the interests and responsibilities of individuals and organisations commissioning the work. There is widespread recognition among the research and policy communities that this situation needs to change, and that a whole-system perspective is now required linking an understanding of the dynamics of marine ecological communities into the currency of ecosystem services to improve our understanding of the whole ecosystem, rather than just parts of it. What is missing is a mechanism to bring existing data together, target new data collection, and integrate data and models all within a common framework focused on ecosystem services. The Marine Ecosystems Research Programme is designed to provide the investment (~£6M over 5 years) needed to support this.

The programme consists of 3 work packages. Following an announcement of opportunity in late 2012, which called for proposals to deliver work packages 1 and 2, and an outline-bid round in early 2013, full proposals for work packages 1 and 2 were submitted in mid-2013. In late 2013 two consortia were selected to take the programme forward. In discussions with NERC and Defra it was clear that it would be efficient to manage these two consortia together. Thus work package 2 became module 6 within the combined programme, which is managed centrally from a programme Office at the Plymouth Marine Laboratory (PML).

This report is a record of the Marine Ecosystems Research Programme kick-off meeting, which was held at PML in June 2014. Being the first time that many members of the two consortia had met, and the first time that many consortium members had met their colleagues since the proposals were being developed, there was much to discuss. The essence of the meeting was to remind participants of what they were to do, how it was to be done, and when. Details of the machinery by which the delivery of programme would be managed and monitored, and the impact of the work maximised were explained and discussed. Integrating workshops were held to facilitate communication across the programme. The Programme Advisory Board was introduced to the community, sat in on deliberations and discussions, and made recommendations. An action list describes how the work is to be taken forward in the coming months.

Actions

Action	Responsible PI	Date	Purpose
Summaries from Module sessions and breakout groups at kick off meeting	Module leaders to provide brief summaries	Asap before 18 June	For inclusion in meeting report
Kick-off Meeting Report	Project Office	Asap before end June	
Matrix of models – distribute draft for comment and additional entries	Icarus Allen	End of June	Internal communication/ integration
2 page summaries for each Module:	Module leaders will	End of June	Internal

• What are you doing • What is the objective • Where will the information go • Will it fill a gap • What can we do with our information and what can other people do with it	produce first draft and distribute for comment		communication. Can be disseminated more broadly as appropriate
Programme reporting: NERC to supply template for 6 monthly management reports	PO will coordinate input from each Partner on activities per module. Module leaders will oversee final draft for their module.	6 monthly cycle: likely January and June	Reports sent to NERC/Defra and Advisory Board. Reports will be translated into a digestible format for stakeholders
Annual Report	Coordinated by Project Office with input from partners	May/June annually	
Deliverables assigned lead	Module leaders will discuss with PIs and assign responsibility per deliverable.	End of June	
Submitting Deliverables	Module leaders to coordinate delivery to PO	As per Deliverable table	Deliverables sent to NERC, translated for the website
Module Leader meeting	Monthly teleconferences during the initial stages of project	End of July	
Workshops - Inform PO of planned meetings so details can be disseminated as appropriate	Workshop organiser	As appropriate	
Annual Meeting	Organised by PO	Poll for dates asap	Date suggested for end of April 2015 in N. Ireland?
SharePoint – Strathclyde to be reactivated and linked to main website	Mike Heath	End of June	
Guideline for Publications – drafted and circulated for comment and agreement	Mark Emmerson, Tom Webb and Paul Somerfield	July	
Data policy – use BODC as a draft	Tom Webb will distil the data management plan and circulate it	July	
Scientist profiles on the website	Project Office	End of June	Individuals to send

			summaries to PO, template will be provided.
Update Case for Support e.g. with latest deliverable list	Project Office	July	

Meeting summary

The Marine Ecosystem Research Programme officially kicked off with a meeting of the Consortium on Wednesday 4th June 2014. All 12 partners were represented at the meeting which intended to highlight the aims and objectives of the Programme and begin work on developing active work plans. List of participants can be found in ***Appendix 1***.

Welcome to PML

The meeting began with a welcome to Plymouth Marine Laboratory from Manuel Barange.

A policy perspective

Carole Kelly from Defra provided a policy perspective for the programme to show how it fits into the wider marine management sector.

The Science Programme

The programme coordinator welcomed the group and set the scene for the programme, explaining the developments that have occurred since project inception, predominantly the linking of work package 1 (IMMERSE) with Work Package 2 (modelling) to create the overall Marine Ecosystem Research Programme (MERP).

The main science programme was then presented by the module leaders.

MERP Modules

Module 1. Marine ecosystem data toolbox & application of macro-ecology led by Tom Webb (PML)

Module 2. Fieldwork to measure poorly known processes led by Angus Atkinson (PML)

Module 3. Ecological processes and their representation in models led by Axel Rossberg (Cefas)

Module 4. Simulating and predicting ecosystem changes using a model ensemble led by Julia Blanchard (UoS)

Module 5. Linking macro-ecology and models to ecosystem services led by Melanie Austen (PML)

Module 6. Developing a model-based understanding of ecosystem service regulation led by Jorn Bruggeman (PML)

Work plans and breakout sessions

Each module had session in which to discuss their specific work plan. For the majority of modules this was done plenary with additional break out groups as needed.

Presentations from these sessions are available online at http://www.marine-ecosystems.org.uk/Meetings

The notes from these sessions are available in the Appendices.

Module 1

For Module 1 notes and ideas see ***Appendix 2***

Key points for discussion under this module included

- project communications (best approach? Wiki pages, SharePoint etc)
- priorities of tools for all
- centralising data storage vs accessing distributed data in situ (limitations of web services)
- bespoke vs adapted methods, systems (NBN? EMECO?)
- example workflows key: what queries do you want to run
- GIS requirements? Maps vs data
- What are the key traits? E.g body size, mobility, what else should be in the database

Module 2

For Module 2 draft work plan see ***Appendix 3***

Key points of discussion for this module included:

- What is the ration of kelp to planktonic primary production at coastal and whole shelf scales? (SAMS, QUB)
- How does the kelp subsidy to food web decrease with distance offshore (SAMS QUB, PML)
- What are the mechanisms for this uptake to the benthos? (PML, QUB, SAMS)
- Complete biomass spectra for pelagic and benthic (Bangor, PML, Cefas, QMUL)
- Need input from module 1 to get details from large scale surveys to gain abundance information. To help work out biomass spectra, this does not need to be species specific data. Tracking data would also be useful here.
- How does the functional diversity (e.g. gelatinousness, motility (PML, Cefas, QMUL)
- How does density dependence operation? (QUB, PML, QMUL)

Open question: is the current data collection still useful and appropriate for the modelling community? Feedback came that data was particularly good for testing the models, only issue is around labelling and communicating traits. How to line up observation definitions with model definitions, the same applies for traits.

Module 3 and 4

Modules 3 and 4 which are very closely linked broke out into a small group to elucidate what the deliverables meant, amended the milestones to better keep track of the tasks, allowing them to form a clear view how all tasks and outputs interact. During this session the group drafted a gant chant to for how the modules would interact (***Appendix 4***) and additional planning notes from the session are available in ***Appendix 4a***

Module 5

Module 5 ran a breakout session with participants doing a round robin to provide information on how is the broader group could incorporate their work in the broad ecosystems agenda. The aim being to get partners to think about what how your work can be integrated into this module.

The module 5 Presentation is available at http://www.marine-ecosystems.org.uk/Meetings

Three breakout groups were run:

- Regulating Services (see ***Appendix 5*** for notes)
- Cultural Services (see ***Appendix 6*** for notes)
- Provisioning services (see ***Appendix 7*** for notes)

Module 6

The work for this module was put in context by presenting recent developments including the coupling work achieved through the EC MEECE project and the previous work that has been done on programming infrastructure. Currently already applied to the pelagic part of the ERSEM model, through MERP the benthic component will be developed.

The main aims through the MERP programme of this work are to:

- Reformulate in terms of unified model, preserve original functionality
- Individual organism as base level of organisation – compatibility with ibms, structured populations (phase II:meroplankton)
- Unified formulation of common processes:

See ***Appendix 8*** for notes from this session

Data integration

A session was held to figure out how to capture what each PI is going to do, what data will they be gather and when.

Data quality

What are the procedures for data quality assurance?

- From a modelling perspective each model owner has a process of version control and testing, but currently no common approach for this.
- Experiments – database of data will include some measure of confidence and as much detail as possible about the data itself.
- Do we need a consortium wide data policy: what format should that data be in? How to ensure quality control?
- Including a data audit to show what has been used where.
- Model matrix needs to be developed will be done via email.

The notes from this session are available in ***Appendix 9***.

MERP Models

Model Flash presentations: all models used in the Programme were briefly presented with time for questions from the consortium. The aim of this session was to ensure everyone was aware of the models in use and try to better understand how they can be integrated across the programme.

Two page descriptions of the models use in the MERP are available in ***Appendix 10***.

Knowledge Exchange and Pathways to Impact

Knowledge Exchange for the programme is coordinated by the Communications Group at Plymouth Marine Laboratory. One of the key preliminary activities of the group has been to develop a Pathways to Impact (PtI) plan. The aim of a PtI is to encourage researchers to be actively involved in thinking about how they will achieve excellence with impact and to explore the pathways for realising this impact. This plan and a list of the potential knowledge exchange activities were presented by Kelly-Marie Davidson (PML) and the floor opened for discussion and feedback. See ***Appendix 11*** for notes from this session.

Potential Knowledge Exchange activities

- Establish a stakeholder group with 6-monthly meetings
- Engagement of the Marine Biodiversity Monitoring Programme, Celtic Seas Partnership, SSB, BESS
- Working with ROpenSci, develop a simple web-interfaces linked with existing initiatives (Emecodata) so that processed versions of our data, such as maps or time series, are accessible (need to find out who suggested this)
- Policy report (D4.5, M42)
- 2 seminars for funders / policy
- Westminster Energy, Environment and Transport Forum Keynote seminar (Angus?)
- British Ecological Society symposium (D1.3, M18)
- Policy secondments
- Updated POST Note on ecosystem services (last one May 2011 but they may be interested to do an update by the end of MERP)
- Project website including subscription option and biographies of MERP participants
- Simple interactive “Past & Futures” web app to enable users to select ecosystem properties, indicators and services to visualise changes to a marine ecosystem through time (need to find out who suggested this)
- Wider public communication via the media (press, broadcast, social media)
- Bi-annual project updates / newsletter
- Programme leaflet
- Feature articles in popular press
- Pod/vodcasts
- Public events at Portaferry (spoke with Nessa and they may be able to move the location due to the aquarium closure) and the National Marine Aquarium (is this actually wanted / beneficial? May be better to combine with NSEW)
- National Science and Engineering Week event on human’s impact on food webs
- Powerpoint and poster template
- Potential annual Defra 2 page summary (mentioned by Carole Kelly – combine with annual report mentioned in the Steering Committee meeting?)
- Communications with SSB research programme
- Media policy
- KE workplan
- Template for publication briefing notes (discussed in the PtI session)
- Interactive seminars for internal comms (discussed during Steering Committee meeting)
- Public perception analysis? (discussed in the PtI session, BESS as an example)
- Factsheets (discussed in the PtI session, VECTORS as an example)

- Reactivate SharePoint (Mike Heath to do)

The draft Pathways to Impact plan (***Appendix 12***) is still under development with Defra and NERC. Once confirmed it will be distributed to all partners.

Feedback from the Programme Advisory Board

Following a closed discussion session the PAB provide feedback to the Consortium on the key points they felt need action and focus in the coming months.

The group saw the key challenge being to ensure that the project develops as a coherent integrated whole rather than a set of disparate projects. This requires a clear focus on end points, in terms of target ecosystem services, scientific outcomes and specific areas of impact in terms of policy, management and business. In general, the aim should be to do a few things well, rather than a lot of things less well. The full response from the PAB can be found in ***Appendix 13***.

Conclusions and next steps

The merging of work package 2 into a combined programme with 6 modules, instead of the 5 in the original work package 1 proposal, works well and is seen to be efficient and sensible. Having the Programme Office, KE Office and PIs in one place will greatly facilitate management and delivery of the programme.

Action Lists were developed from the general meeting and from the Programme Management Group meeting. These will be addressed over coming months. It was also noted that the Programme Stakeholder Panel has yet to be assembled, and how the programme is to interact with this group formed the subject of discussions at various levels. A way forward was agreed, and will also be actioned in coming months.

Being the first time some people had met, and the first time some colleagues had met face to face since the proposals were being developed, there was much to discuss, particularly with respect to detailed work plans. The Programme Advisory Board picked up on the fact that integration is key to the success of the programme, and there was some discussion about how best to ensure this. Given that this meeting was a kick-off meeting, and few tasks are scheduled to be completed within the first year, it is to be expected that there will be several months of spin-up time. Developing more detailed schedules of work will be the focus of the programme management over the next 6 months.

Appendix 1: Marine Ecosystem Research Programme Kick-off Meeting Participant list

1	John	Aldridge	Centre for Environment, Fisheries and Aquaculture Science
2	Icarus	Allen	Plymouth Marine Laboratory
3	Yuri	Artioli	Plymouth Marine Laboratory
4	Angus	Atkinson	Plymouth Marine Laboratory
5	Melanie	Austen	Plymouth Marine Laboratory
6	Arwin	Bargery	British Oceanographic Data Centre
7	Nicola	Beaumont	Plymouth Marine Laboratory
8	Paul	Blackwell	University of Sheffield
9	Jorn	Bruggeman	Plymouth Marine Laboratory
10	Michael	Burrows	Scottish Association for Marine Science
11	Momme	Butenschon	Plymouth Marine Laboratory
12	Tasman	Crowe	University College Dublin (Programme Advisory Board)
13	Kelly-Marie	Davidson	Plymouth Marine Laboratory
14	Martin	Edwards	Sir Alister Hardy Foundation for Ocean Science
15	Mark	Emmerson	Queen's University Belfast
16	Elaine	Fileman	Plymouth Marine Laboratory
17	Kevin	Gaston	University of Exeter (Programme Advisory Board)
18	Rachel	Harmer	Plymouth Marine Laboratory
19	Jessica	Heard	Plymouth Marine Laboratory
20	Mike	Heath	University of Strathclyde
21	Pierre	Hélaouët	Sir Alister Hardy Foundation for Ocean Science
22	Sheila	Heymans	Scottish Association for Marine Science
23	Jan Geert	Hiddink	Bangor University
24	Andrew	Hirst	Queen Mary, University of London
25	Carole	Kelly	Department for Environment, Food and Rural Affairs
26	Rachel	Leader	Natural Environment Research Council
27	Pennie	Lindeque	Plymouth Marine Laboratory
28	Steve	Mackinson	Centre for Environment, Fisheries and Aquaculture Science
29	Sophie	McCoy	Plymouth Marine Laboratory
30	Eugene	Murphy	British Antarctic Survey (Programme Advisory Board)
31	Rudi	Nager	Glasgow University
32	Vicki	Norton	Natural Environment Research Council
33	Nessa	O'connor	Queens University, Belfast
34	David	Paterson	University of St Andrews (Programme Advisory Board)
35	John	Pinnegar	Centre for Environment, Fisheries and Aquaculture Science
36	Luca	Polimene	Plymouth Marine Laboratory
37	Ana	Queiros	Plymouth Marine Laboratory
38	Axel	Rossberg	Centre for Environment, Fisheries and Aquaculture Science
39	Sevrine	Sailley	Plymouth Marine Laboratory
40	Michaela	Schratzberger	Centre for Environment, Fisheries and Aquaculture Science
41	Kate	Searle	Centre for Ecology & Hydrology, NERC
42	Paul	Somerfield	Plymouth Marine Laboratory
43	Nick	Stephens	Plymouth Marine Laboratory
44	Rob	Thomas	British Oceanographic Data Centre

45	Sonja	Van Leeuwen	Centre for Environment, Fisheries and Aquaculture Science
46	Sarah	Wakelin	National Oceanography Centre
47	Tom	Webb	Sheffield University
48	Mike	Webb	Natural Environment Research Council
49	Claire	Widdicombe	Plymouth Marine Laboratory

MERP Module 1

Marine ecosystem data toolbox and macroecology

	Yr1				Yr2				Yr3				Yr4			
	q1	q2	q3	q4	q1	q2	q3	q4	q1	q2	q3	q4	q1	q2	q3	q4
Dataset ID, compilation, formatting QC																
Literature-based data collection (e.g. seabird diets)																
Ecoinformatics tool development																
Delivery of synthetic data products to modelling team																
Macroecological analyses of Western Seas																
Characterisation of higher predator communities																
Size- versus species-based macroecology																
Macroecology symposium with BES Macroecology group																

Milestones: data

- Comprehensive inventory and compilation of metadata of existing datasets

Gut contents?

Abundance?

Dataset ID

Description

Time series?

dataset	owner	description	taxa covered	gut contents	stable isotopes	abundance	body mass	time series	notes
(Eur)OBIS	open	Global compilation of occurrence records for all marine taxa	all						I work closely with VLIZ / IODE who manage OBIS
WoRMS	open (with res	Taxonomy of all marine taxa, including synonyms etc.	all						I work closely with VLIZ who manage WoRMS, and I am a registered user
NBN	various; larget	Compiles data from many UK (terrestrial & marine) surveys, across most taxonomic groups	all						We (BES Macroecology Group) have been working with NBN to improve access
ICES	ICES	Various, inlcuding International Bottom Trawl, Gut Contents, Fish Larvae, others.	mainly fish	Some		Some	Some	10-100y	Some webservices available to facilitate access; includes some data available from Cefas & elsewhere
CPR	SAHFOS	The Continuous Plankton Recorder Survey	plankton					50+y	Sahfos contacts for Immerse: Martin Edwards, Pierre Helaouet; Paul, Martin & I have a PhD student working on CPR data
Biotic	open	Biological traits of benthic species	benthic species				Species-level estimates		I probably have a more useable, and almost as comprehensive, database of biological traits - am aiming for it to be integrated into WoRMS soon too
Biomor 1,2	published & di	Benthic biodiversity in the Irish Sea	benthic infauna & epifauna			Some (include	Some biomass		I have used this, and have a copy
CSEMP	BODC	Clean Seas Environment Monitoruing Programme	Macrobenthic infaunal inverts			Some			I have used this, and have a copy
MNCR	JNCC (so shou	Marine Nature Conservation Review	Intertidal & Shallow subtidal communities			Some			I have used this, and have a copy
SeaSearch	seasearch.co.u	Fish, benthic inverts, from visual SCUBA surveys				Some			I have used this, and have a copy
Seabird colony	JNCC	Whole colony count data for UK & Rep Ireland	Seabirds			Yes	Species-level menas available (from other sources which I have)	25y (ongoing)	
Seabirds at Se	JNCC; access	Seabirds & cetaceans at sea	Seabirds, Cetaceans			Yes	Species-level menas available (from other sources which I have)	30+y (ongoing)	
Western Chan	PML/MBA	Oceanographic timeseries / marine biodiversity reference site	phytoplankton, zooplankton, fish, benthos			Yes		5-100+y	

Owner

Taxa

Body mass?

Notes

Stable Isotopes?

Milestones: data

- Comprehensive inventory and compilation of metadata of existing datasets

- Identify & describe scope of other relevant initiatives (iMarine, EMODnet, MEDIN, EMECO…)

- Objective: working draft (template) for discussion at Sept 2014 Module 1 meeting, Sheffield

- Responsible: Webb (+ summer students)

Milestones: data

- Specific, targeted data collection
  - Top predator resource use (Nager + PGRA)
  - Improved vital rates coverage, especially for benthic organisms (Hirst + PDRA)
  - Compilation of Species-Abundance Distributions (Webb + PDRA / Students)

Milestones: communication

- Set up wiki or similar to document progress
- Establish lines of communication (Google+, HipChat…)
- Have in place by September

Milestones: ecoinformatics

- Identify data resources with existing webservices
- Prioritise according to consortium needs
- Develop programmatic access to key datasets
- Document example use cases and workflows

Milestones: ecoinformatics

- Responsible: Webb + PDRA

- Timescale: from end 2014, initial outputs mid 2015

Milestones: macroecology

- Basic quantification of patterns for major functional groups
- Causes & consequences of variation in predator communities
- Quantifying environmental variation
- Scale-dependence of macroecological patterns and relationships across functional groups
- Consumption scaling and dimensionality of trophic interactions
- Empirical relationships between size- and species- based macroecological relationships

Discussion points

- Relative priorities of tools for all v providing access on request
- Centralising (some) data storage v accessing distributed data in situ (limitations of webservices)
- Bespoke v adapted methods, systems (NBN? EMECO?)
- Example workflows key: what queries would you like to run?
- GIS requirements? Maps v data
- Key traits?

MERP Module 1

Overview

M1 components

- Ecoinformatics: improving access to existing data
- Macroecology: analysing existing data
- 'Translation' between empirical and modelling currencies

Existing Data

- The Western Seas of the UK constitiute 0.01% of global marine area
- They contain ~8% of all records (2M) in the major global marine biodiversity database OBIS
- These include distributional records of c.25K species covering all major marine taxa
- At least 1,000 records a year since 1950, 10,000 a year since 1972

Some taxa are very well known…

- Zooplankton

  Spatially extensive, long-term data from the Continuous Plankton Recorder Survey

- Fish

  >30y spatially extensive annual bottom trawl surveys

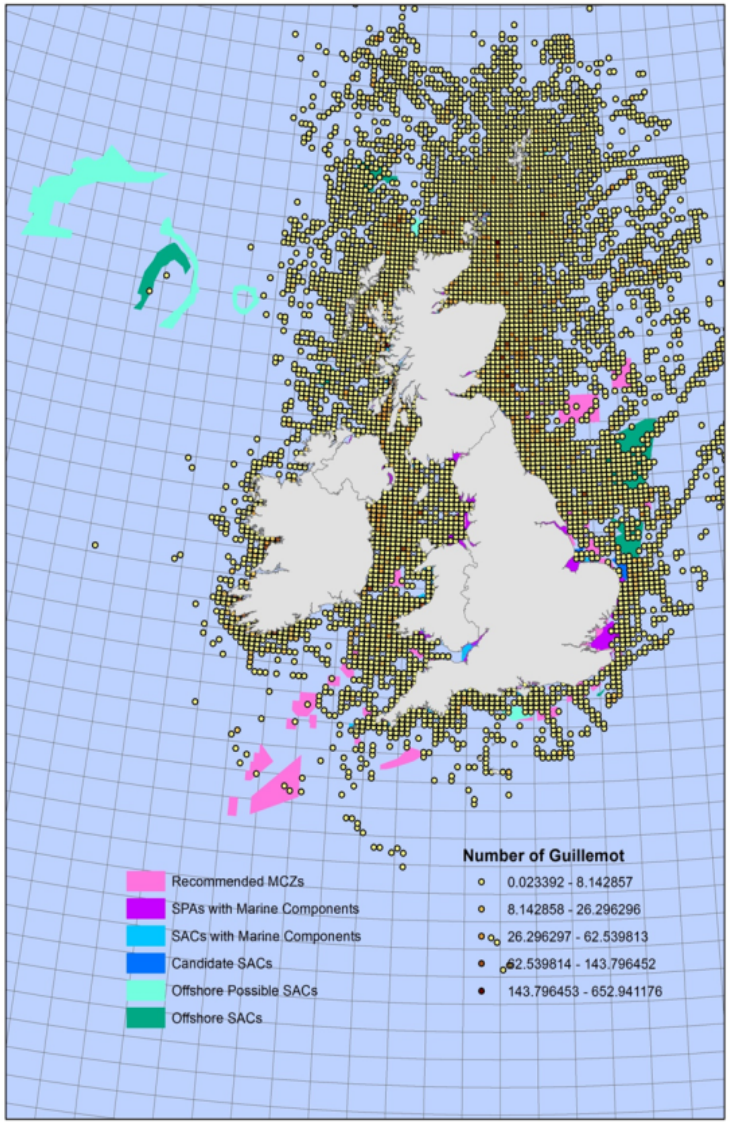
  Stomach-content analyses for >26K individuals and stable isotope data for >3,600 individuals in the Celtic Sea

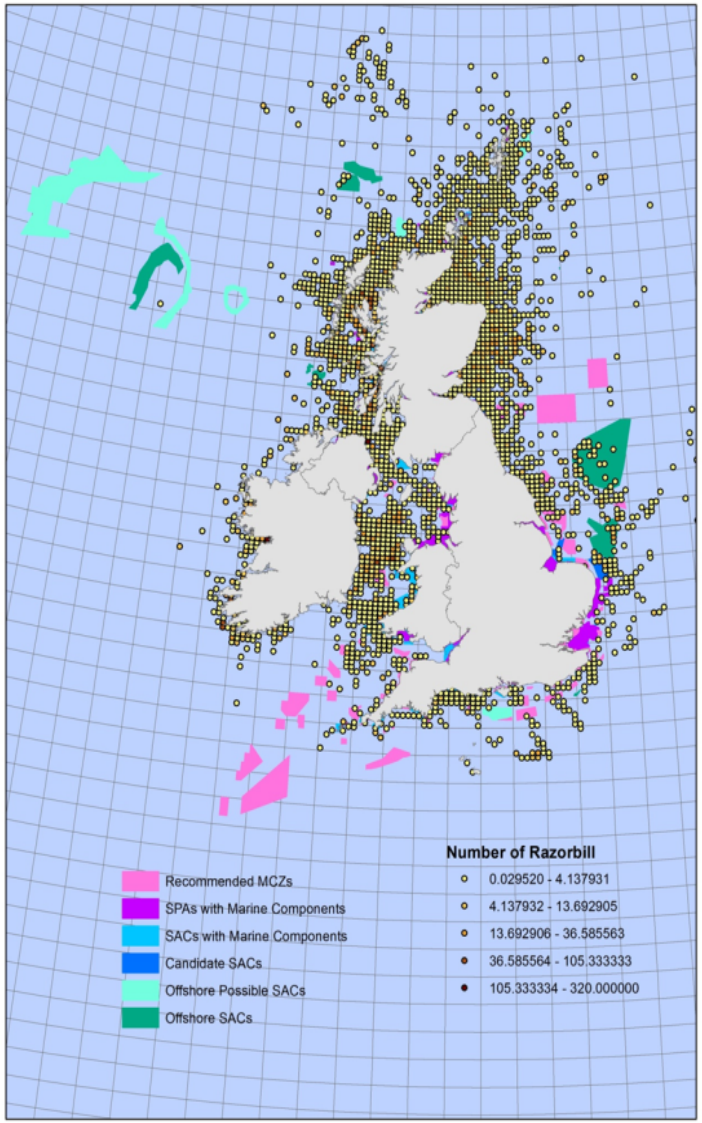
- Seabirds

  600,000km survey effort, 1980—present >1M at-sea records

  >8M breeding birds counted at >3K coastal colonies

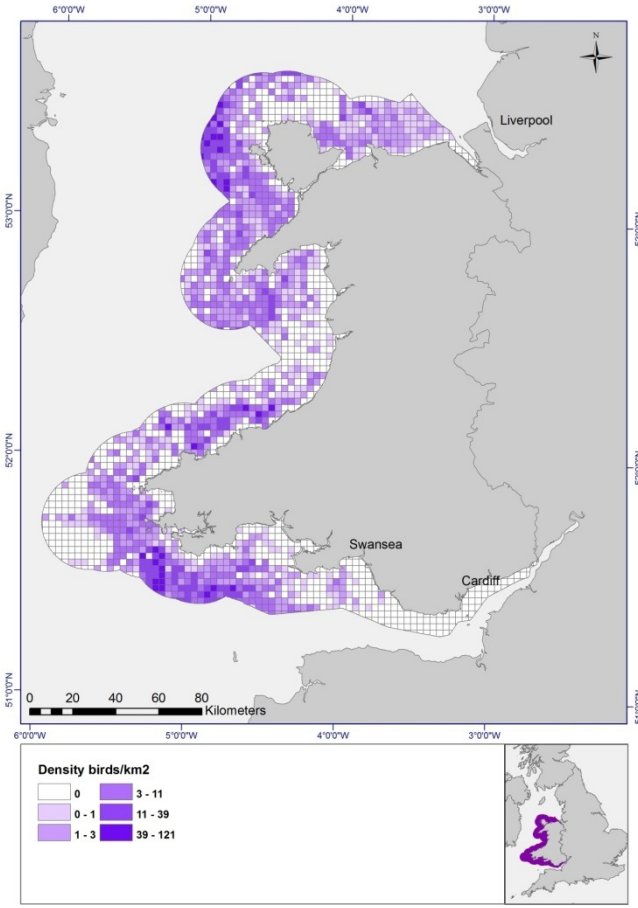
Extensive distribution records…



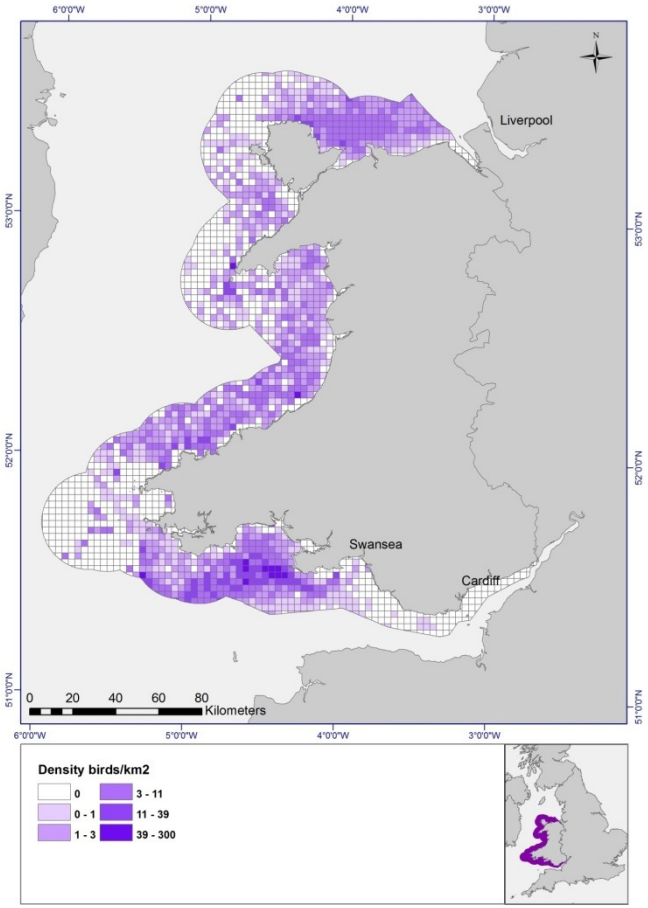


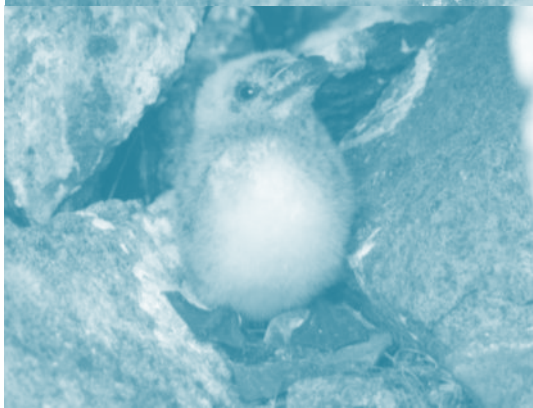
…detailed, seasonally resolved maps…

Summer

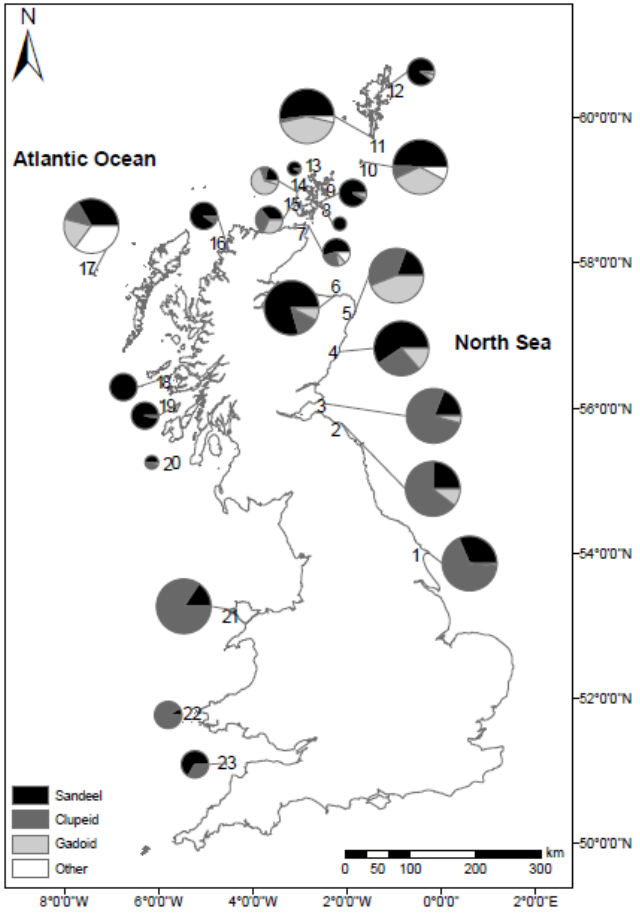


Winter



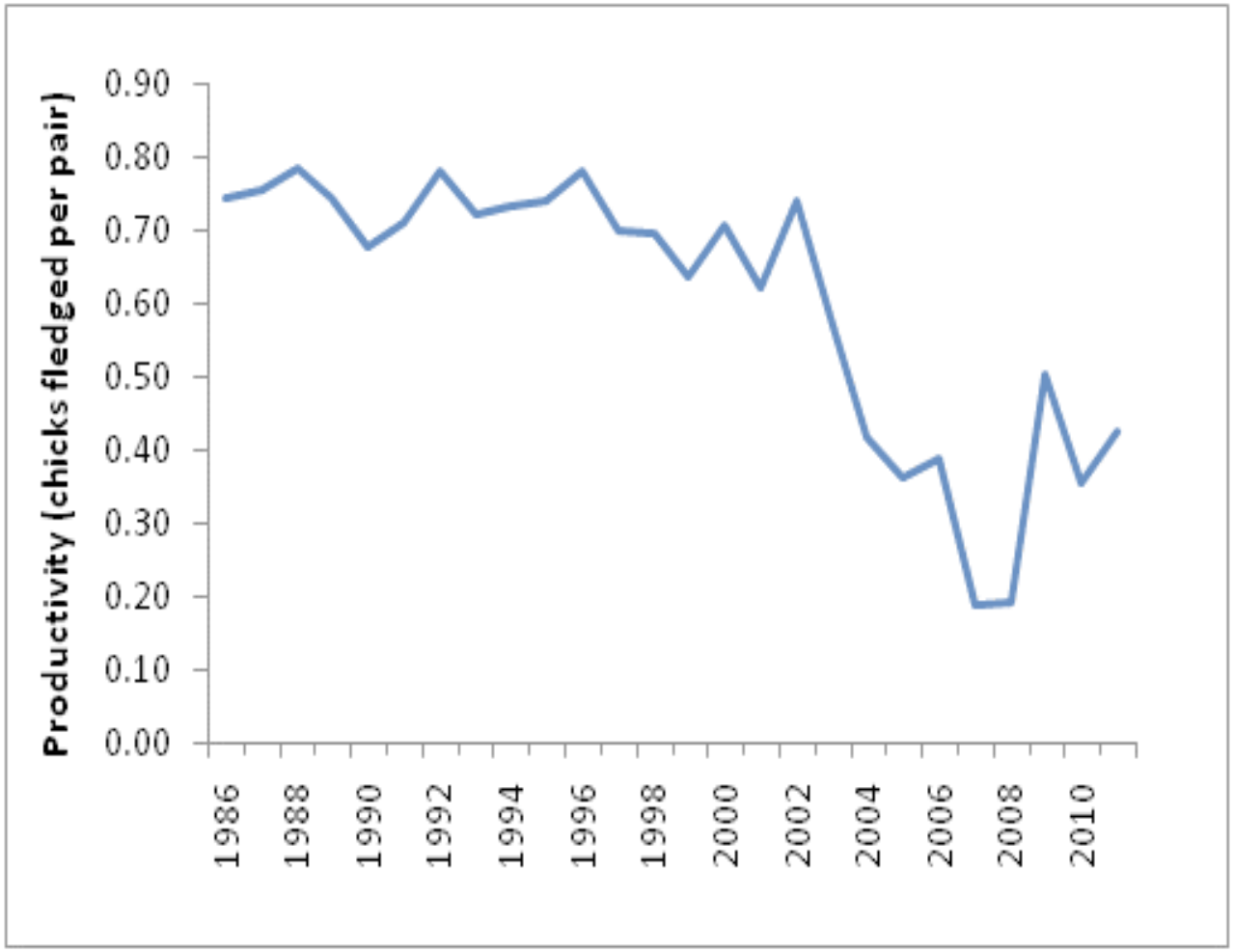


…dietary composition…



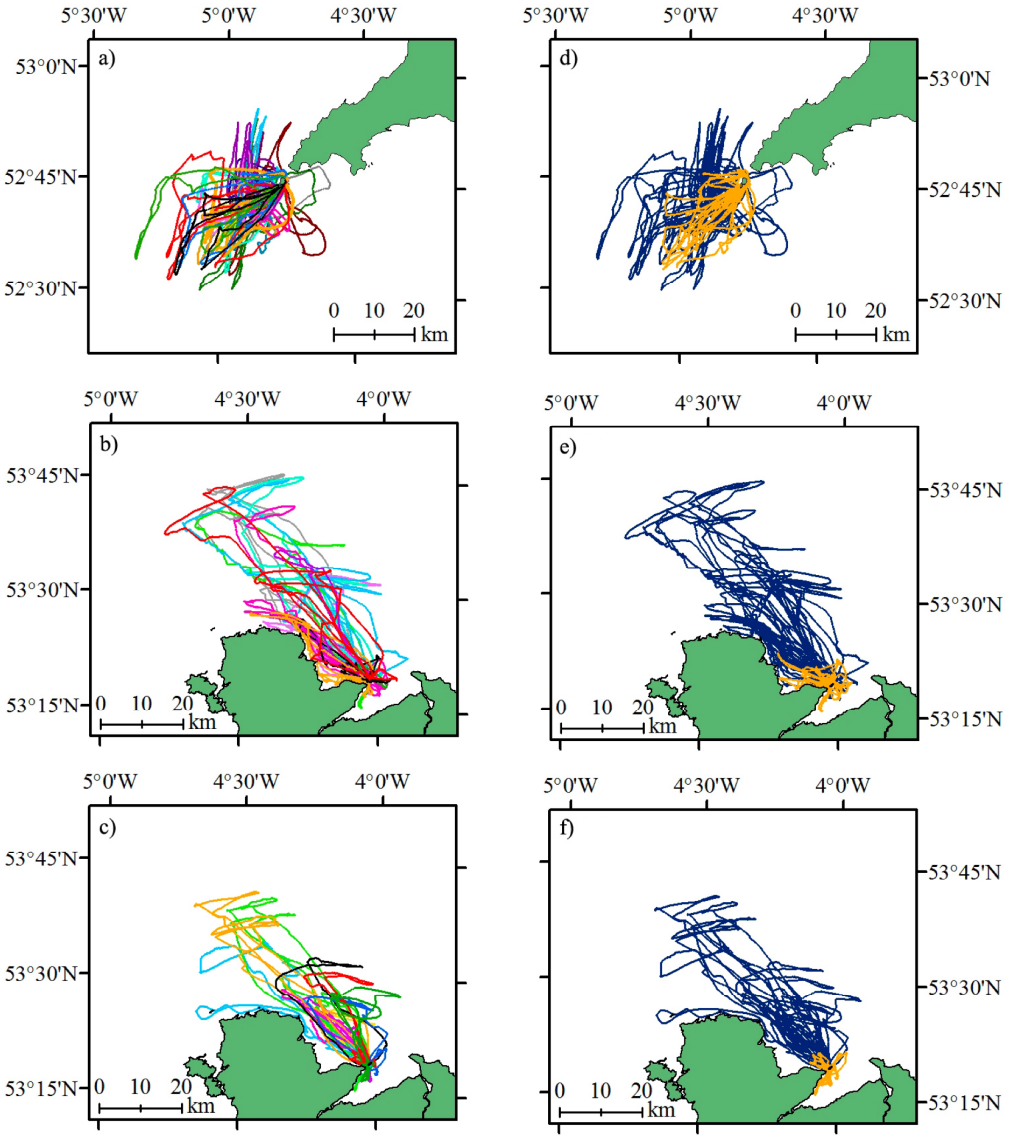
Anderson et al (2013) Ibis

…breeding productivity…

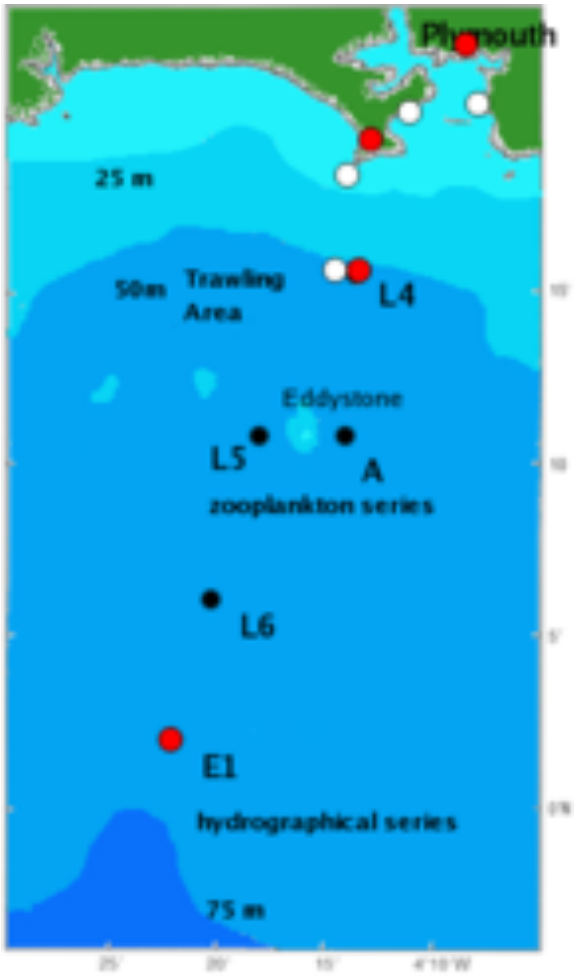


(**Source:** Joint Nature Conservation Committee, 2012)

…and individual behaviour.



Some sites are comprehensively sampled…



From photons to fish, from seconds to centuries…

But comprehensive macroecological meta-anlayses are hindered because data are:

- stored in different places
- under different standards
- covering different areas and time periods

Living in an Ivory Basement

Stochastic thoughts on science, testing, and programming

misc | personal | python | science | teaching | testing

Some myths of reproducible computational research

About 10 days ago, I gave a talk in Manchester to Carole Goble's group, hosted by Aleksandra Pawlik. The talk title was "Six ways to Sunday: Approaches to computational reproducibility in non-model sequence analysis." I've posted the slides (here).

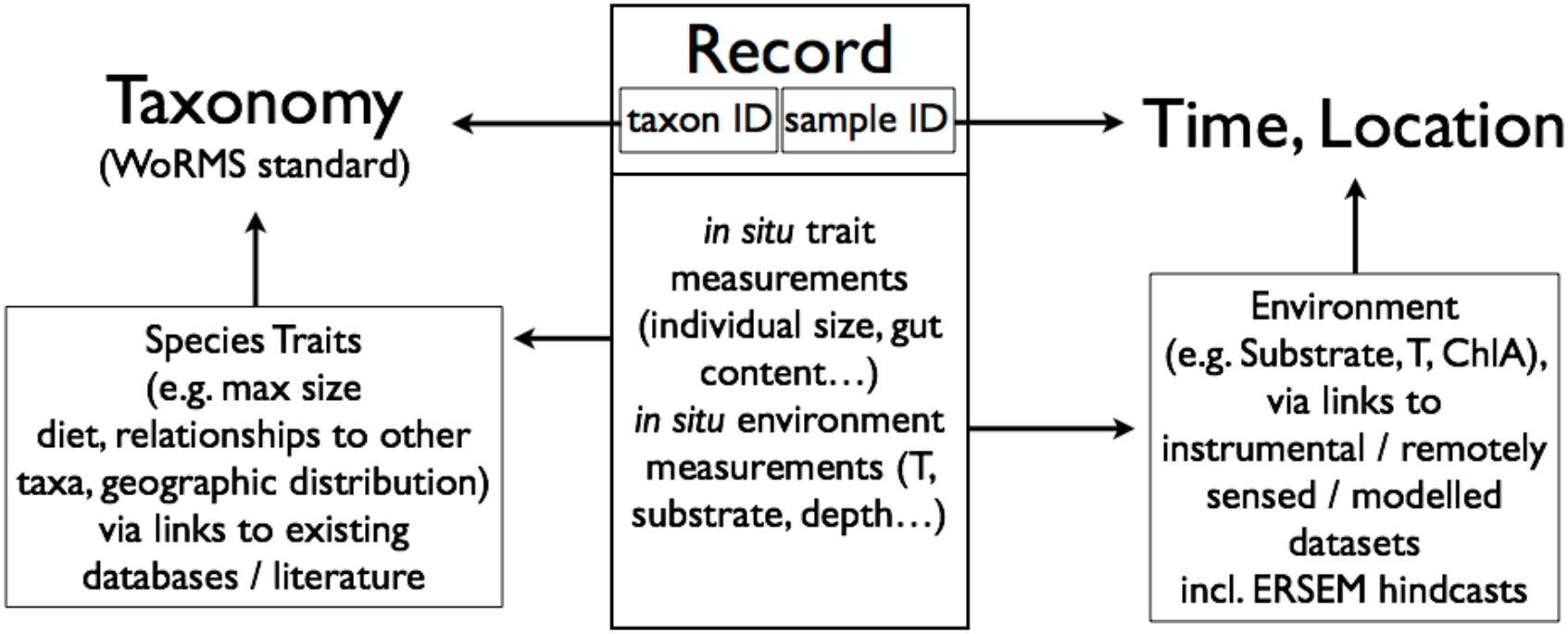
Sat 31 May 2014
By C. Titus Brown
In science.
tags: reproducibility rants

For the talk, I put together a list of five things that I felt were "myths" of reproducible computational research: attitudes that wrongly discouraged people from actually *doing* computational research reproducibly. I thought it was worth reproducing them below with a bit of discussion.

"What we need right now is scientists actually using stuff that already exists, not engineers building new stuff that no one will ever use"

MERP Module 1 will…

- Build tools to access these data
- Use **taxonomic** and **location** keys to **enrich** existing data with multiple additional sources



- Spatially- and temporally- resolved taxonomic & functional diversity, size spectra
- Patterns of co-occurrence between species of the same trophic level
- Patterns of co-occurrence between predators and prey
- Correlated changes across trophic levels
- Species—environment relationships

Macroecology

- Macroecology of all major functional groups
- Spatial distributions & abundance
- Physiology & vital rates
- Scale dependence
- Environmental covariates
- Habitat & consumption dimensionality

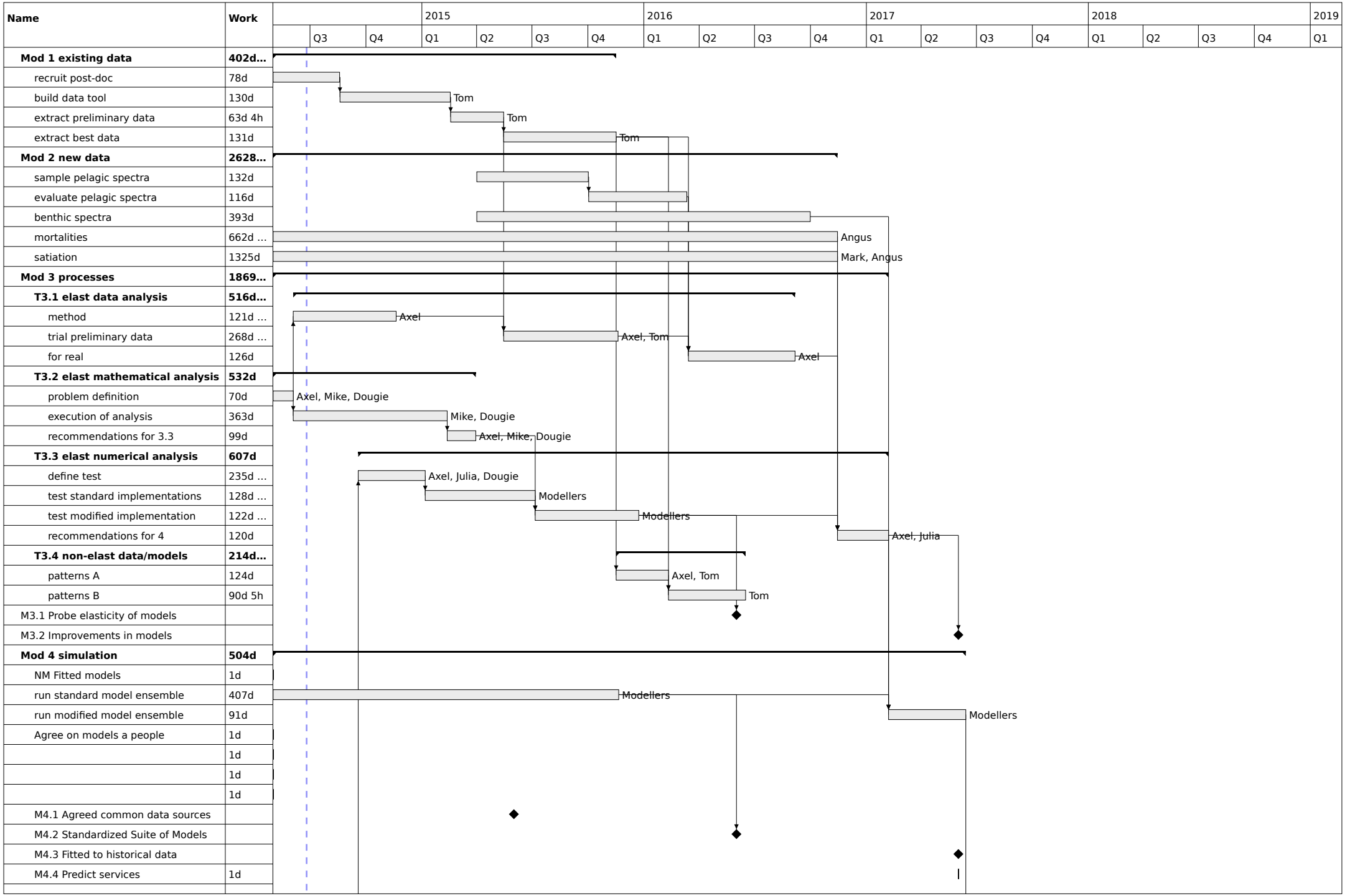
Integration

- Empirical relationships between size spectra and species-level macroecology
  - Builds on work by Rossberg, Reuman et al.
- Empirical estimates of key model parameters
- Ultimately: translation between currencies of empiricists & modellers & into services

MERP Module 2 workplan

Deliverable	Lead partner For delivery and contributors	Objective (e.g. paper title)	Possible Lead for objective And potential main contributors	What the objective entails
2.1 Report on the quantification of trophic and non-trophic benthic-pelagic coupling pathways for macroalgal-derived carbon sources	**Burrows?** O'Connor Queiros Pinnegar	Contribution of macrophytes to total primary production within 20 km from shelf and at whole shelf scales	O'Connor? Burrows? Others, n-DRA's etc	First part of Task 2.1 in case for support. Combination of historical distrib and production data and models, and in situ new primary production experiments at key ref sites to estimate kelp primary production across UK, and comparison with satellite/model-derived phyto primary production
		What is the contribution of macrophyte detritus c.f phytoplankton to the benthic food web and how does this change with distance offshore?	Burrows O'Connor Pinnegar n-pDRAs etc?	Under debate. Possibly a series of transects running from kelp beds to 15-20 km offshore. Tracers (e.g. ^{13}C) in key benthic organisms and in water column seston. Possibly more of a grid type of approach?
2.5 Parameterisation of trophic and non-trophic pathways of carbon assimilation in coastal benthic-pelagic sytems in ecoosytem models	**Quierós?** others	How exactly do primary production sources enter the benthic food web?	Quierós n-others?	In situ isotopic tracers and mesocosms involving "feeding" ^{13}C-enriched material into benthic consumers and mixers/re-processors. Aimed to improve parameterisation of benthic component of ERSEM. Likely focus is L4 given the knowledge base of this site
2.3 Report on "end to end" pelagic and benthic biomass spectra across regional gradients and seasons	**Hiddink** (benthic) **Atkinson ??** (pelagic)	Seasonal change in the pelagic biomass spectrum: analysis of slopes and biomass domes	? Lilley? (QMUL PDRA), van der Kooij? Pinnegar?, Fileman?, Atkinson?, Hirst?	Examine how the "full planktonic" biomass spectrum (i.e from bacteria up to macroplankton) changes at the L4 site by repeated seasonal sampling during 2015 with bottles up to night-time 1 m nets (2015). Some biomass spectrum data (up to mesozoo size) have already been collected at L4 and E1 to augment this. This can then be "spliced" onto the larger scale biomass spectrum obtained from Autumn 2015 Poseidon cruise and other data from M1 where possible. Combination with historical fish diet data for another paper?
		Regional and seasonal gradients in the benthic biomass spectrum: slopes/ biomass domes	Hiddink, Quierós Van der Kooij Pinnegar	Determined from Poseidon (Aut 2015) and Prince Madog (Aut 2015/Spring 2016) cruises across gradients in fishing pressure and primary production. Also says in case for support Task 2.2 that a benthic size spectrum will be obtained by the 2015 seasonal coverage of L4. Is this still true?

2.4 Report on the parameterisation of functional responses of feeding and mortality related to traits	**Atkinson** (pelagic) **Emmerson** (benthic)	Feeding selectivity, prey size and functional responses of zooplankton with contrasting feeding modes: *C. helgolandicus* and *Oithona similis*	Fileman, Lilly	15-20 incubations at PML the season (mainly 2015). These species incubated in the natural range of food concentrations from scarce to saturating. Looking at satiation levels and shape of functional response on the range of individual food items when they are present in the natural ranges of mixtures these species encounter. Analysis of whether prey switching occurs. Delivery by mid 2016 roughly.
		Functional responses of key benthic species and the effects of grazer size	Emmerson	Target species include those of commercial value, suite includes Nephrops, velvet swimming crab, whelk and common starfish. Also looks at intraspecific variation in body size and how this affects feeding. Labwork in 2015?
		Mortality rates of *Calanus helgolandicus*	Maud , , (associated PhD student) Hirst	Comparison of mortality rates during ~4 full seasons of regular sampling at the L4 site. Use of a longer (25 year) time series to further explore whether any density-dependent effects are visible. (This work is already underway as an existing PhD but can be listed also as contributing to MERP?)
2.2 Report on the dynamics of interactions between gelatinous zooplankton and fish larvae	**Lindeque** Atkinson et al	Development of Next generation sequencing techniques to understand zooplankton diets	Lindeque (NGS), Lilley?	In-situ diet analysis based on ~6 diel cycles of sampling at L4 using large nets to catch several key jelly taxa (likely Siphonophores, Ctenophores and possibly Chaeotganths) and larvae of various fish species during 2015. 454 sequencing to determine prey diversity at Operational Taxonomic unit level and where possible identifications based on reference database. Semi quantitative because the amounts of DNA recovered for each OTU are quantified. Laboratory "calibrations" by feeding jellies with known assemblages of copepod species and tracing their stomach content with NGS. This can also double up as functional response trials of the gelatinous predators
		Using traditional diet analysis to quantify trophic overlap between jellies and fish larvae.	Atkinson	Paired mandible methods and microscopic analysis (e.g. of prey nematocysts) to determine whether jellies eat fish larvae and vice versa and also the size/species spectrum of crustaceans that they eat. Separate paper because the NGS and traditional methods inform on different aspects of feeding but they can be set in a comparative sense


Name
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Mod 1 existing data 402d...
recruit post-doc 78d
build data tool 130d
Tom
extract preliminary data 63d 4h
Tom
extract best data 131d
Tom
Mod 2 new data 2628...
sample pelagic spectra 132d
evaluate pelagic spectra 116d
benthic spectra 393d
mortalities 662d ...
Angus
satiation 1325d
Mark, Angus
Mod 3 processes 1869...
T3.1 elast data analysis 516d...
method 121d ...
Axel
trial preliminary data 268d ...
Axel, Tom
for real 126d
Axel
T3.2 elast mathematical analysis 532d
problem definition 70d
Axel, Mike, Dougie
execution of analysis 363d
Mike, Dougie
recommendations for 3.3 99d
Axel, Mike, Dougie
T3.3 elast numerical analysis 607d
define test 235d ...
Axel, Julia, Dougie
test standard implementations 128d ...
Modellers
test modified implementation 122d ...
Modellers
recommendations for 4 120d
Axel, Julia
T3.4 non-elast data/models 214d...
patterns A 124d
Axel, Tom
patterns B 90d 5h
Tom
M3.1 Probe elasticity of models
M3.2 Improvements in models
Mod 4 simulation 504d
NM Fitted models 1d
run standard model ensemble 407d
Modellers
run modified model ensemble 91d
Modellers
Agree on models a people 1d
1d
1d
1d
M4.1 Agreed common data sources
M4.2 Standardized Suite of Models
M4.3 Fitted to historical data
M4.4 Predict services 1d

Module 4 Workplan discussion notes

We had representation from all of the module 4 partners. Sarah Wanless could not make it but a colleague of hers was there.

1. To achieve a common understanding of the tasks, milestones and deliverables, we prepared a table that maps the milestones and deliverables to tasks. This is supposed to serve as a reference table for all the module partners to see how the work they will do fits with a coordinated view of delivery on the whole module.

2. In preparing the table we made several additions/ changes to make note of

   Milestones were modified. We added a new milestone which lead to renumbering of the others:

   - M4.1 Specification of the alternative models and their driving and fitting data that will form the ensemble and the baseline runs (M10) (i.e agreed common data sources and format required to fit models).
   - M4.2 Comparative assessment of the baseline outputs from the model ensemble as the basis for quantifying uncertainty (M20) NOTE: [this requires models are fitted to historical data – hence depends on new M4.3 below.
   - M4.3(NEW) Models fitted to historical data (M18).
   - M4.4 (NEW) Models validated with data generated by the project and/or other areas (M24).
   - M4.5 (was 4.3) Predictions of the response of ecosystem states and services in response to climate and anthropogenic drivers (M30) .
   - Deliverables – remain the same, but we added additional explanatory text so they easier to understand.
   - We added some text relating to Task 4.1, to describe the first steps required to develop an ensemble. This refers to common, compatible data for fitting and driving the various models. It will require having a specific meeting to pin this down in detail and achieve greater clarity on what is needed to 'build' the ensemble.
   - There might be a need for further discussions with module 3 to finesse the timings of the milestones.
   - More reflection on timing of the module 4 milestones and those of feed-in and feed-out connections to other modules still needs to be considered. I would suggest that this is the responsibility of each of the partners to identify these in their specific tables.

4. Using the reference table, each partner iis asked to complete a similar table to identify specifically what they will do, how it maps to the module tasks, how the work is partitioned/ shared between partners and who exactly will be doing the work. These tables should be valuable to both the individual partners for clarifying the thinking on what they will do and for you as module coordinator to monitor progress toward the module milestones and deliverables.

5. There was a long discussion about how to integrate the ERSEM modelling work (led by Jorn Bruggeman) with the models in this module. While everyone felt the need for this integration, there really was no clear answer to this. The different evolution of the proposals and the disproportionate

effort that will go in to the ERSEM work means (in my personal view) that unless specific plans are resolved soon, it will continue to be an issue for the lifetime of the project.

6. I made a presentation of the overview of Module 4. It's supposed to be module 4 in pictures, but note that text on tasks and from the proposal are included in the notes areas of the slides.

7. There was a Steering group meeting, where we talked about various things such as workshops, responsibilities of module leaders etc. Jess will be sending around the minutes of the meeting. At that meeting I made it clear that I will not be able to undertake the role as deputy lead on module 4. I'm sorry about that, but I'm not sure how I got the task in the first place and unfortunately the time/funding I have available will only extend to overseeing some of the modelling work at Cefas.

8. There was a lot of discussion about how to get each module to work with one another. This will be a focus for the first few months, so that everyone has a common understanding of the jigsaw. Talked about various ways to do this including webinars etc.

MERP Ecosystem Services Working Group: Carbon Sequestration

Nick Stephens

Nicky Beaumont's workshop aimed to understand Ecosystem Services (ES) and the regulation of these same services. Initially the discussion addressed carbon budgets as implications for climate regulation.

Round I

In trying to outline the key processes that influence carbon cycling, and in particular those processes that would contribute to carbon budget calculations, the discussion immediately diverted to issues concerning the spatial scale and the region for carbon budget calculations. As part of MERP, a number of relatively specific environments are considered throughout the proposal (i.e. regions of high macrophyte abundance). The significance of such a domain, potentially contributing to 50% of the water column primary production, would be lost in a larger scale regional analysis with most macrophyte abundance being within 20km of the coast. At these larger scales, the main source for carbon loss form the system is through advection into deeper waters at the continental shelf boundaries.

Discussions about the use of the exclusive economic zone (EEZ) as a working domain, to aid a subsequent ES analysis, were followed by a brief outline of where the MERP measurement sites are actually located. The discussion then trended back to the Celtic Sea and West Scotland Region but then came back to what we are trying to achieve? What is the question/aim that the proposed carbon budgets would address, and more importantly what are the services/processes that can be achievably managed? Mike Burrow gave an example of a recent Scottish report where the concentrations of carbon sequestration in the coastal zone where provided. Although these calculations were quite broad, they seem to be what was required for the purposes of the Scottish report. This provided a basis to push the discussion forwards again.

The discussions came to a close as we moved on to talk about risk and disturbance, which there appeared to be a consensus we were going too far from the discussion aim. The issue though appeared to be the scope of the MERP project with respect to carbon sequestration. The MERP project essentially addresses benthic/benthic coupling, food web dynamics, trophic structure, biodiversity and the biological aspects that lead to changes in ecosystem, response and community resilience. The biogeochemical response and other processes necessary to calculate a carbon budget are covered elsewhere, in the Shelf-Seas Biogeochemistry (SSB) program for example.

Round II

A change in tack to address the permanence of carbon sequestration and burial started with addressing the importance of different sources and in particular the importance of terrestrial sources in Shelf-Sea sediments. Quickly though, the discussion came back to which processes are included in MERP, rather than SSB. There was a consensus that MERP aims to elucidate metabolism and biologically-mediated rates (interestingly the term consumption was used at one point). It was also noted that differences in perspectives appear to be divided across modules (a point addressed later in the MERP meeting in my opinion). Also noted was that the models we are using are relatively rudimentary and there is still a requirement for elucidation of the processes to some extent.

Again the concerns about what we are trying to achieve in terms of a carbon budget is something that was not clear. MERP concerns the biological turnover of organic material rather than the quantification of burial per se. A more productive suggestion (Andrew Hirst) of trophic structure and C/energy transfer in fish populations would potentially be of more benefit.

Integrating Workshop: Ecosystem Services

Recap of Overall Objectives –

- Have we captured the key functions that are:
    - essential to ecosystem service delivery
    - good indicators of changes in delivery of the different ecosystem services

- What other functions and attributes of biodiversity should we include?

- Which of these functions and attributes of biodiversity are being investigated by MERP that will help us to model and understand changes in ES including understanding pinch points, key roles, flows from biodiversity and functions to intermediate and final ecosystem services?
    - What sort of data/model outputs are already available?
    - When will relevant MERP data/models/understanding on these functions, biodiversity attributes and flows be available?
    - What are dependencies between MERP modules to enable this to happen?
    - At what spatial and temporal scales are these available or being addressed in MERP?

Cultural Services Station:

Facilitator: Caroline Hattam

Rapporteur: Kayleigh Wyles

Session Procedure –

1) Clarification on the key terms (cultural services, indicators, functions)
2) Pick a cultural service to investigate
3) Pick an indicator
4) Explore the influential functions for that indicator
5) Highlight which aspects MERP does / could / or does not feed into.

Main Discussion Points –

- Decided to focus on the indicators where there's less of a knowledge gap:
  - Charismatic species
  - Biotypes of significant importance
  - Chemical …
- Highlighted that the list in Table 2 was not exhaustive
  - E.g. number & quality of beaches is not only measured by blue flag, but also GES, MPAs, SSSIs…
- Focused on water quality and Abundance and diversity of key species of recreational interest:

A) Cultural Service: Leisure, recreation & tourism ⇨Indicator: Water Quality

Summary of the key functions & ways in which MERP current / future work could feed into it:

Function	*Incorporating into MERP*
Phytoplankton Blooms	M1 (& 2 possibly) – data to support the models M4 & 6 – ability to run models
Viruses etc	NA – no info available
HABS	
SPM / nutrient cycling / light quality of water - Indirect & direct (e.g. can't see the fish – links to B below)	M6
Macrophytes – water quality	
Jelly fish	M4

Additional comments within A:

- All modules can feed into the indicators, but the difficulty seems to be *translating* them into the services
    - And at what stage should this be done (throughout, or purely Module 5's responsibility?)
- Linking to the ecosystem services will be based on inferences and potentially very speculative
    - Not in scope of MERP to examine directly (e.g. Willing to Pay for the services)
    - Acknowledged for being very tenuous

B) Cultural Service: Leisure, recreation & tourism ⇨Indicator: Abundance and diversity of key species of recreational interest ("sexier than water quality")

Summary of the key functions & ways in which MERP current / future work could feed into it (however this discussion evolved to focusing more on spatial and temporal factors, see below)

Function	*Incorporating into MERP*
Food & prey Inc. change in prey that could then be less good to the species * note – spatial and temporal factors (varies seasonally and geographically)	M4 & 6 – will look at ratios, can look at timing, size and quality of food M1 – large scale long term data on food supplies
Habitat & Quality	
Flow of energy through food web	
Climatic issues Inc. seasonal weather, climate change and storms / wrecks – where winds blow birds off cliffs * note – varies spatially and temporally	
Parasites / disease dynamics	NA – not in MERP
Contaminants	
Water quality	
Human activities – multiple use of environment Inc. fishing, wind farms (can detract species)	NA for MERP

Additional comments within B:

- Identified popular species that could fall in the charismatic species:
    - Seabirds (people and "birders" who go to see migrating birds or breeding colonies)

- Whales / porpoises (e.g. whale watching boat trips)
- Basking sharks
- Seals (e.g. to see the white fluffy seal pups)
- Underwater species too e.g. seahorses (scuba divers) – note mirror planktons will be looked at that could be related (M__)

- Seasonal differences
  - E.g. breeding and migratory patterns (MERP = focus on breeding more)
- Spatial Scales
  - Defra would like both small scale (e.g. to help advise on MPAs) and regional scales
  - Is a trade-off between spatial coverage and resolution of the data.
  - M4 can accommodate different scales to a certain extent – predicting environmental conditions indirectly for higher trophic levels (preparing for correlational analyses)
- Interlinks between services, indicators etc – highlights the complexity of this process
  - E.g. water quality links with disease, contaminants, Gene diversity, weather
  - E.g. biotypes ⇨ influences food webs ⇨ which are food for the species of interest; and food webs can be influenced by physiological measures, water quality…
  - E.g diversity ⇨ habitat ⇨ food web
- Often perceive cultural services as those that have an economic value (overlooking other non-material methods)

Provisioning Services notes_ Facilitator: Mel Austin.

What's the ecological stuff that would provide us with the services (fish populations for food) we need?

With reference to Table 3a on the handout

Q1. Are we capturing the key functions important for ecosystem services, with a focus on wild fish/ shellfish for food? (1a in table 3a)

Group 1, Group 2, Group 3

Function: Maintenance of Food web dynamics

- Composition and abundance of predators – important for food web dynamics
- The service is the production of things people eat, but we need to consider quality – eg. The food quality related to toxins, pollution, disease, pathogens, parasites etc.
- Will pressure gradients help?
-

Q2. How do we unpack the connection between changes in fish abundance and food-web dynamics?

- Food-web models do this – they can be used to predict changes in biomass of functional groups under different scenarios of changes (i.e. under different pressures). This is what is intended in Module 4.
- Stable isotopes can also provide information on this, showing the trophic linkages among functional groups

Q3. Where do we see the limiting extent of fish production?

- Something we could pick up on is timing of events. Timing of production – MATCH-MISMATCH can affect. Baseline information is important to understand and measure responses to change in timing. This may include understanding of resilience.
- Can models take account of this? - Yes to some degree – if the model has seasonally resolved dynamics. Empirical data can be used to track this.
- To answer some of these questions, models can treat them as sensitivity analyses? E.g How sensitive are model predictions to the cycling of nutrients
- Different models have different strengths. How do we identify which models are suitable providing relevant information on which provisioning services?
- Most of the models are focussed on functional groups and size composition so might not be able to answer species specific questions. Some of the models being used are resolved to species level.
- Spatial scale of the 'question' in relation to the models available is of high importance. Need to recognise at what scale the current models can provide meaningful insight, and identify where changes or alternative approaches need to be taken. Analyses might require nested approaches.
- Pulses of flow in nutrient – seasonal changes related to changes in river flow. ERSEM can take account of this.

Indicator idea: what about using behaviour birds – foraging range and diet etc, as an indicator relating to an assessment of habitat quality and maintenance of food web dynamics.

Function: provision of habitat

- Had the idea in proposal (Mike Burrows) that we would be able to assess the value of kelp as a habitat and its role in the fish production. Particularly as habitat for juvenile fish. (link to function: support breeding populations…
- Temperature, salinity, oxygen etc are element of 'habitat' (physical oceanography) that can affect food provisioning services. ERSEM can provide this kind of information.
- Distribution and connectivity of suitable habitat.

Module 6: developing a model based understanding of ecosystem service regulation (J. Bruggeman)

- Where we're coming from: ERSEM
ERSEM (European regional Seas Ecosystem Model)is the base model from which all development will be done.
- Where we're going
The aim is to increase the biodiversity in the model to see effect of stressors on the environment. And to do see in a traceable, hierarchical manner.

-Programming infrastructure
Coupling of ersem to physical model, with a number of modules representing organisms/function/processes/elements. The use of module is dynamic and the user can select which to use easily before running the model
Q/A: how easy is it to code a new module? easily codable, with only a little to add but no need to go deep in the code.

-Caricature organisms
Diversity broken into manageable chunks with on universal organism at the base of the organisation.
Key processes (growth, respiration0 will have a unified formulation.
Use of Dynamic Energy Budget (DEB) with storage and structures pool through which flows are passing
Q/A: will there be multiple pool in an organisms? Only the storage and structure pools

-Resource acquisition by model organisms
Define three key processes: Photosynthesis (P), Osmotrophy (O) and Predation (Pred) as the main way to acquire resource and use them to unify the organisms further. For example: P+O corresponds to diatoms that can then be divided into size classes; P+O+Pred for multicellular eukariotes (bacteria or small phytoplankton), Pred for multicellular heterotrophs and P for multicellular autotrophs (kelp, macrophytes).
Timeline: by months 6
Q/A: Nice parallel with modules 3&4. it would be good to interact during the developing process for better interfacing between models.

-Data needs
Base model parameters
Specific for functional response and diet -> interaction with Module 2.
Macrophyte data for development (Module 2)
Q/A: litterature and historical record available on fish diet (as long as they eat fish) -> Can be used to validate/compare model output
Q/A: Importance of prey switching and occurence? (Module 2)
Q/A: How do we deal with non physiological parameters like the interaction between substrate and benthic organisms? We don't have a caricatural organism yet, something along the lines of a type of benthic organism (burrower, suspension feeder, ...) along with a variation of key parameters/traits with size.

-Higher trophic level
Not moving toward having fish in ERSEM but a simple top closure that is not the mesozooplankton is to be added (Month 6)
Connection with other models (Module 3 and 4): define the cutting point between the lower trophic level (ERSEM) and the higher trophic level from this model
Q/A: Need to be realistic with capacity to explore top-down control/pressure by fish. Planned two way coupling during Phase II (Year 3)

-Traits and trade-offs
Which traits explain most of the variability?
Data needs in regards to traits might be meet by Module 1 (?)

-DivERSEM: brute force diversity
A coupled GOTM-FABM-ERSEM to be available by Month 6

-Start of 3D simulations by year2

-Prediction and validation in general
Bulk properties
Ecosystem structure -> data/interaction with module 2
Need for expert knowledge to evaluate data and what is important
Link with module 5

-Validation specific
Module 1 could help by providing: size spectra, species specific abundance and measure of mixotrophy, predator type and abundance
Important need is relative abundance of a species and how it varies accros gradient of different conditions

Discussion, Comments, Questions and answers:
-Why is reproduction only treated in Phase II?
Reproduction is implicit present in the food web. As an explicit process it is more of a big unknown and might need the inclusion of life stages
-What is achieved by doing the proposed modification?
Added flexibility in the model diversity by gaining more diversity. We'll gain a test bed to see what biodiversity is needed for certain ecosystem services and function (need to clarify the ecologucal questions, by talking with other modules)
-What do you mean by osmotrophy and mixotrophy?
Osmotrophy => consumption of dissolved organic matter. Mixotrophy => use of organic coumpounds (other organisms or particulate organic matter) and light. Check for conditions that favor one or the other in the model through looking at individual species
-Need of a matrix with models and model need in term of data ("shopping list")
-Delivery of the proper data to the higher trophic level models (Module 3 and 4) will need interactions
-How do we add development history tosome organisms?
Starting point toward adding a size/age structure. There's already a move in that direction with the addition of meroplankton
-(Mel) Need of iterative discussion with the ecosystem services module to develop scenarios and see where we can help each other
-(Axel) More complexity can mean that the model gets out of control, or we have variables with unrealistic values. Suggest that we try things in simple 0D / toy models at first before moving in to the 2D and 3D versions.
What work in 0D might not work in 3D so a parallel development would be best
-(Ana Q.) In Phase I there's addition of meroplankton and 'reproduction'. This seems more like an approach dedicated towards the pelagic than the benthos. There are data on these processes in the benthos.
-(Tom Webb)What are the trait data needed to input in the model or for comparing emergent behaviour. What kind of detail are needed?
Mostly laboratory data for model input, althoug we do not know which traits we'll use in the model yet. Abundance and relative abundance or species for model validation
Experimentalist might know better the most relevant traits that should be prioritised in the model development

MERP – Data Integreation

Thursday 5th June 2014

Workshop 1: Modelling – Data, information interactions between MERP Modules

Nicola B. – conceptually, would like an arrow between data/fieldwork and services (doesn't necessarily need to go via modelling modules).

Intra-modelling information exchange

- Are we coupling any of the models together?
- Not only the empiricists who will be feeding into models – also other modellers (see post it exercise below).
- Mike – there will be one way coupling to Strath E2E
- Some outputs of ERSEM will feed into other models in a non-dynamic sense. E.g. basic inputs to EwE but not necessarily dynamically.
- Can be difficult to do two-way coupling because of temporal-spatial discrepancies/difficulties and inconsistencies. Computational issues.
- Will look at 2 way coupling in Phase 2 of M6 (dynamic size spectra. i.e. Blanchard model).
- MERP-Mip?? Model intercomparison programme?? (EU project MARIFRAME)
- Task 4.1 looking at how we will pull together driving datasets so using common starting point.

M1 – modelling interactions

- Which traits? Linking to macro-ecology.
- Can we generate a key list of parameters needed for the models (a matrix)?
- Axel – desire to get size spectra from databases, and link to diversity spectra – beyond this we can only generate a wish list as we do not know how M1 will work out.

- Tom - we can be certain of some traits e.g. body size, what is best focus broad coverage or in depth.
- Lots of data exists in 10g to 10kg region but not sizes covered in M6, some data on phytoplankton size spectra exist.
- In ERSEM interested in size fractions of the phytoplankton. In terms of traits, anything approaching physiological rates will be useful.
- Andrew (Q Mary) – for plankton quite a lot of trait information had already been gathered, but not for benthic species.
- Paul – Important issue is not specifics but generalities – how do we promote interactions between field works and empiricists and modellers – otherwise where will the information from M1 and M2 go? How do you make this communication work? Get right beople to talk to each other.
- Axel – size spectra interesting if consider across time and spatial gradients, this is what is different?
- Tom – we need a conduit to ease the transfer of information, with a general overview (clearing house) – Tom to serve this function.
- Mike – likely to be partial, scrappy datasets therefore will need to stitch these things together. Unrealistic to expect Tom to do all of this. How could it possibly work? Underestimating messiness.
- Icarus – currently missing a mechanism to get people together to talk about these issues – a conceptual framework, with realistic expectations. A need for direct communication – a forum.
- Steve M. – a good start would be to identify 'the people' who to talk to e.g. if you want to find out about field programme, experiments etc. knowing 'who' is vital. Data owners/champions.
- Axel – do I know who to talk to in other modules?
- Icarus – matrix to be developed by e-mail as first cut.
- Mike – responsibility for understanding models shouldn't just be left to the modellers, need everyone to understand what the models do, what they mean, what they are for?? Challenge for the modelling community to describe in an understandable way, but also the other way around.
- Mark – do we need to convene a meeting (soon) to go through the models, crawl all over the details and work out how they can contribute.

- Icarus – models belong to the community, need to generate 'ownership'. Data is extremely valuable, but expert knowledge is potentially even more valuable. Knowledge of what is sensible and not sensible.
- Mark – how do we progress this?? M1 is intending a meeting in September, should we try to bring the two communities together. Is it an appropriate time ti do this?
- Angus – from M2 perspective this is before the start of the fieldwork programme and so could be quite a good prelude.
- Mike – what ecosystem services could these models provide information on. Can we **go through each model at a time and describe (in a 2 pager) what they could contribute.**
- Nicky – would be a good chance to take a fresh look at ecosystem services. Policy makers often want information on all of them, but often not possible. Do the best we can. Discussion this morning suggests that we might focus on a few services and do things well – rather than doing them all poorly.
- Taz – should involve stakeholders in this discussion/rationalisation.
- Mark – rather than module leaders to act as conduit, should emphasis be on individual PIs?
- When people talking about data and measurements need to ensure some measure of uncertainty is provided.
- Carol Kelly – is there a process of quality assurance, data coming in, outputs coming out. **What is the process for assurance of QA?**
- Icarus – each group/model owner will have their own protocols for QA, but there are no common approaches at the moment? Not just a modelling issue, this is also an M1 issue.
- Tom – as part of M1 (catalogue of database) will try to look at QA procedures, what protocols are in place? Important role for expertise. Data audit to say what data has been used where.
- Tom – do we need a consortium wide data policy? e.g MEDIN standards – with specified QA procedures etc. Who is going to take the lead on this?
- Tom – there is a data management plan that covers some issues. Provides a bit of a foundation. Should involve BODC in this dialogue.
- Jess – is a consortium data policy different to the existing plan?

- Mark – yes, provides some policing. Agreed data formats etc.
- Jess – to go on steering committee agenda.
- Mike – we are not setting up a data repository, this goes to BODC.
- Anna – BODC do ensure that everything is properly documented but not necessarily quality controlled.
- Carol – is there going to be a literature review stage (involving Post docs etc) or is this just a piecemeal - using data in their organisations.
- Andrew – for the planktonic parts of M1 there will be a literature based exercise in the first instance.
- Anna – matrix/shopping list might be impractical but given that we are all in the same room, should we make the most of the opportunity, speed-dating to work out who should talk to who?
- Steve – in the proposal text, the higher level linkages are there already – but what is needed is an hour to produce a picture of this. It is scattered throughout the text at the moment and so difficult to understand. But can't do this in plenary.
- - One extra thing needed as M6 is not explicitly linked to any of the ex-IMMERSE modules. Will need to put a bit of thought into this (from both sides).

M2 – modelling interactions

- As Angus pointed out there is an issue here about timescales (both ways). M2 need input from modellers (shopping list) now.
- Steve T2.3 and 2.4 come in month 36 but tasks in M4 com in month 18 so they will have to rely on existing data and can not wait for the new data. Perhaps later on for cross-validation/ performance testing and tweaking, but not possible to use the information for model construction – will not be available in time. Do not want a conversation about detailed units etc and expectation that the information will be used.
- Axel's presentation suggested that need explicit information on a certain date, but has already been talking to Mark to settle thie issue.
- Mark lots of information being collected by different groups – we need to properly resolve inter-dependencies. Liked Axel's software to highlight linkages and hold individuals to task – need a proper ghant char with connectivities.

- Mike B – nowhere in proposal is it clear how macroalgae info will be taken up in modelling work packages. It would be nice to identify the conduits through which this knowledge could be taken up (e.g. a potential macrophyte module for E2E).
- Can definitely think about trying to include macrophytes in M6, would certainly be an aspiration, even though not hard wired into the proposal.
- Mark – we can modify our work plan – this is some scope to modify our plans.
- Sheila – we will have to do this anyway – M5 modellers could tweak their models early on so that they can accommodate the new knowledge on macrophytes as it comes available later in the project.
- Icarus – similarly with the fieldwork outputs on benthic and pelagic size spectra.
- Mike B – **ecology 'push' and modeller 'pull'** both need to be encouraged and facilitated.
- Sheila similar to knowing more about the models, we also need to know more about the fieldwork.
- Angus – perhaps **a 2 pager on each element, describing in clear language- - what will be done, what is expected, why it is being done – when and where??**
- Icarus – is this needed for all modules???
- Sheila – do we have a timescale for all of the 2 pagers, as we need to do this pretty soon??
- Jess – is this responsibility of module leaders.
- Icarus – **for each model it will have to be model owners for field/labwork, will probably have to be assigned to 3 people (1) macroalgae, (2) size spectra, (3) lab experiments.**
- Angus – for the matrix, can we have a priority list of what is needed with some ranking so it doesn't end up as a massive shopping list of everything. Are there things that are most urgently required. We will need some steer.
- Mark – **for Cefas data would be useful to have a summary** of how to obtain datasets, who to contact, whether a formal approach is needed.
- Axel – elasticity is responsiveness to a pressure, sensitivity is responsiveness to a particular parameter.

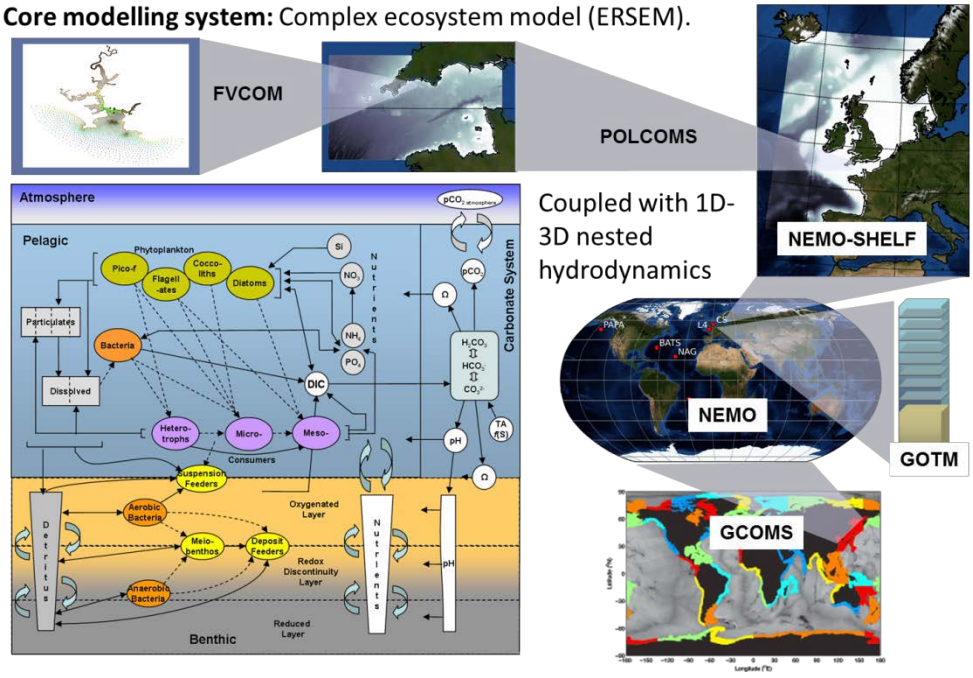
- Mark – should each of the models list the parameters they are most sensitivity to e.g. originally thought about experiments to characterise 'vulnerability' in EwE models?
- Mike – can we do **3 minute presentations of each model tomorrow morning**?? 2 pagers already exist for most, from MSCC meeting. There are six models included in MERP.
- Mike B – then a **rattle through what parameters will be collected in M1 and M2.**
- Mel – what about post-its. **After presentations - Put a sheet on the wall for each model and ask people put post its, with their name on – saying what data they might be able to contribute**.
- Dave P – will this also provide the basis to outline what ecosystem services might be addressed by each mode?
- Icarus – each presentation – what the model does, spatial-temporal scales – ecosystem services, data needs – names etc.
- Should we circulate the MSCC 2 pagers?? (forwarded to Jess)
- 7 models including ERSEM

Appendix 10. Models applied in MERP

European Regional Seas Ecosystem Model (ERSEM-GOTM/NEMO)

Model description prepared by: Icarus Allen

Version: 5/5/14



[

1. What is the scope of the model? ERSEM (Baretta et al 1995; Blackford et al., 2004): *European Regional Seas Ecosystem Model (ERSEM)* is a generic lower-trophic level/ model designed to represent the biogeochemical cycling of C and nutrients (N, P, Si, O2, Fe) as an emergent property of ecosystem interaction. It is currently coupled to following hydrodynamic models/ domains: 1-D relocatable GOTM water column; download from http://www.shelfseasmodelling.org/Download-code,3D domains include; NE Atlantic NEMO –shelf (1/10 ^{o}); N Atlantic NEMO (1/4 ^{o}), NEMO-shelf(1/12 ^{o}); Global NEMO (1^{o}), GCOMS (global coastal ocean model) (1/12 ^{o}) – see figure. Ensemble Kalman Filter ocean colour data assimilation system (Ciavatta et al 2012) for the NE Atlantic embedded into POLCOMS-ERSEM.

2. What is the model doing? The ecosystem is subdivided into three functional types: producers (phytoplankton), decomposers (bacteria) and consumers (zooplankton), and then further subdivided by trait (size, silica uptake) to create a foodweb. Physiological (ingestion, respiration, excretion and egestion) and population (growth, migration and mortality) processes are included in the descriptions of functional group dynamics. Four phytoplankton (picophytoplankton, nanophytoplankton, diatoms and non siliceous macrophytoplankton), three zooplankton (microzooplankton, heterotrophic nanoflagellates and mesozooplankton) and one bacteria are represented, along with the cycling of C, N, P, Si and O_2 through pelagic (Blackford et al., 2004) and benthic (Blackford, 1997) ecosystems. .

3. How has the model been validated? Validated against in-situ data e.g. ICES, BODC, CPR etc. (e.g., Allen et al 2007, Holt et al 2012, Saux Picart 2014) and satellite ocean colour (e.g. Shutler et al 2011). In general skill is good for T, S, nutrients, oxygen, nutrients, less good for Chl and plankton. Skill deteriorates as we go up the foodweb (Allen et al 2007). Models capture seasonality well, but often show phase shifts during the spring bloom. Models have skill at spatial scales of order ~50km^2 (Shutter et al 2011).

4. How has the model been used? ERSEM has used for shelf seas water quality monitoring and climate impact assessment (hydrodynamic control (e.g. Holt et al 2012), high CO_2 (Artioli et al 2014), eutrophication (Saux Picart et al 2014) trophic amplification (e.g. Chust et al 2014), has been used to assess climate impacts on fisheries, fisheries economics and food security (e.g. Barange et al., 2014), and is run operationally by the UK Met Office (e.g. Siddorn et al 2007). Reanalysis simulations (i.e. Hindcast with data assimilation have been made) to estimate the shelf C budget.

5. How could the model be used in the future? ERSEM is being redeveloped through the Shelf Seas Biogeochemistry programs to improve process description and quantify the shelf seas carbon ('blue carbon') and nutrient budgets (past and future climate). Marine Ecosystems will develop ERSEM as a tracable scalable modelling framework to better represent biodiversity-relevant processes over a range of spatial and temporal scales, and hence simulate changes in function and the consequences of such changes in the context of ecosystem services. Model outputs will inform the implementation of the Marine Strategy Framework Directive (MSFD), the Marine and Coastal Access Act, Marine (Scotland) Act, Common Fisheries Policy and the OSPAR Joint Assessment and Monitoring Programme as well as the work of UK government departments. ERSEM can help support an ecosystem approach to policy, regulatory and management initiatives, including the implementation of the EU Biodiversity Strategy, the Natural Environment White Paper and the further development of the Marine Conservation Zones network.

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GETM-ERSEM-BFM

Model description prepared by:

Johan van der Molen

Version: 15-4-2014

1. What is the scope of the model?

North Sea setup, North-west European Shelf setup, NIOZ has Wadden Sea setup

Included:

- 1D (GOTM) or 3D (GETM) hydrodynamics
- N,P,C,Si
- Pelagic: 6 phytoplankton groups, 4 zooplankton groups, bacteria, macroalgae, filterfeeder larvae, disolved and particulate organic carbon, CO2 & pH, SPM resuspension, detritus resuspension and transport
- Benthic: 3 layers, bacteria, benthic diatoms, 5 benthic functional groups, CO2 & pH

2. What is the model doing?

Coupled 1D or 3D hydrodynamics and biogeochemistry, with lower trophic level pelagic ecosystem and intermediate trophic level benthic ecosystem. Functional group approach. Parallel computations.

3. How has the model been validated?

SmartBuoy data, surface and bottom, three sites, chlorophyll, SPM, temperature, RMS and bias, results varying between good and poor [van der Molen et al., 2013]. Ship-based benthic data, three sites, 16 variables, RMS and bias, results ranging between good and poor [van der Molen et al., 2013]. Stonehaven data: nitrate: good reproduction seasonal cycle; phosphate: idem.; ammonium: under-prediction winter values; silicate: good reproduction seasonal cycle, but with positive bias [Aldridge et al., 2012]. Meso cosm data: chlorophyll, nutrients, phaeocystis, bacteria, heterotrophic nanoflagellates, cyanobacteria, lysis: results: good agreement [Ruardij et al., 2005]. RIKZ station data: chlorophyll, nutrients, phaeocystis [Ruardij, pers. comm.]

4. How has the model been used?

Eutrophication and riverine nutrient transport [Lenhart et al., 2010], potential impacts of large-scale macroalgae farming [Aldridge et al., 2012], potential impact of climate change and trawling [van der Molen et al., 2013], ecosystem indicators [Painting et al., 2013; Tett et al., 2013], deep chlorophyll maximum production [van Leeuwen et al., 2013], intertidal benthic primary production [Gerla et al., 2014], phaeocystis [Ruardij et al., 2005], food fields for Mnemiopsis Leidyi [van der Molen et al, 2014a], potential impact of large-scale wind farms [van der Molen et al., 2014b]

5. How could the model be used in the future?

1. hindcasts: understanding historic events, assessments, validation
2. future projections: impacts of climate change and ocean acidification
3. management scenario's: what if?; e.g. wind farms, tidal farms, macroalgae farms, nutrient reduction scenario's, trawling, thermal plumes
4. academic scenario's: process understanding & development

References:

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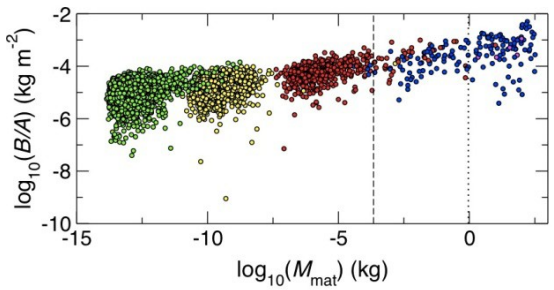
Population-Dynamical Matching Model (PDMM)

Model description prepared by: Axel G. Rossberg

Version: 08 May 2014



The PDMM, modelling a temperate marine shelf community (after Fung et al. 2013): each point represents maturation body masses and biomass densities of one of 1000s of model species interacting through a complex food web. Colours represent nearest integer trophic level: green=1, yellow=2, red=3, blue=4 and pink=5. The dashed and dotted vertical lines correspond to size thresholds for model fish species and "large" model fish species, respectively.

1. What is the scope of the model?

The model can represent, among others, typical temperate marine shelf communities, covering species of all sizes from phytoplankton to large fish, at species resolution. The model is spatially unresolved, though versions with coupled spatial "patches" have been described (Rossberg et al. 2008).

2. What is the model doing?

The model constructs complex and population-dynamically stable ecological model communities at species resolution by mimicking the natural process of community assembly by successive invasion. Each species is represented by its dynamic population biomass, and a set of fixed traits that determine food-web structure and physiological parameters. Ontogenetic growth is modelled implicitly through wide predator-prey size-ratio windows (Rossberg 2012). The behaviour of consumer individuals is modelled implicitly through Type 2 functional responses extended to incorporate prey switching. Recent variants of the model were described by Fung et al. (2013) and Rossberg (2013).

3. How has the model been validated?

The model has been shown to reproduce among others: size-abundance relations (Rossberg et al. 2008), the distribution of species richness per trophic level (Rossberg et al. 2008, Rossberg 2013), species-size distributions (Rossberg 2013), and key patterns in food-web topology (Rossberg et al. 2008). Fung et al.

(2013) published a model parameterization that reproduced, among others, typical empirical values for: body sizes of phytoplankton and fish, trophic levels of fish, and dietary diversity of fish.

4. How has the model been used?

The model was initially used to elucidate the mechanisms controlling size-abundance relations (Rossberg et al. 2008). Rossberg (2013) used it to develop and verify a broad theory of food-web structure and dynamics. Shephard et al. (2013) use the PDMM to model the dynamics of the Large Fish Indicator (LFI) in the Celtic Sea, following similar work by ICES (2011) for the North Sea. Fung et al. (2013) revealed the reasons for the observed slow recovery of the LFI by probing the PDMM. ICES (2012) used the PDMM to study biodiversity-production relations for fish in temperate shelve communities.

5. How could the model be used in the future?

Further studies of biodiversity vs. ecosystem-functioning relations using the PDMM are currently under way. Cefas is also using the PDMM to study the long-term implications of various management strategies to reach Maximum Sustainable Yield from multiple interacting fish stocks. The model could further be used to study the (isolated or combined) effects of fishing, ocean acidification, and climate change and the resulting community turnover on community structure and productivity. PDMM communities could be used to model pathways of POPs through food webs. The PDMM could also be used to derive and parameterize simpler descriptions of marine communities, such as those centred on size spectra.

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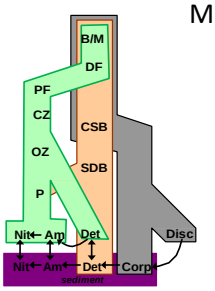
Strathclyde end-to-end ecosystem model (StrathE2E)

Model description prepared by: Michael Heath
Version: 28 April 2014



1. What is the scope of the model?

Twenty-two state variables are included in the model, representing the nitrogen mass (moles N. m^{-2} sea surface) of classes of detritus, dissolved inorganic nutrient, plankton, benthos, fish, birds and mammals. Dynamics of these variables are simulated in continuous time and output at daily intervals by integrating a set of linked ordinary differential equations (ODEs) describing the key physical, geochemical and biological processes which occur in the sea and seabed sediments. These include the feeding of living components, and the production, consumption and mineralisation of detritus including fishery discards. Uptake of food is defined by Michaelis-Menten functions for each resource-consumer interaction defined by a preference matrix. Time-dependent external drivers and boundary conditions for the model are harvesting rates of fish and benthos, temperature, sea surface irradiance, suspended sediment, inflow rates of water and nutrient across the external ocean boundaries and from rivers, vertical mixing rates, and atmospheric deposition of nutrients.

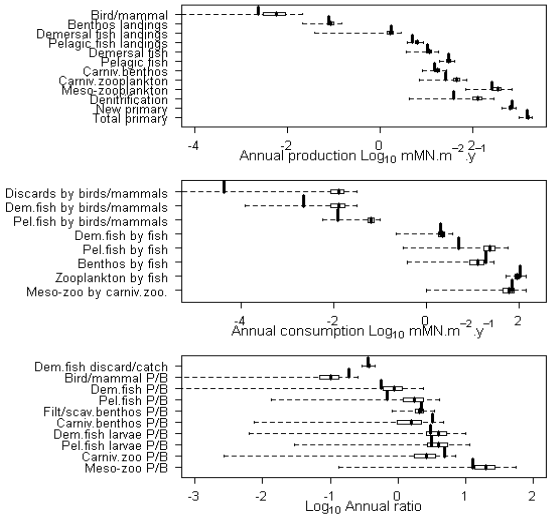
2. What is the model doing?

The model represents the time-dependent dynamics of the ecosystem components in a spatial region which is assumed to be horizontally homogeneous, but vertically layered. The geographic setting is defined by fixed properties (layer thicknesses and sediment porosity) and the time dependent drivers and boundary conditions. Biological properties are defined by parameters of the various uptake, excretion, mortality and biogeochemical processes. Typically, the model outputs data at daily time intervals and also delivers annual averaged concentrations and annually integrated rates. A version of the model configured for the North Sea with limited scope for varying the inputs, can be run online at http://www.mathstat.strath.ac.uk/outreach/e2e/

For the published North Sea version of the model (Heath 2012), ocean driving and boundary were derived from runs of the NORWECOM model and from archived observations. As part of the EU-BASIN project, sets of driving and boundary data have been assembled for a range of European shelf sea regions from outputs of the UK ERSEM model. Running the model for these regions and comparing with data is work in progress.

3. How has the model been validated?

Simulated annealing was used (Heath 2012) to fit parameters of the StrathE2E model of the North Sea so as to minimise the discrepancy between the stationary annual cycle of the model and data on monthly and annual averaged abundances of state variables, production rates and feeding fluxes in the North Sea ecosystem, averaged over the period 1970-1999. During fitting, the model was driven by 1970-1999 average annual cycles of environmental conditions and harvesting rates of demersal and



pelagic fish and benthic invertebrates. Details of the minimised discrepancy between outputs from the baseline model and each element the observed data are given in Fig. 1.

Figure 1 - Residual discrepancies between the best-fit model and observed data. The three panels show different categories of observed data from the North Sea – annual production, annual consumption, and annual ratios. Within each panel, each row is a discrete metric averaged over 1970-1999 where possible. Box and whiskers show the range, quartiles and median over the period, or a nominal estimate of variation where no firm data exist. The vertical tick-mark above each box and whisker indicates the corresponding value from the best-fit model as a result of parameter optimisation by simulated annealing.

4. How has the model been used?

- Simulation of fishery yields and MSY in relation to the combination of pelagic and demersal harvesting rates (Heath 2012).
- Simulation of trophic cascades and the sensitivity to top-down and bottom-up drivers (fishing and river nutrient inputs (Heath et al. 2014a)
- Sensitivity of fishery yields to environmental drivers and biological parameters (Morris et al. 2014)
- Cascading trophic effects of scenarios for implementing a discard ban (Heath et al. 2014b)

5. How could the model be used in the future?

- Sensitivity of fisheries to ocean acidification effects (work in progress)
- Hindcasting ecosystem harvest rates since the 1960's and dis-aggregating the effects of environment and fishing (work in progress)
- Comparing fishery yields and MSY in different shelf sea regions (work in progress)
- Projecting the cumulative effects of harvesting and environmental change (temperature, ocean transport) in the future
- Ecological effects of alternative discard ban measures
- Coupling of the E2E ecological model to economic and social models based on game theory and/or agent based methods (work in progress)

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Ecopath with Ecosim (EwE)

Model description prepared by: Sheila Heymans, Steve Mackinson
Version: 30/04/2014

1. What is the scope of the model?

Around the UK we have models of the North Sea (ICES IVa-c; 570,000km²; 68 Functional groups (FGs): 3 mammals, 1 birds, 44 fish, 13 invertebrates, 3 primary producers, 3 non-living FGs[1,2]); Celtic Sea (ICES VIIf-j; 222,665km² 64 FGs: 3 mammals, 6 birds, 34 fish, 17 inverts, 1 producer, 3 non-living[9]); Western English Channel (ICES VIIe; 56,452km², 50 FGs: 2 mammals, 1 birds, 32 fish, 14 invertebrates, 1 producer, 1 non-living[10]); Eastern English Channel (ICES VIId; km², 51 FGs: 2 mammals, 1 birds, 29 fish, 15 invertebrates, 2 producer, 1 non-living[12]); English channel (as a whole) (ICES VIId and e; 89,607km², 45 FGs[13]); West Coast of Scotland (WCScotland) (ICES VIa < 200m; 110,000 km²; 3 mammals, 1 birds, 23 fish, 7 invertebrates, 1 producer, 1 non-living[3,4]); Deep West Coast of Scotland (ICES VIa, 400-2000m; 76,000 km²; 34 FGs: 1 mammal, 19 fish, 8 invertebrates, 1 producer, 1 non-living[5]); Clyde Sea (3,632km²; 37 FGs: 2 mammals, 1 birds, 21 fish, 11 invertebrates, 1 producer, 1 non-living[6,7]) and; Irish Sea (ICES VIIa; 58,000km²; 53 FGs: 3 mammals, 1 birds, 27 fish, 14 invertebrates, 3 producers, 3 non-living FGs[2,8]). Of these models the North Sea[1], Eastern English Channel, Celtic Sea (nearly), WC Scotland[4] and Clyde Sea[7] are spatially defined.

2. What is the model doing?

For Ecopath with Ecosim in general – see Appendix 1 'Model Description summary sheet, prepared and published by ICES WGSAM 2013[18]).

3. How has the model been validated?

The North Sea[17], Irish Sea[2], Celtic sea, WC Scotland[4] and Clyde Sea[7] models have been calibrated through fitting to historic time series data between 1991-2007, 1973-2003, 1985-2008 and 1985-2008 respectively, using the formal statistical fitting technique proposed by Mackinson et al. (2009)[2]. Considerable work has also been done on the performance of spatial predictions in the North Sea (submitted paper) – and is being used to guide the development of standards, criteria and methods for doing better. Updates of the models fits are done on a needs basis, since resources available do not allow for regular updates.

4. How has the model been used?

The North Sea model is being used for evaluating the trade-offs among alternative fishing strategies (particularly related to MSY and mixed fisheries) and to investigate the relative influence of fishing and climate on the North Sea ecosystem [14-16]. It is applied in the ICES WG on multispecies assessment [17]. The Irish sea model has been used to investigate fisheries and climate effects and similar work is underway using the Celtic Sea model. WC Scotland model describes the dynamics of the gadoid and demersal fisheries between 1985-2008 both in time and space[3,4]. The Clyde Sea model has been tested for its feasibility for ecosystem based management, by testing the input parameters and simulations between 1985-2008[7], and found to need refinement. See also Appendix 1.

5. How could the model be used in the future?

Key values of EWE models seen as are: (i) assessing the ecosystem impacts (food-webs and biodiversity) of fisheries and climate through its affect on changes in the food-web structure and function (ii)

evaluating the performance and trade-offs among alternative fishing strategies designed to achieve objectives for fisheries (e.g MSY) simultaneously with environmental objective (e.g MSFD GES food webs, biodiversity). Work is underway using these models to help establish relevant model derived indicators that respond to pressures in a measurable way. (iii) evaluation of spatial management policies – in this respect much of the capability already available have not been fully realised.

Specific models have the capacity to address specific issues, either through their original design or through changes in the detail of the functional groups and fisheries. For example: The Clyde Sea Forum is very keen to use the Clyde model to address ecosystem based management questions, including the impact of MPAs and spatial closures. The WC Scotland model will be used in the marine spatial planning of the area by the MASTS project on MSP of WC Scotland. The WC Scotland and Celtic Sea models will be used under MERP (NERC TAP) to model the temporal and spatial dynamics and to compare to other modelling techniques and the Irish Sea model under Lo-Rise (NERC RATE) to model the uptake of radioactive C14 into the foodweb. Other applications include the evaluation of the impacts of aggregate extraction in the Channel[19], and evaluation of the environmental impacts of oil and gas installations.

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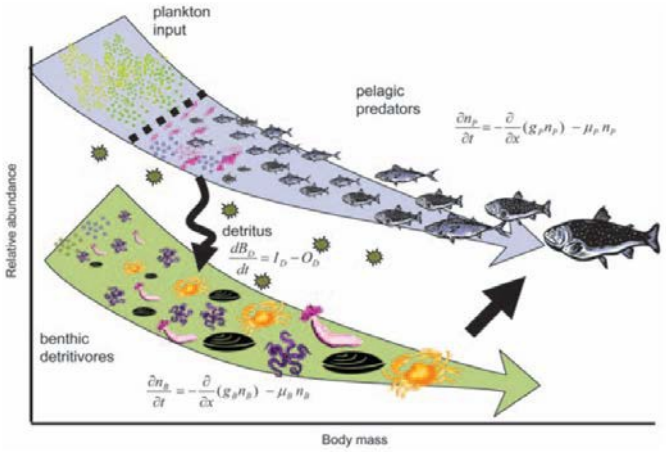
Coupled Community Size-Spectrum Model

Model description prepared by: Julia Blanchard, Michael Spence and Simon Jennings

Version: May 8 2014



The coupled size-spectrum model describes the structure and dynamics of two interacting size structured communities. The "pelagic" community consists of predators feeding on other predators and on "benthic" prey that share and compete for detritus.

1. What is the scope of the model?

The model was developed to represent the size and abundance of organisms in two coupled size-structured food chains, one based on predation and supported by primary production and one based on energy sharing and supported by detritus (Blanchard et al., 2009). Species are not represented explicitly. In many systems coupled size-structured food chains can be considered to represent pelagic and benthic food chains. The primary producer spectrum forms part of the food supply for the pelagic predator spectrum and is a source of a proportion of the dead particles that pass via a 'detritus pool' to the energy sharing spectrum. Phytoplankton dynamics are not modeled explicitly because the plankton spectrum is fixed by primary production inputs from data or other models. In various applications, outputs of size and abundance in each food chain can be used to predict changes in the size spectrum (relationship between log abundance and log body mass) in response to fishing, temperature and primary production as well as predicting fishery yields. The model has also been used to understand the emergence of size structure in pelagic and benthic food webs in the absence of fishing (Blanchard et al. 2011; Blanchard, et al., 2012; Woodworth-Jefcoats et al., 2013; Barange et al., 2014).

2. What is the model doing?

The model provides predictions of the abundance of organisms in each size-structured food chain at size. In both food chains we are concerned with the continuous function N(*m,t*) gives the density per unit mass per unit volume for organisms of mass *m* at time *t*. The continuous processes of growth and mortality that arise from organisms encountering and eating available and suitable food govern the temporal dynamics and lead to a partial differential equation for each size spectrum. The feeding rate of predators is a function of the preference for prey in each spectrum, the volume of water searched and

the probability that a predator will eat a prey of given mass. When the effects of temperature are modeled these influence feeding rates and intrinsic rates of mortality.

3. How has the model been validated?

Predictions of size-spectrum slopes were validated in the North Sea by comparing model predictions with empirical data on the size structure of pelagic predator and benthic detritivore communities. The model correctly predicted differences in the slopes of size spectra between these communities (Blanchard et al., 2009). Fish production estimates from an application to 78 EEZ using physical– biogeochemical model inputs for 1992–2001 have been compared with national catch statistics from the United Nations Food and Agriculture Organisation (FAO) database and showed reasonable correspondence (Blanchard et al., 2012). The greatest discrepancies between predicted and reported catches were those for EEZ within the Indo-Pacific and Northwest Pacific shelf seas. Large discrepancies were also associated with high interannual variability in both model- and data-based catch estimates,
for example, for Peru and Chile EEZ. Modelled relative growth rates have been compared with empirical growth rates for species from the North Sea and elsewhere and fall within reasonable bounds given that the coupled size-spectrum model treats growth as a continuous process and does not represent species.

4. How has the model been used?

Applications of this model have included the assessment of fishing impacts on community size structure and abundance in the North Sea (Blanchard et al 2009), theoretical exploration of the effects of coupling between pelagic and benthic food webs on responses to fishing (Blanchard et al. 2011) and prediction of the medium-term and long-term effects of climate change on fish production at regional and global scales (Blanchard et al., 2012; Woodworth-Jefcoats et al. 2013; Barange et al., 2014). An extension of the model to include different functional groups (predators, herbivores and detritovires) and size-dependent prey vulnerability has been applied to coral reefs to investigate the consequences of habitat complexity loss on fisheries (Rogers, Blanchard & Mumby, 2014).

5. How could the model be used in the future?

There is some ongoing work (Blanchard et al., unpublished) that fits the model to landings data from 85 different regions around the world and then use the fitted model to infer fishing mortalities for each region. This is done by taking into account the error structure of the data, uncertainty in the parameters and structural uncertainty (Spence et al., unpublished). This should enable results to be reported with quantifiable uncertainty measures (Harwood & Stokes, 2003) in order to assist policy makers. The model forms part of an ensemble being used to address climate effects on fisheries as part the FISH-MIP model inter-comparison project.

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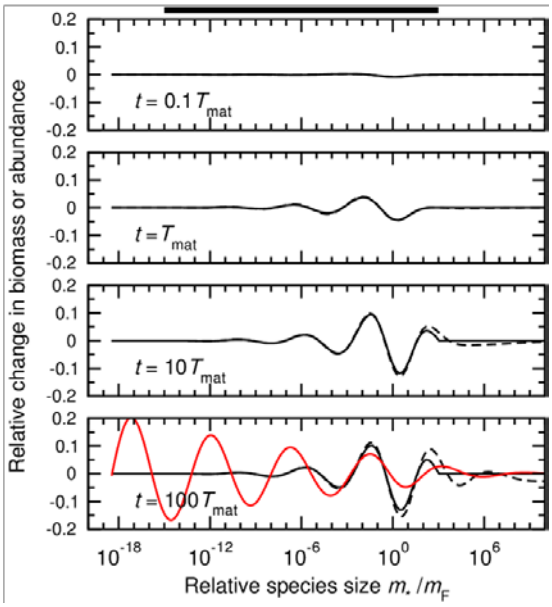
Species Size-Spectrum Model (SSSM)

Model description prepared by: Axel G. Rossberg

Version: 08 May 2014



SSSM simulated top-down trophic cascades in marine size-spectra at four moments after the onset of fishing (following Rossberg 2012). The horizontal axis is the maturation body mass of species relative to the main body-mass class targeted by fishing. T_{mat} is the age at maturation of the targeted size class. With different parameters, cascades can be attenuated (black) or amplified (red).

1. What is the scope of the model?

The SSSM (Rossberg 2012) is a highly simplified description of the dynamics of (spatially unresolved) marine species size-spectra, i.e. of the distribution of community biomass over species of different (maximal or maturation) body sizes.

2. What is the model doing?

The SSSM is unique among size-spectrum models in having been derived through controlled analytic approximations from a detailed individual-based, species-resolved model of marine community dynamics that explicitly represents all density dependencies at all life stages (Hartvig 2011). In particular, no assumptions about stock-recruitment relations are made.

The model predicts, in a linear approximation, changes in the abundances of species within body-size classes resulting from deviations of population abundances in other size classes from equilibrium and

from external pressures. Because of its simplicity, the model can be evaluated either numerically or in a highly efficient analytic approximation of its dynamics (Rossberg 2013).

3. How has the model been validated?

The SSSM has been shown to reproduce the known classical bottom-up and top-down effects at size-spectrum level (Rossberg 2012). Contrasting other size-spectrum models, the observed amplification of bottom-up effects from lower to higher trophic levels is reproduced, and the model's derivation is consistent with the observed approximate constancy of cohort biomasses throughout life stages (Houde 1997).

4. How has the model been used?

An important prediction by the model is that top-down trophic cascades can be both attenuating and amplifying, depending on model parameter (see Figure above).

5. How could the model be used in the future?

After having fitted the SSSM to empirical data or more detailed models, it could be used to inform policy makers, based on a simple and transparent management model, about high-level ecosystem responses to anthropogenic pressures (eutrophication, pollution, acidification, fishing, etc). It could so support the definition of broadly agreed management measures and their objectives in an open, integrative process.

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Multispecies Size Spectrum Model
(Multispecies size spectrum ecological modelling in R - mizer)

Model description prepared by: Michael Spence, Julia Blanchard, Simon Jennings and Finlay Scott

Version: May 8, 2014

1. What is the scope of the model?

The model was developed to represent the size and abundance of all organisms from zooplankton to large fish predators in a size-structured food web. A proportion of the organisms are represented by species specific-traits and body size while others are represented solely by body size. In this form, the model has principally been used to describe the effects of fishing on interacting species and the size-spectrum (relationship between log abundance and log body size). The model is based on the equations of Hartvig, Anderson and Beyer (2011) and Andersen & Pedersen (2010), that describe the dynamics of generic species based on life history traits, but with an explicit representation of species-specific traits in a real community (Blanchard et al., 2014). The model provides a means of scaling from individual processes (growth and mortality rates) to population structure (size distribution of each species) and community structure (sum of size distributions of all species). Model outputs of species identity, size and abundance can be used to estimate standard fisheries and conservation reference points for these species as well as a range of community and food web indicators for evaluating the effects of fishing. The R package 'mizer' has been developed for implementing the multi-species size spectrum model to a wide range of systems, which also contains documentation on the model equations and processes (Scott, Blanchard, & Andersen, 2014). The model is intended for regional application. It treats the sea as a homogenous environment although information on spatial co-occurrence can be used to parameterise interactions among species.

2. What is the model doing?

The model provides predictions of the abundance of each species at size. The core of the model involves ontogenetic feeding and growth, mortality, and reproduction driven by size-dependent predation and maturation processes (Hartvig, Andersen, & Beyer, 2011; Scott, Blanchard, & Andersen, 2014). It thus differs from some other size-based models that assume deterministic growth based on life history parameters. The smallest individuals in the model do not eat fish belonging to the fish populations, but consume smaller planktonic or benthic organisms which we describe as a background resource spectrum. Fish grow and die according to size-dependent predation and, if mature, recruit new young which are put back into the system at the minimum weight. The model is able to predict abundance at size, biomass, growth and mortality rates for each species. For a complete description of the model see Hartvig, Andersen, & Beyer, (2011) or Scott, Blanchard, & Andersen (2014).

3. How has the model been validated?

Validation has only been attempted for the North Sea. Blanchard et al. (2014) parameterized the model using life history data and rates of fishing mortality from single species stock assessments. They fitted the model output of species' catches and spawning stock biomass to time-averaged landings data and

spawning stock biomass from ICES stock assessments. Modelled species size distributions were validated by comparison with trawl survey data from the North Sea Quarter 1 International Bottom Trawl Survey from 1983 to 2010. In general the modeled size distributions were consistent with data and most discrepancies could be explained (Blanchard et al., 2014).

4. How has the model been used?

Blanchard et al. (2014), developed and applied a multi species size spectrum model of the North Sea community to assess the response of populations and the community to fishing and to determine whether meeting management targets for exploited North Sea populations will be sufficient to meet proposed Marine Strategy Framework Directive targets for biodiversity and food web functioning (including the "Large fish indicator"). Applications of the Hartvig et al. model (also dubbed the "Fish community size resolved model, FCSRM), with less detailed species-specific parameterization, have also been carried out in the Celtic Sea and Irish Sea to examine the response of size based indicators to the effects of fishing as well as exploring the role of forage fishing (Houle et al. ,2013; Houle et al., 2012; Shephard et al., 2012). There is a growing number of existing but unpublished applications of the multispecies size spectrum model (including to deep waters off the West of Scotland, the Celtic Sea, Scotian Shelf and Baltic Sea).

5. How could the model be used in the future?

This modeling framework is being developed for use in management strategy evaluation and in a risk assessment framework. There is some ongoing work that examines parameter and model uncertainty as well as the error structure of the data (Spence, Blackwell & Blanchard, unpublished). These advances will mean that model outputs can be presented with associated measures of uncertainty and allow users of the advice to better assess the risks associated with alternate management options (Harwood & Stokes, 2003; Blanchard et al., 2014). The model structure allows non-fish species to be explicitly represented in the model and there is ongoing work to add seabirds (Masters student with Blanchard) and marine mammals (Houle et al., unpublished). The consequences of different size and species selectivity, bioeconomic processes and trade-offs are also areas being explored.

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Strathclyde length-structured partial ecosystem model (FishSUMS)

Model description prepared by: Douglas Speirs
Version: 29 April 2014

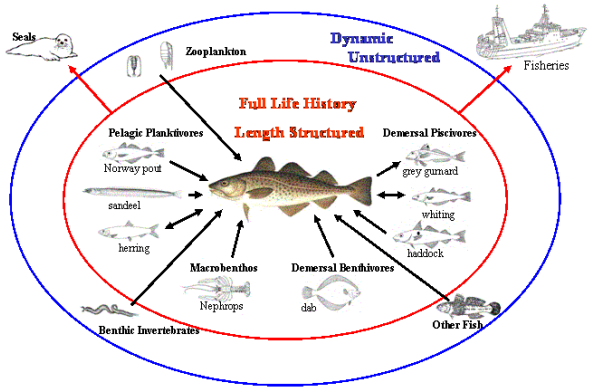

Figure 1 – schematic structure of the FishSUMS model for a cod-focused set of species. The species inside the red ellipse are modelled as coupled length structured populations. The functional groups representing the rest of the ecosystem that are represented as biomass spectra lie within the blue ellipse. Fishing and other sources of external mortality are drivers of the system.

1. What is the scope of the model?

The model represents the population dynamics of a set of key trophically linked predator and prey species. For each species the state variables are biomass by length class. In discrete time steps the state variables are updated through increasing length, density-dependent mortality, and losses due fishing and predation by explicitly modelled species, and seasonal reproduction. Additional food resources not modelled at the species level are characterised by three biomass spectra representing zooplankton, benthos, and "other fish". Outputs from the model are time series of total species biomass (TSB), normalised length distributions at annual census dates, annual recruitment, catch and landings, for each of the focal species.

The published description of the model (Speirs et al. 2010) was configured for the North Sea with a set of nine structured species focused on cod and its main predators and prey (Fig. 1). Subsequent work (Speirs et al., and McCaig et al., 2014) has extended this set of species to include plaice and saithe so as to include the eight most abundant demesral species that make up >90% of the North Sea biomass. In general the model is configurable for any set of structured species and unstructured prey groups. The model has been developed as a package for the R software environment, and is available on request http://www.strath.ac.uk/fisheries/products/fishsums/.

2. What is the model doing?

The lengths of individuals among the length-structured focal species follow von Bertalanffy growth curves characterised by an initial size, a growth rate parameter, and an asymptotic length. For any species-specific set of von Bertalanffy parameters this allows us to define a logarithmic transformation of length in which classes of equal width have the property that, if over the discrete time step a constant fraction of the individuals in each class progress to the next one. By selecting the number of length classes and the fraction progressing we can control the variability in length of a cohort while ensuring that the resulting mean length follows the desired von Bertalanffy growth rate. Species-specific cubic-power relationships between length and wet-weight allow us to equate numbers and biomass at length.

Survivorship of individuals from one time step to the next is determined by mortality from density dependence, predation from species explicitly represented in the model and from fishing. Growth of any population from one length class to the next implies a food ration, the assimilated component of

which must cover the associated increase in weight, the maintenance of existing body mass and, for reproducing individuals, the biomass of released eggs. The proportion of the total uptake removed from any individual prey class is a weighted average of the total biomass over all prey length classes. The averaging weights in this calculation are diet preferences are obtained from the product of a length-independent and a length-dependent preference that is a function of the prey-class-length/predator-class-length ratio. Individuals in a given model length class only consume prey in smaller classes. The largest length class of any species has no predators, and so the time-step survivorship of that class depends only on the biomass of that species. This then allows us to calculate the survivorship of the next largest length class, and the predation load it imposes on the remaining length classes, and so on through all the model length classes in descending order of size. The life cycle is closed by placing the egg production (during a spawning season) from the mature fraction of the population, obtained from a cumulative normal distribution, into an egg class.

3. How has the model been validated?

Speirs et al. (2010) validated the cod-focused North Sea model by comparing the time series outputs of TSB, recruitment, and landings, with those from ICES stock assessments, and by comparing normalised Quarter 1 length distributions of individual species with those obtained from IBTS survey data. Most model parameters were obtained by independent estimates, but the density dependence mortality parameters were treated as treated a free tuning parameters to obtain qualitative fits to the data. Speirs et al. (2014) carried out a similar exercise, but also including the North Sea Large Fish Indicator (essentially the biomass ration of fish over 40 cm in the IBTS survey) as a target.

4. How has the model been used?

- Simulation of cod yields and MSY in relation to harvesting rates on other species, particularly herring (Speirs et al. 2010).
- Simulation of the historical North Sea LFI (Speirs et al. 2014).
- Forward runs of the response of the LFI to changes in effort due to different fishing metiers (Speirs et al. 2014).
- Hindcasting changes in fish diet and biomass fluxes in the North Sea (McCaig et al. 2014).

5. How could the model be used in the future?

- In conjunction with automated parameter estimation algorithm the model could be used as a length-based multispecies stock assessment tool.
- Comparing fishery yields and MSY in different shelf sea regions.
- Comparing top-down and bottom up trophic cascades (currently only top-down effects are possible, so this would require a modification of the representation of growth – this is work in progress in a single-species context as part of EU-BASIN).
- Population effects of alternative discard ban measures.

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Appendix 11

MERP Pathways to Impact: working together and how to get involved

MERP kick off meeting: 4th-6th June 2014

Kelly-Marie Davidson (KMD) and Kelvin Boot (KB)

Key points of the previous days talks were reiterated including: it is a contractual requirement for everyone involved in MERP into interact with Knowledge Exchange (KE). The group was also reminded that a central depository of KE activities will be held in order for PML to report back to DEFRA, and so it is vital for MERP scientists to engage with KE.

The list of potential programme impacts was discussed. Manuel Barange commented that the impacts seemed generic. Kelvin Boot (KB0 agreed with this however reiterated that these are merely a skeleton and that Kelly-Marie Davidson (KMD) is asking for feedback from the group in order to make these points more specific.

Mel Austen commented on point two and suggested the wording could be changed to 'identifying and promoting opportunities of employing an ecosystem approach…' with regards to Marine Conservation Zones and marine spatial planning. Also to add employing this approach with regards to marine licencing.

Mike Heath expressed that he also had a problem with the second point on the slide re: 'supporting further development of Marine Conservation Zones' and whether that actually is 'a good thing'. Mike went on to say MERP should instead be providing an evidence base on which to take decisions about Marine Conservations Groups. KB and KMD agreed with this suggestion.

There is a comment from the group which addressed the fact that to write about an impact in the future – the scientists must understand who they have had an impact on. It is as of yet unknown who will be impacted on by the programme, these groups need to be identified. KB also informs the group that as soon as a stakeholder group has been set up, they will be met with to determine the group's wants and needs.

Mel raises the point that it would be helpful when identifying stakeholders, to engage with industry in terms of making marine licencing easier for them by thinking about an ecosystem services approach which is scientifically valid, based on tools which come out of MERP. She also comments that marine licencing is often overlooked however the day to day issues with industry and licencing is important.

It is remarked that the generic needs of any stakeholder will be robust evidence. The same group member also commented that it would be useful to identify the key knowledge gaps with policy first in order to make impacts more specific. MERP can then provide specific example of how the work package modules will address these. Can prioritise by which ecosystem goods are most desirable to the stakeholders.

It is noted that there is a mixed community in the room and for some impact is important in terms of referencing and the way in which this impact can be traced is through the citation of papers and the way in which they inform policy. Therefore it is important, the speaker commented, that for those

coming from an academic situation that there is a mechanism by which publications get traced through to policy. It is suggested that as a strategy MERP could release a briefing note for every paper which comes out of MERP – targeted at individuals with the potential to influence policy.

KB raises the point that part of the future discussions with stakeholders will revolve around finding out how they want to receive this information, whether that be in the form of a briefing note or otherwise.

There are mixed opinions about whether the briefing note for every paper released is a good idea or whether this will overload the stakeholders with information. KB mentions there could be a briefing note every time but this does not then have to be given to all the stakeholders – the briefing notes would be extremely useful to have in the 'arsenal' of information.

David Paterson raises the matter of public perception being very important to stakeholders e.g. how much does the public know about this, how important is it to them. The value of measures the scientists could take to protect these ecosystem functions. Not always the science per say, more how the public perceives it and how it can be used.

The previous slide is commented on with regards to 'the wider scientific community' in that one of the things MERP will be doing is making predictions, and if this is successful than one of the unique strengths of the project will be that it didn't just base things on a single model. Scientifically valuable but also had value from a perception point of view.

Mel comments of KB's notion of having an 'arsenal' and reflects on a recent VECTORS meeting in Brussels where their fact sheets were extremely popular and talks about the value of having these things available for people.

Paul Somerfield emphasises the criticality of understanding other people's and requirements in terms needs of impact, but also to inform the group that there was a programme management meeting on the previous day where they discussed who would be useful to have in the stakeholder group and individuals who would be most relevant. He also asked the group if they had any more ideas or names for the stakeholder group.

KB tells Paul that PML Communications would like to meet with the stakeholder group at the earliest opportunity.

Tom Webb asks KMD if there any plans to make the MERP website accessible on mobile phones as it is currently not compatible. KMD responds that will most likely happen in the near future.

Paul comments that whilst the impact plan is intended to be an 'aspirational' document, it should also be a 'living' document that can change and be update with new information as and when. Needs to be a constant process – not just finalising a document. Agreeing a process is key.

KMD discussed programme internal communications, what will be available and the most suitable ways of doing this. She also urged the group to come forward with more ideas for internal communication methods.

Ana raised the question of whether basecamp should be used for MERP. KMD responds that it is something to look into and could be appropriate however it is also very large.

Axel commented that he prefers email as a vehicle for internal communications, which leads KMD to asking the group as a show of hands which types of internal communication are most popular. Email is the most popular followed by wikis and newsletters. Social media is the least popular.

The group discussed the usefulness of having a SharePoint. KMD informs the group that a SharePoint should be possible within the CMS and will be organised soon. Jess Heard addressed the group to ask if there were any preferred alternatives to Basecamp. A system called 'Huddle' was recommended but considered quite costly.

Tom Webb suggested Dropbox and google drive.

MERP already has a SharePoint site which is hosted at Strathclyde. It was generally considered a sensible idea to keep this system in place for the programme.

Mel commented that SharePoint is very useful for people who may have joined the programme at a later stage because they can look back through the thread of what's been happening in that module and get up to speed quickly. KB asked the group to email either KMD or Jess to state their preferred method of sharing.

David Paterson suggested that it would be a good idea to take a look at the impacts list and reduce it, in order to do a few things well rather than lots poorly. He also queried how realistic the 'app' idea was. KMD responded that the app was already in development which is why it was included in the pathways to impact, however urges whoever had the idea for the app to come and discuss this with her after the meeting.

KB concluded the meeting by reiterating the plan to meet with the stakeholders and informed the group that a revised second version of the impacts will be sent on to them.

Appendix 12

MERP Pathways to Impact

Who are the non-academic beneficiaries and how will they benefit? This programme has the potential to provide significant and extensive impacts and benefits to a wide range of stakeholders. Knowledge gained will allow a more holistic view of the UK marine environment, increased understanding of the ecosystem services it provides and its resilience to the direct and indirect pressures it faces. It will bring together new and existing data on UK marine ecosystem processes, biodiversity, food webs and function with models and current understanding of ecosystem services within a common framework for use by the wider scientific community, policymakers, environmental regulators, environmental managers and wider society. **Developing and implementing policy:** MERP will deliver whole ecosystem synthesis, modelling and understanding to improve marine management through the refinement of the Marine Strategy Framework Directive's (MSFD) Good Environmental Status (GES) indicators and targets (including Biodiversity, Foodwebs, Eutrophication, Seabed Integrity and Hydrography), as well as fisheries, aquaculture, energy provision, marine planning, licensing and conservation aspects under initiatives such as the Marine and Coastal Access Act, Marine (Scotland) Act, Common Fisheries Policy and the OSPAR Joint Assessment and Monitoring Programme. Stakeholders involved with policy-making, such as Defra, DECC and Marine Scotland, will benefit from improved knowledge and predictive skill for key indicators of the state of the marine environment. By delivering our outputs and novel approaches in the common currency of ecosystem services and improving understanding of the effects of changing pressures (e.g. fishing and climate change), we will identify and promote opportunities to employ an ecosystem approach within the development of policy, regulatory and management strategies. MERP also has the breadth of expertise (e.g. benthic-pelagic, inshore-offshore) to provide a robust evidence base for the development of Marine Conservation Zones, based on the most comprehensive field, lab and modelled evidence, and marine spatial planning for habitat identification. **Influencing and informing policy:** Stakeholders with a role to inform and influence marine policy will benefit greatly from the new knowledge and outputs from this programme, including JNCC, Natural England, Scottish Natural Heritage, Natural Resources Wales, Met Office, among many others. These benefits will be in the form of accessible, cleaned and integrated data sets including processed data, ecoinformatic tools, products (e.g. maps and visualisations) and interpretations, which will help facilitate increased knowledge of marine ecosystem processes, functions, biodiversity and services and model outputs. A data legacy will be provided by BODC and MEDIN, allowing open access to rationalised data for scientists, education, industry and the public. **Industry:** By identifying key stakeholders within industry, specifically marine planning and licencing, we will promote the use of MERP tools to allow stakeholders, such as the MMO, Defra, Decc, Scottish Government, Natural Resources Wales, JNCC, Crown Estate and subsequently offshore development companies, to consider planning and licencing in terms of a scientifically valid, ecosystem services approach. **Wider society:** There is significant wider public interest in the research of MERP in that the UK is an island nation and the shelf seas are a source of food and energy that is susceptible to environmental change with consequent socio-economic implications. More indirect outcomes will include improved understanding of regional goods and services, their resilience, and links between different types of human benefits derived from marine ecosystems including recreational and aesthetic values. This is an area of significant public interest, and provides an opportunity for increased public engagement with marine ecosystem research. While the work here focuses on European waters, the model tools are widely applicable to shelf seas around the world and, therefore, could be extended to address food security issues relating to changes in the global marine ecosystem.

What activities will be used to reach these beneficiaries? The partners of MERP already have strong connections with bodies responsible for developing and implementing policy, which will enable us to access the target beneficiaries. For example, Cefas, SAMS, PML, Bangor are contributing to development of indicators, targets and defining GES under the MSFD, and Cefas and PML are active on a range of ICES working groups, such as fisheries stock assessment and management, ecosystem modelling, marine biodiversity, benthic ecology and climatic data. Cefas also have direct links to policy and marine regulation via Defra and the MMO. We will use these long established links to provide outputs from our model ensemble to inform the relevant government policies, MSFD working groups, ICES working groups and MSFD Assessments, as well as other biodiversity-related evidence groups. We have allocated a good budget to continue engagement with such key stakeholders, via an experienced Knowledge Exchange (KE) Officer and we have dedicated funds to support the attendance of a Stakeholder Panel at project meetings, which will include a cross-section of MERP users. This will be the main mechanism to reach the stakeholders mentioned above, accompanied by targeted communication materials, to allow upstream and continued engagement of these beneficiaries to tailor plans (where necessary), optimise the relevance of outputs and disseminate objectives and findings to the appropriate beneficiaries. We will engage relevant marine ecosystem initiatives, such as the Marine Biodiversity Monitoring Programme and the Celtic Seas Partnership, to help feed knowledge and MERP developed tools to targeted stakeholders. A policy report will be produced (Deliverable 4.5, Month 42), following feedback from policy stakeholders on required content and format. Impact activities to monitor and identify new potential for KE will be a standing item on the agenda of meetings of the MERP Executive Steering Group. MERP will work closely with other related programmes, such as BESS and SSB programmes, to ensure outputs are consistent, relevant and receive maximum exposure. Communication will be maintained between meetings through electronic updates. Two seminars

for funders and policy specialists will be held at Defra to encourage dialogue between the programme participants and beneficiaries presenting 1) initial findings and to gain feedback to ensure the direction of the project is aligned and relevant to policy requirements and 2) key findings and potential areas for future investigation. Through the Westminster Energy, Environment and Transport Forum we will lobby for a Keynote seminar (high-level, impartial, cross-party public events) focused on marine ecosystems and the MSFD. Events regularly receive prominent coverage in the national and trade press. In collaboration with the British Ecological Society we will develop a symposium (Deliverable 1.3, Month 18) entitled "Ecosystem Service Regulation under Environmental Change: linking processes with predictions across ecological scales and pressures", facilitating dissemination of the project's outputs with the wider scientific community and informed stakeholders. We will encourage opportunities for brief secondments of project scientists to our policy and regulatory beneficiaries (e.g. Defra), particularly to understand the needs of these beneficiaries and thus help tailor the production of policy briefs and synthesis reports, to include recommendations on how pressures on UK seas can be managed to sustain a healthy and beneficial marine environment into the future. Discussions will be held with the Parliamentary Office of Science and Technology to encourage an updated POST Note based on the findings of MERP. A project website will be created, tailored to the programme's diverse audience with tiered content to provide various levels of accessibility. Working with ROpenSci we will develop simple web-interfaces linked with existing initiatives (Emecodata) so that processed versions of our data, such as maps or time series, are accessible. This work will also feed into the international policy arena, for example, via membership of the UN Pool of Experts on the Oceans. We will create a simple interactive "Past & Futures" web app to enable users to select ecosystem properties, indicators and services to visualise changes to a marine ecosystem through time. The results of these scenarios will benefit those responsible for marine use and resource management, such as the MMO, Crown Estate and JNCC and MCCIP. Communication to wider society will mainly be via PML's Communications Group with input from the partner institutes. We will seek to provide measured information to a concerned general public, balancing uncertainty in future predictions with firm scientific principles. News will be disseminated via traditional and new media channels including: bi-annual project news and updates circulated to the programme contacts database and available from the website; press releases of newsworthy developments; a programme leaflet for dissemination at relevant meetings; feature articles for the national and international specialist press; interactions with the broadcast media; a brief programme overview podcast via the Coffee Break Science series, and regular updates via established social media feeds, such as @MarineRippleEffect on Twitter. The Consortium members have wide interview experience on national radio and TV. Public events will be held at the National Marine Aquarium and at the Portaferry Aquarium Open Day. Local National Science and Engineering Week activities will be themed around human's impact on food webs, which will also be extended to talks in partner schools.

How will activities be evaluated for success? Incorporation of MERP outputs into policy and for wider impact will be continuously monitored and evaluated using a combination of relevant elements from established evaluation models, to help understand and demonstrate the programme's impact on policy and other beneficiaries. The Kick-off and Stakeholder meetings will be used to assess the current policy and beneficiary environments with the target groups, which will also provide a benchmark for impact evaluation. Traditional evaluation methods will include publications, impact factors and citations.

What are the costs? In addition to the institute specific outreach costs, a central outreach budget is allocated to the PML Project Office. This currently includes 13hpw for a KE Officer (Davidson, PGDip in Science Communication) with expert web support, plus associated outreach costs of £115k (mainly associated with hosting the Annual Science and Stakeholder meetings with Travel & Subsistence costs, symposium, printing costs and public exhibits). An experienced science communicator and BBC Radio 4 presenter has also been budgeted to provide expert communication knowledge and well established links to the media.

Appendix 13

Marine Ecosystems Research Programme

PAG report to kick off meeting – 6 June 2014

Programme Advisory Group report

MERP comprises a strong consortium with great potential to make important steps forward in improving understanding marine ecosystems, how they deliver ecosystem services and benefits and forecasting how they will change in the future in response to environmental change and human activities. There is a good spirit in the project and a general enthusiasm to engage in real collaboration.

The key challenge is to ensure that the project develops as a coherent integrated whole rather than a set of disparate projects. This requires a clear focus on end points, in terms of target ecosystem services, scientific outcomes and specific areas of impact in terms of policy, management and business. In general, the aim should be to do a few things well, rather than a lot of things less well.

Clear management structures are needed to be able to do that in a project of this size and complexity. The proposal does include frequent mention of links between different elements of work and they have also been identified in presentations and discussions, but they need to take a more concrete and detailed form now. The proposed matrix and flow diagrams are clearly important, as will be assigning responsibility to individuals and timelines for activities and links / dependencies between them, all of which should be summarised in a project management flow diagram. Everyone will need to engage fully, delivering on their individual responsibilities and taking collective ownership of the work under strong leadership and project management. Extensive dialogue will be needed, particularly in the first few months.

The consortium recognises the need to develop mechanisms for integration. A number of module-level meetings are proposed in September, for example, and consideration is being given as to how best to facilitate interaction within and between modules, including webinars, monthly Skype meetings of module leaders for the first few months and attendance of individual modellers at empirical workshops and vice versa. The PAG recommends as much inter-module interaction as possible and will review progress in development of management structures in the coming months. Some areas have already been highlighted as potentially presenting particular challenges. Links between Module 6 and Modules 1-5 need particular attention because of their separate origins as WP2 and WP1. Size spectra were also highlighted as a potential challenge and will need careful consideration.

The PAG recommends that Stakeholder Advisory Group should be constituted as soon as possible with a specific remit to help decide which ecosystem services to focus on, what kind of information is needed and in what format to maximise impact in terms of specific policy and management initiatives. We suggest that that group is kept quite small and focussed on the above remit. There should be a separate process of consultation with a much wider range of interested parties, such that they can be kept informed and provide viewpoints as the work develops. This can be done later in the project.

Overall, the programme has clear potential to deliver excellent science with important impacts. Considerable effort will be required to maximise integration and ensure that the project fulfils its potential.

continues …

Actions agreed by the MERP consortium following presentation of PAG report

1	Share minutes of steering committee meetings with other PIs.	Module leaders
2	Draw up (or at least discuss) some kind of contractual agreement between institutions regarding data sharing and IP.	?
3	Create a SharePoint for file-sharing with version control – this will either be a new facility or reactivation of the Strathclyde portal, whichever is the best option.	JH
4	Profiles of all members of the consortium will be published on the programme website, to include a brief summary of their role (Jess will provide them with a template).	JH, All
5	The programme office will circulate guidelines for publication to the consortium to ensure consistency.	JH