QUEST_FISH: Predicting the impacts and consequences of climate change on global fish production

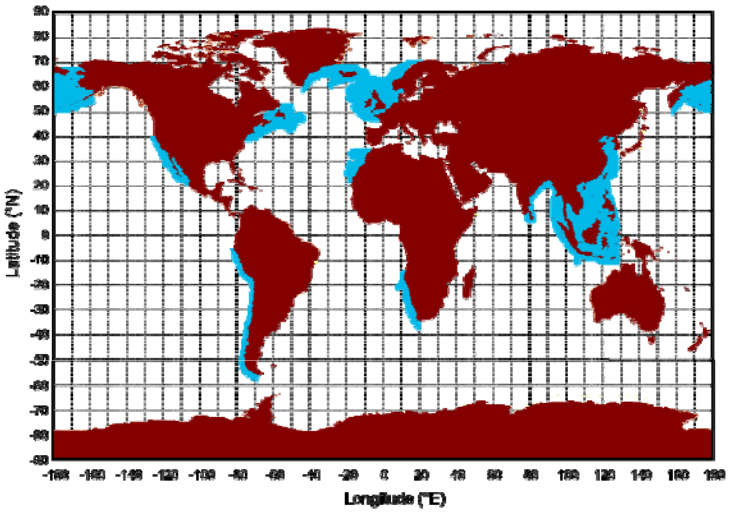
This document summarises the detailed list of deliverables, geographical and temporal domains and other basic information that allows the project to move forward. Agreed by all PIs in November 2007 after the 1st PIs meeting. However, this is a living document that will be modified as the project develops.

1 - TIME SLICES

It has been agreed that we will run 4 time slices (1800, 2005, 2050 and 2100) to begin with, with a possibility of including a 2030 slice if computational time can be handled. For each slice we will run 3 ensembles, so that both the climate variability and the climate change signals are captured. For each slice we will have 5 years of data.

2- GEOGRAPHICAL DOMAINS

Based on the time slices agreed upon geographical domains were selected based on the LME priority exercise conducted at the kick-off meeting in Plymouth (October 2007). GCOMS domains do not match exactly the LME domains, and so occasionally more than one GCOMS domain is required to cover a full LME (e.g. Humbolt), and other times one GCOMS domain resolves several LMEs (e.g.East China Sea/ Yellow Sea). At some point the GCOMS/ERSEM-based output variables will have to be geographically trimmed to match LME-based records (e.g. catches). It is envisaged that this process will be done by the PML Module 1 scientist (Robert Holmes).



The GCOMS/LMEs domains and the time-slices/ensembles selected will commit 4 months of continuous processing on the POL cluster, PML cluster and Hector processors. We should review the schedule in October 2008.

Geographical map of the 20 LMEs (14GCOMS domains) of QUEST_Fish

GCOMS Domain Name	Short Name	min. longitude (°E)	max. longitude (°E)	min. latitude (°N)	max. latitude (°N)	B-points number	Hours for a 5-y simulation	
CHIna Sea	CHIS23	112	128	22	43	12294	34.08	TABLE CONTINUES BELOW
TACHILe	CHIL15	-80	-68	-59	-21	9321	25.84	
PERU	PERU17	-85	-68	-21	-5	4537	12.58	
Bay of BENgal	BBEN31	78	104	-10	25	21419	59.38	
INDOnesia	INDO32	99	129	-13	22	61334	170.03	
North-West EUrope	NWEU01	-21	14	46	62	28858	80.00	
BERing Sea	BERS21	158	-157	47	68	46494	128.89	
West Central AFrica	WCAF39	-25	-7	0	21	6157	17.07	
North-West AFrica	NWAF40	-25	0	21	35	9614	26.65	
NORwegian Sea	NORS03	0	24	62	71	7305	20.25	
BENGuela current	BENG37	5	20	-39	-14	8307	23.03	
Iceland and South-East Greenland	ISEG04	-44	0	57	69	21349	59.18	
North-West AMerica	NWAM19	-130	-100	20	40	9367	25.97	
NEwFoundLand	NEFL09	-80	-40	38	53	21483	59.56	

TABLE CONTINUES FROM ABOVE	LME(s)	mgC.m2.d	km2	2003 catch	%catch	Sum % Catch
	East China Sea / Yellow Sea	1,058	1,212,441	8,193,703	13.27614	13.27
	Humbolt	737	2,544,850	7,882,524	12.77194	26.04
	Humbolt					26.04
	Bay Bengal	568	3,660,127	4,005,393	6.48988	32.53
	South China Sea/ Sulu celebes/ Indonesian Sea	619	3,269,343	3,400,611	5.50996	38.04
	North Sea / Central Biscay Shelf	908	1,449,726	3,270,453	5.299067	43.34
	East BS/ West BS	609	3,349,908	2,660,944	4.311489	47.65
	NW Africa	1,280	1,121,173	1,963,028	3.180666	50.83
	NW Africa					
	Norwegian Shelf	498	1,116,127	1,767,790	2.864324	53.70
	Benguela	1,158	1,456,812	1,415,244	2.293099	55.99
	Iceland Shelf/ East Greenland	509	634,622	1,320,155	2.139028	58.13
	California	501	2,208,710	692,277	1.121686	59.25
	NE US/ Scotian shelf/ Newfoundland Labrador	916	1,199,643	614,389	0.995486	**60.25**

3- DELIVERABLES/ VARIABLES MODULE 1

Module 1: Climate Change forcing scenarios and predictive planktonic ecosystem responses					
Partners	PML*	POL	UoP	CEMARE	UEA
Man Months	8	5.75			
* Lead Partner: Icarus Allen, PML					

Deliverables (as per the proposal):

1.1. Analysis of simulations from the re-anaylsis forced runs (month 6)
1.2. Simulations from 7 high-priority GCOM's domains (Month 8)
1.3. Simulation from 7 lower priority GCOM'S domains (month 12)
1.4. Final simulations of 14 GCOM's domains (month 24)
1.5. Analysis of climatic variability in coastal-ocean primary production (month 30)

Variables and resolution:

- Driver inputs into GCOMS – Hadley monthly runs (Graham to check with Jason Lowe if higher resolution is required)
- Boundary conditions:
  - *Physics:* (for 2005 runs)
  - *tides* – TOPEX
  - *T&S, currents* - NEMO (0.25 deg. res.) from ESSC Reading
  - *river flow* - GRDL (global rivers database)
  - *atmospheric fluxes* - ERA40/operational model (ECMWF)
  - *Biology: Nutrients (either from climatology or from models) + rivers .*
  - *May have to extrapolate P and Si from N using Redfield ratio.*
- GCOMS outputs to input ERSEM:
  - temperature (mixed layer average and bottom layer): output daily on model grid
  - also available T & S daily averaged 3D fields, as well as tidal data and current fields from our own analysis of the runs
- ERSEM outputs:
  - primary production (gCm^{-3}) (water column daily average for each phytoplankton type): output daily on model grid.
  - secondary production (gCm^{-3}) (water column daily average for each zooplankton type): output daily on model grid
  - flux of C ($gCm^{-3}t^{-1}$) entering benthos/fraction of PP entering the benthic system (water column daily average): output daily on model grid
  - Average depth of mixed and bottom layers: output daily on model grid
  - detritus production (gCm^{-3}) (water column daily average for each detritus group): output daily on model grid
  - Minimum time steps are daily (for Julia) and annual (for Simon). Spatial resolution minimum is 36 km cells (can be aggregated) for Simon (Julia will test aggregations).

Module 2: Development of fish biomass and production predictions					
Partners	PML (CEFAS)*	POL	UoP	CEMARE	UEA
Man Months	13.2				
* Lead Partner : Nicholas Dulvy, CEFAS (Subcontracted by PML)					

Deliverables (as per the proposal):

2.1. To determine the scaling between primary production and fisheries production across a range of large marine ecosystems by month 15.
2.2. To produce PPMR and TE estimates by month 15, and fish biomass and production estimates from time-averaged size-based models, for each large marine ecosystem and the time scenarios developed in Module 1, by month 28.
2.3. To incorporate temperature dependency into models by month 8, and produce fish biomass and production estimates, derived from temperature-dependent dynamic size-based models, for each large marine ecosystem and time scenario developed in module 1, by month 28.

Variables and resolution:

- biomass density (and abundance density) of fish (and benthos if required) by size class or integrated across any specified size ranges
- Annual spatial estimates per each LME/GCOMS scenario (14 GCOMS [up to 20 LMEs] x 4 scenarios)
- Spatio-temporal estimates of biomass density of fish and benthos by size class derived from temperature dependent size-based models for each model scenario and LMETE and PPMR estimates for each LME

Module 3: Impacts and Consequences of Global Environmental Change on the Fishmeal -based global food markets

Partners	PML*	POL	UoP*	CEMARE	UEA
Man Months	4.5		12	11	

* Lead Partner : Lynda Rodwell, UoP and Manuel Barange, PML

Deliverables

3.1. Collation of databases for climate drivers and fishmeal production for the case studies (mo 6)
3.2. Development of climate change-production-market scenarios and alternatives (mo 12)
3.3. Development of exploratory and predictive modelling scenarios (of climate *versus* fishmeal production) for the case studies (mo 18)
3.4. Further development of the global fishmeal model, including improvements in the input data, trade and market parameters (mo 24)
3.5. Identification of the outputs of high/low road scenarios regarding market trends (mo 24)
3.6. Determine the technical and economic feasibility of substituting fishmeal with alternative ingredients in the Scottish salmon farming industry based on scenarios and model results 3.2-3.5. The possibility of including another case study such as shrimp farming in Asia will be explored. (mo 24)

Module 4: Future vulnerability of national economies and global fishmeal and food markets to effects of climate change and other drivers on fisheries

Partners	PML	POL	UoP	CEMARE	UEA*
Man Months					30^{+}

* Lead Partner : Dr Edward Allison, UEA

$^{+}$16 mo funded through this proposal, the rest funded by WorldFish Centre

Deliverables

4.1. Develop risk exposure, sensitivity, adaptive capacity indicator frameworks for each scale (mo 6)
4.2. Collate relevant data, construct indices and develop exposure-sensitivity-adaptive capacity scenarios from production data (modules 1&2), fishmeal trade model (module 3) (mo 12)
4.3. Case-study research on social and economic impacts of drivers and exploration of possible adaptive measures for one or more major world fishery (mo 18)
4.4. Publications on predictions of vulnerability of fisheries to climate change and future socio-economic scenarios, at geographical scales relevant to policy formulation (e.g. national , LME, Global) (mo 28)

4.5. Identification of adaptive measures to build resilience of the fishery/food system/ecosystem to future climate change and other relevant drivers (mo 28)