

COST Action FA1004 Conservation Physiology of Marine Fishes

Minutes of the 2nd Conference on Conservation Physiology of Marine Fishes.

Hotel Brioni, Pula, Croatia, 24 – 26 September 2012

The timetable of the meeting is shown in Annex 1.

The **objectives of this second meeting** were to

1. hold workshops for all working groups
2. encourage networking among members of the Action
3. discuss the budget plan and activities for Action year 2
4. discuss funding and reporting of short term scientific missions

The list of delegates attending this Pula meeting is carried in Annex 2.

General Overview (David McKenzie)

The meeting started with a short introduction by the local organiser and host Bojan Hamer (Ruđer Bošković Institute, Centre for Marine Research, Rovinj). David McKenzie (Action Chair) then presented the general objectives for the three-day conference.

A specific highlight of the conference was that each day started with two 30-minute plenary lectures on aspects of conservation physiology (see programme in Annex 1). These were given by international experts in the field, and also by an ESR (Shaun Killen) who reported on his STSM. In particular, two external experts, Dr Tony Farrell (University of British Columbia) and Dr Denis Chabot (Department of Fisheries and Oceans, Mont Joli, Quebec), gave lectures about the state of the art of marine fish conservation physiology in Canada, which were extremely informative for the continuing development of our network and Action.

The workshops were held to take forward activities of the three Working Groups (WG1 Basic physiological knowledge; WG2 Integrating physiology into forecasting, and WG3 Conservation physiology and decision-making), in line with their specific objectives in the Memorandum of Understanding. The **composition of the working groups** can be found on the intranet section of the project website (<http://fish-conservation.nu/>), based upon expression of interest by each delegate at the 1st conference (CIMAR, Porto, Portugal, September 2011), and updated by the Action chair.

WG1 workshop was on Monday 24/09/12, WG2 on Tuesday 25/09/12, WG3 on Wednesday 26/09/12. The WG leaders chaired these workshops. Details and minutes are below, after the General Overview.

In the evening of Tuesday, there was a poster session that was very lively and well attended. The other evenings involved visits to the local Aquarium and a walking tour of Pula's historic centre, during which delegates had the opportunity to mingle and network.

On Wednesday, after the WG3 workshop, there was a general discussion and MC meeting. This was chaired by David McKenzie, and involved a discussion around the 2nd year budget plan (Annex 3), and how best to proceed with the Action in general.

The main budget items for year 2 are scientific meetings and short-term scientific missions.

Meetings. The meetings detailed in the budget plan comprise the 2nd conference in Pula, and a WG1 workshop on spring 2013 dedicated to the review papers that are a deliverable for WG1 (see the specific minutes below).

COST will also fund a general workshop to be held in collaboration with the Society for Experimental Biology, during their Annual Main Meeting in Valencia, Spain, in early July 2012. Paolo Domenici, David McKenzie and Craig Franklin (SEB Animal Section Secretary and convenor of their Conservation Physiology interest group) are organising a two-day session/workshop, comprising talks and posters, entitled “Conservation Physiology of Marine Fishes”.

COST will fund at least 40 Action participants to showcase their marine fish conservation physiology research. A particular focus will be on applications for physiological knowledge in ecological models, and the state of the art in this field. A specific objective is to promote Early Career Researchers (ESRs) at this workshop, so please consider candidates within your laboratory. COST can contribute to travel, accommodation and subsistence, according to COST rules. It cannot pay for registration to the SEB meeting, which is required. The SEB will contribute funding for non-cost (non EU) researchers, so that the workshop should provide a review of the state of the art of the field globally. The SEB has just launched a journal entitled Conservation Physiology, with an “Animal” and a “Plant” editor. Steve Cooke, external expert in our Action, is the Animal editor, and we are discussing the possibility of a special issue of that journal, in which participants in the workshop can submit their research. More details will be forthcoming before the end of 2012.

Following the discussions of these meetings, Adriaan Rijnsdorp asked if it would be possible to provide funding for students to attend a Dynamic Energy Budget Symposium in Texel, Netherlands, in April 2013. This had not been considered in the budget plan, but should be possible because we will underspend on the Pula meeting. Since then, we have been in contact with the symposium organisers, who have agreed to label one day as a COST workshop focussed on applications of the DEB for marine fishes. This allows us to provide funding for participants, we need to wait until we have completed payments for Pula, to see what we have available. Once again, the emphasis is on funding ESRs. More details will be forthcoming before the end of 2012

Short Term Scientific Missions. The COST will fund at least 10 of these in Action year 2, for ESRs. The emphasis is meant to be on WG2. There will be three call deadlines during the year, 15 November, 15 February, 15 May. ESRs should apply through the online tool, applications will be evaluated by the STSM coordinator and committee, after these collection dates. Recipients of funding will be required to prepare a 150 word report of their STSM, plus a suitable photo, which will be put on the Action website.

Other matters. The **COST website** has an intranet area, password CONPHY2012 (case sensitive). Delegates can find minutes of all meetings, COST updates, the 2nd year budget plan, etc, in this area. **We need photos for this website**, of marine fishes or dynamic researchers saving the world. Please email these to the COST website creator/manager, Michael Axelsson (michael.axelsson@bioenv.gu.se).

The Action now has a Facebook interest group, Conservation Physiology of Marine Fishes, set up by Shaun Killen.

The conference went smoothly and the workshops and round tables were all very well-attended and discussion was open, lively and constructive.

The conference was ended by David McKenzie at 15h00 on Wednesday 26th September 2012, with many thanks to the local organiser, Bojan Hamer.

General Decisions Taken by the MC

The following general decisions were taken by the Management Committee at the conference, following general discussion among all delegates:

- 1) A portion of the budget for 2011/2012, derived from underspend on the Pula conference, will be spent for a workshop for WG2, held within the DEB Symposium in Texel, Netherlands. **NB** the actual amount will be clear when delegates have been reimbursed for the Pula meeting
- 2) That we will budget for a 3rd Conference on Conservation Physiology of Marine Fishes in Action year 3, as it was agreed once again that a single conference comprising sequential workshops for all WGs was the cheapest option because many delegates are members of more than one WG. The venues proposed were Faro or Barcelona. The conference will be in early September 2012.
- 3) That, in year 3, we will budget for training schools in WG1 (telemetry techniques, tentatively in La Rochelle or Faro), and in WG2 (individual level modelling, tentatively in Bergen or Hamburg), and workshops in WG2 (comparative modelling) and in WG3 (meeting with policy makers and stakeholders), venues for these workshops TBD.

Note that decisions made within each WG are outlined in their specific minutes below.

WG1 – Basic Physiological Knowledge

Workshop 24/09/2012

Chair : Guy Claireaux

Work Group 1 workshop started with an introductory presentation by Guy Claireaux. This presentation highlighted the immediate objective of the group, which is to develop the database of fundamental physiological knowledge.

In order to begin the process of collecting and collating physiological data, and to identify gaps in knowledge, a matrix was constructed at the 1st conference (Porto, see minutes of that conference on website). This identified major subject areas to consider for a literature survey, and to identify persons to undertake this. It was agreed that the focus should be on European species, although at the Pula meeting we decided to extend this to all marine fishes. The deadline for this was set at Dec 2012.

<u>Subject area</u>	Physiology	Behaviour	Ecology
Temperature	Peck/Axelsson	Killen/Sanchez	Milazzo/Azzuro Ruzafa
Hypoxia	Chabot/McKenzie	Domenici/Lefrançois	Chabot
Salinity	J Wilson	J Wilson	Ruzafa
Ocean Acidification	Pörtner	McCormick	Peck/Pörtner
Contaminants	Claireaux/DeBoeck	Sloman/Cooke	Ruzafa/Azzuro

Half a day was dedicated to WG1 discussion and round table. The main subject of discussion concerned the structure and content of the fish physiology and energetics database.

Regarding the content, available indicators of physiological performance and energetics were listed and discussed with regard to their relevance to the modellers. The availability of established relationships with key environmental factors (temperature, oxygenation, salinity, pH/CO₂, contaminants) and/or proxies of individual Darwinian fitness (survival, growth, swimming speed...) was examined.

During the discussion, some delegates raised the question of how to include aspects of behaviour. This led to lively exchange of opinions. The consensus was that the paucity and discontinuous nature of the available data sets made them inappropriate for the envisaged bioenergetic modelling procedures.

Discussion also concerned the species that should be included. It was the view of a majority of participants that the database should not be limited to European marine species and that key species from estuarine and even freshwater ecosystems should be included.

The structure of the database was discussed at some length. Denis Chabot proposed an excel spreadsheet format based on previous work. The compatibility of the proposed structure with already existing, partial databases was examined. A structure was eventually

agreed upon and Denis Chabot, Christian Jorgensen and Guy Claireaux are currently testing the database structure for a limited data set, before circulating it to all WG1 members.

It rapidly become obvious that the amount of work required to gather and standardized all the information available among the delegates required a dedicated person. It was proposed Morten Bo Svendsen would make a 3-month STSM to Goran Nilsson's lab to complete the database as far as possible. Pr Nilsson has all the experience require and this STSM will be conducted in close contact with D. Chabot, C. Jorgensen and G. Claireaux.

WG 2 Interactions between Physiologists and Ecologists

Workshop 25/09/2012

Chairs: Christian Jørgensen, Adriaan Rijnsdorp & Myron Peck

Introduction.

WG2 met on the 2nd day. Myron Peck has joined the chair group (with Christian Jørgensen and Adriaan Rijnsdorp).

After a brief recapitulation of the tasks, six topics that emerged from the Oristano WG2-workshop held in June 2012 (Jørgensen et al. 2012) were introduced for further discussion. To facilitate the discussion, the meeting broke up into sub-groups and reported back their results to the plenary. The results of the discussion are summarized below. For each topic, the introductory text is reproduced (in grey) and comments raised during the discussion are reported (*in italics*). Since the groups could choose which points to focus on, some points were not discussed and are reported only very briefly below. Feedback also suggested that the group discussions themselves were valuable, although they did not always end with firm conclusions.

1. Implementing aerobic scope

From the overview of modelling methods during the WG2 workshop in Sardinia, it seemed that several different types of model are implementing or are moving towards implementing aerobic scope. While measurements and general scaling relationships seem to be available for the lower boundary of SMR, the maximum oxygen uptake is studied in fewer species and its scaling with temperature and size known for just a few examples.

- a) Is it possible to derive general shapes for how max oxygen uptake scales with body size, temperature, ambient oxygen saturation, and potentially other environmental factors?

*It is essential to capture the asymmetry of the relationship between metabolic rate and temperature. For several species, aerobic scope is still positive almost up to the lethal temperature. Effects of body size on the relationship with temperature are not well known. Body size seems to be less important than life stage. The relation between temperature preference and aerobic scope was discussed. The shape of the curve may not be the same for all fish, and lack of oxygen transport may **not** explain temperature tolerance. Tolerance is related to the edges of the relationship, while preference is related to the optimum. How is preference related to optimal temperature for growth?*

- b) Are there indirect sources of data that can be used to derive aerobic scope?

Peak heart rate is correlated to higher metabolic scope in some species and has been used to determine optimum temperature (pike, sea bass) but not to quantify metabolic scope.

- c) Are laboratory measurements on captive fish representative for wild populations?

Aquaculture individuals may not be representative for wild fish. This will depend on the 'level' of selection or on the body state (fat aquaculture fish may swim slower than non-fat wild ones). It was discussed how aerobic scope can be used to quantify the thermal niche.

- d) When would one need to resolve the individual physiological processes that add up towards AMR, and when would a simpler approach that only considers routine metabolic rate suffice?
- e) Are modellers right when they have identified aerobic scope as a key to improving model predictions?

Points d) and e) combined: It depends what you want with your model: for assessing thermal range, metabolic scope (i.e. active metabolic rate and standard metabolic rate) is needed. If you 'prefer' energy budget approach, routine metabolic rate should be enough. It was also mentioned that the Limiting Oxygen Concentration (LOC) may depend on process: it is expected that at decreasing oxygen concentrations activities are successively shut down. The importance of including aerobic scope therefore depends on the process one wants to model.

2. Short- and long-term costs of high metabolic rates

Although organisms can sustain metabolic rates close to their aerobic maximum they rarely do so, at least routinely. Understanding why is important as models now regularly assume that metabolic rate can be anywhere up to the aerobic maximum, which can make wrong predictions for how much an individual may achieve.

- a) Average, long-term, routine metabolic rate may be well below the max metabolic rate (AMR), but at what levels?
- b) How can routine metabolic rate be measured in free-living fish or in controlled laboratory situations? Doubly-labelled water is routinely used in terrestrial animals but does not work for water-breathers. Accelerometer tags may be one alternative, but are there also others?

Measurements of routine metabolic rate in the field are possible through telemetry: the accelerometry approach gives good correlation to assess metabolic rate (both aerobic and anaerobic).

- c) Do estimates of routine metabolic rate already exist? How do they compare to AMR?
- d) What are the dominant costs of sustained high metabolic rates: oxidative damage and the need for repair, or lack of swimming ability to escape predators?

3. Temperature dependence of physiological rates

A key factor in studies of biological responses to climate change is temperature, motivated by the ubiquitous effects of temperature on physiological rates. But what are the key physiological mechanisms that determine optimal temperatures or the upper and lower temperatures at which an organism can thrive, i.e. the range of tolerable temperatures or temperature window?

- a) Is the optimal temperature or temperature window related to body size? Why and how?
- b) Are there relationships between temperature tolerance and temperature preference? What are the processes that link these two?
- c) How may eco-physiological knowledge predict the ecology and behavioural responses of wild fish?

Work is needed to collect data on: (i) size/life-stage thermal optima for growth and fitness; (ii) temporal/seasonal variation in thermal optima and size effects; (iii) species where life-stages are separated in space may exhibit larger differences in optima than species inhabiting similar areas throughout life; (iv) links between aerobic scope and temperature preference, i.e., temperature preference could be season and life-stage specific; (v) context-dependent prioritization, e.g. selecting cold water to minimize metabolic rate when resources are limited (e.g. starvation, hypoxia) versus maximizing aerobic scope during favourable conditions by selecting warmer water to fight disease/parasites. Is it expected that natural selection will favour a preferred temperature that is the same as the optimal temperature for growth/aerobic scope?

The question was raised whether there is one optimum physiological temperature and one optimum ecological temperature. If temperatures rise, which processes do you switch off? Physiologists guesstimated that reproduction ceases first, then feeding. The cost of heat-shock proteins is likely small and can be ignored in models.

4. Swimming energetics

Models vary in how they implement costs of swimming. Is the cost of swimming temperature-dependent? Is the cost of activity best described by a term multiplied with SMR, or is it an additive term? In math terms, these are potential formulations (MR is metabolic rate, SMR and Act are functions for standard metabolic rate and cost of swimming, T is temperature, M is body mass, U is swimming speed):

$$MR = SMR(T,M) + Act(U, M)$$

$$MR = SMR(T,M) + Act(U,T,M)$$

$$MR = SMR(T,M) * Act(U)$$

$$MR = SMR(T,M) * Act(U,T)$$

$$MR = SMR(T,M) * Act(U,T,M)$$

- a) Are there general lessons whereby scaling relationships obtained in one species can be used for other species?
- b) Are there types of species (pelagics, demersal, flatfish, ambush predators) for which the scaling relationships are different?
- c) Do scaling relationships differ between aerobic and anaerobic swimming?

- d) Escapes from predators likely depend more on burst swimming speeds than aerobic swimming – does burst swimming speed scale in similar ways?

This topic was not discussed in plenary.

5. Incorporating new physiological knowledge

Most of model development is done by modellers without involvement of expert physiologists or ecologists. The relationships that end up in models are therefore often based on superficially reading the physiological literature. The mechanisms that end up being incorporated are likely biased towards those having simple functional forms, that are easy to scale or transfer between species, or where parameters exist for several species.

- a) As physiologist, do you see physiological mechanisms that may affect population-level patterns such as distribution, habitat use, abundance, growth, or reproduction, but that currently are unused but should be incorporated in models? Which mechanisms? What may they affect? And how should they be implemented?

Not all environmental factors influence a fish through bioenergetics: CO₂ levels are known to affect brain function, fertilization success, and sensory systems. There might be differential effects of stressors on: predators and prey; parasites/diseases and hosts; interspecific competitors. There can also be direct effects of temperature, e.g. on behaviour, production of gametes, fertilization, or early life-stage survival.

- b) As ecologist, do you consider the interactions between behaviour and physiology well enough represented in current models? Where do you see room for improvement, and for what population-level patterns may these be important?

How do you quantify behaviour in habitat suitability models? Measurement scales and scoring systems are difficult to compare among studies. There is a need to quantify effects on growth/survival. How do you scale up from behaviour at the individual level to ecosystem modelling: link behaviour to growth/survival, observations of behaviour in the field, patterns of species movement, spatial distribution, community composition are outcomes of behaviour at the individual level. There are likely physiological triggers for behaviour, e.g. temperature-related triggers for reproductive output, that are candidates to be included in models.

- c) Are there stressors that receive too little attention, or for which empirical studies and modelling should rethink their focus?

Other stressors (that are not addressed by this Action): environmental noise (ships, offshore wind) leading to stress, reduced growth, avoidance; electromagnetic fields from underwater cables; endocrine disruptors; anthropogenic selection pressures; commercial and recreational fisheries selecting for specific behavioural or physiological phenotypes.

6. Relevance for management or policy

Modellers often work from available information and scale those mechanisms to broader patterns. But sometimes the reverse perspective is fruitful: what broad-scale questions may modelling shed light on, but have not yet done so? What key predictions or patterns is it desirable that modelling can inform? For some or each example, what should such a model include, and which known or unknown physiological or ecological information would it rely on? Likely, assumptions need to be made to compensate for lack of specific knowledge, so how critical or defensible are those assumptions?

What key predictions or patterns is it desirable that modelling can inform: (i) species distribution (different models, different layers, to be compared with observed fish distribution); (ii) productivity/recruitment; (iii) plasticity: capacity of species to adapt to climate change (an index of adaptability?); (iv) changes of temperatures correlated to changes in maximal size or growth; (v) identifying involved physiological processes.

WG3 Conservation physiology and decision-making

Workshop 26/09/2012

Chair: Julian Metcalfe

Julian Metcalfe opened the WG3 workshop with news about an article describing the aims and objectives of the Cost Action that is to be published in the magazine **International Innovation** Published by Research Media Ltd (see: <http://www.research-europe.com/index.php/international-innovation>).

International Innovation is considered to be the leading global dissemination resource for the wider scientific, technology and research communities within Europe, with discrete publications covering, but not limited to, climate, energy, environment, food & agriculture. Although not peer reviewed, the publication is widely regarded as a credible international science research journal, providing access to presentations from leading research teams and institutes and insightful comment from leading figures across science, technology and administration industries. Julian explained that the article would provide a valuable opportunity to connect with prospective project partners from the wider scientific community as well as with EU and national policy advisors and decision makers for marine environments and other stakeholders who would be interested in knowing about the COST Action. It was noted that the Executive Committee had previously discussed the publishing this article at its meeting in Paris in July 2012 (see website intranet for minutes) and had decided it would be a useful piece of dissemination. Subsequently the Management Committee decided, by email, to use part of the 1st year's budget to pay for the article.

Julian explained that the article would take the form of an interview of two members of the Action, with an overview of the Action written by their journalists. Julian and David McKenzie had agreed to be interviewed. In this brief WG3 workshop we discussed what questions we should pose and then answer. There was general agreement to focus the questions around the Action MoU and objectives but avoid wider issues relating to the EU Common Fisheries Policy or the sustainability of EU fisheries. This has since been done, and the article has gone to press.

The workshop also discussed the fact that WG3 will gain impetus as the Action progresses, once we have more information and arguments to present to policy advisors, decision makers and other stakeholders.

COST Action FA1004
2nd Conference on
Conservation Physiology
of Marine Fishes



Hotel Brioni, Pula, Croatia
September 24, 25, 26, 2012

Local organiser: Bojan Hamer, Center for Marine Research, Rovinj.

GENERAL INFORMATION

Travel: Delegates should organise their own travel, and the COST Action expects to pay up to € 500 per delegate (except experts from non-COST countries). Pula has an airport with flights from various cities in Europe (<http://www.airport-pula.hr/>).

Venue: Hotel Brioni. Situated right on the beach in a wooded peninsula near Pula (http://www.arenaturist.com/croatia_hotels/hotel_brioni). See following page for reservation form, to get special conference rate. Conference delegates will be refunded for four nights at a rate of € 60 per night, hence a maximum total of € 240 for accommodation. There are many hotels in Pula itself if you do not like the look of the Brioni.

Bojan Hamer, our local organiser, suggests that delegates consider staying an extra day to visit the Brioni National Park (<http://www.brijuni.hr/en/>).

Meeting structure. The 2nd Conference will comprise three full days, the detailed programme is overleaf. The following main activities will take place:

- **Invited lectures** Each day will start with two 30-min lectures by invited experts, the list is currently being finalised.
- **WG1 workshop** This will take place after the lectures on day 1 (see below). The primary objective of this WG is to collect and collate data on the impact of increasing temperature, ocean acidification, coastal hypoxic zones, salinity and pollutants, on the physiology of those species for which information is available. Specifically, to characterise physiological tolerance ranges for indices of energy flux such as aerobic metabolic scope, growth, swimming performance, digestive performance. At the 1st conference (Porto 2011), individuals were identified to lead these activities, and a deadline of December 2012 was set. The workshop in Pula will focus on this activity. WG1 members have received guidelines and will be allowed to select a group of their choice to discuss a given factor, led by the individuals identified at Porto. The objective is to exploit expert knowledge to ensure that we have a complete list of available literature. The data would then be collated for the December 2012 deadline. A secondary objective is to identify a series of literature reviews that will mine information from the database.
- **WG2 workshop** This will take place after the lectures on day 2. This WG is ahead of the planned timetable in the MoU. After successful meetings in Porto (2011) and Oristano (2012), the leaders of this WG will take the conclusions from these meetings to structure the workshop in Pula.
- **Poster sessions** There will be convivial poster-sessions in the evenings of days 1 and 2, with refreshments, to promote networking and reveal opportunities for collaboration.

Delegates are strongly encouraged to present a poster of their current research. Please advise us by **Friday September 14th 2012** if you will be bringing a poster. Presentations by early stage researchers are particularly welcome.

- **WG3 meeting** There will be a short meeting to discuss progress in WG3 in the morning of day 3, after the lectures.
- **Summing up and MC meeting** This will be in the morning of day 3, after the WG3 meeting, to progress with COST business. In particular, information will be provided of the next activities planned, and suggestions for STSM subjects.
- **Networking for research collaboration and STSMs** The final afternoon will be available for people to finalise networking, in particular to focus on possible STSMs etc.

PROGRAMME

Monday 24 September

09:15 Welcome (Bojan Hamer ; David McKenzie)

09:30 *Environmental factors and behaviour of marine fishes* by Paolo Domenici (CNR Oristano)

10:00 *Future CO₂ drives fish crazy* by Göran Nilsson (Oslo)

10:30 Refreshment Break

11:00 WG1 Workshop (Chair: Guy Claireaux)

12:30 Lunch

14:00 WG1 Workshop (cont.)

16:00 Refreshment Break

16:30 WG1 Workshop: Synthesis of progress

17:30 End of day

18:30 Poster Session

Tuesday 25 September

09:30 *Temperature and tuna* by Holly Shiels (Manchester)

10:00 *The tail that wags the dog? Tales of tolerance and intolerance* by Tony (A.P.) Farrell (UBC)

10:30 Refreshment Break

11:00 WG2 Workshop (Chair: Christian Jørgensen, Adriaan Rijnsdorp)

12:30 Lunch

14:00 WG2 Workshop (cont.)

16:00 Refreshment Break

16:30 WG2 Workshop: Synthesis of progress

17:30 End of day

18:30 Poster Session

Wednesday 26 September

09:30 *The effects of temperature and exhaustive exercise on escape ability in mullet* by Shaun Killen (Glasgow)

10:00 *Recent advances on the impact of hypoxia and temperature on the metabolism of a few cold-water species common to North America and Europe* by Denis Chabot (DFO Mont Joli)

10:30 Refreshment Break

11:00 WG3 Meeting (Chair: Julian Metcalfe)

11:30 COST Action Business (Chair: David McKenzie)

12:30 Lunch

14:00 Networking, STSM discussions

17:00 End of conference

Annex 2

Participants

Family Name	First Name	Affiliation	Nat	WG1	WG2	WG3	email
Andersen	Rasmus Ern	University of Aarhus	DK	1			work@rasmusern.dk
Antognarelli	Fabio	CNR Oristano	I	1	1		fabio.antognarelli@iamc.cnr.it
Azzurro	Ernesto	ICM CSIC	I	1	1		azzurro@icm.csic.es
Bastos	Eliane	University of Exeter	GB	1			E.S.R.De-Bastos@exeter.ac.uk
Bayley	Mark	University of Aarhus	DK	1			mark.bayley@biology.au.dk
Chabot	Denis	DFO Mont Joli	CA	1	1		denis.chabot@dfo-mpo.gc.ca
Claireaux	Guy	U.Bretagne Occidentale	F	1	1	1	Guy.Claireaux@univ-brest.fr
Darnaude	Audrey	University of Montpellier	F		1		audrey.darnaude@univ-montp2.fr
Domenici	Paolo	CNR Oristano	I	1	1	1	paolo.domenici@cnr.it
Farrell	Anthony	University of British Columbia	CA	1	1	1	farrellt@mail.ubc.ca
Grigoriou	Panos	Hellenic Center Marine Research	GR	1			pgrigoriou@her.hcmr.gr
Guerreiro	Pedro	University of Algarve	P	1	1	1	pmgg@ualg.pt
Hamer	Bojan	Ruder Boskovic Institute	HR	1			hamer@cim.irb.hr
Holt	Rebecca E.	University of Bergen	NO		1		rebecca.holt@bio.uib.no
Jorgensen	Christian	University of Bergen	NO		1		Christian.Jorgensen@bio.uib.no
Killen	Shaun	University of Glasgow	GB	1	1	1	Shaun.Killen@glasgow.ac.uk
Kulczykowska	Ewa	IOPAN	PL	1			ekulczykowska@iopan.gda.pl
Lefrançois	Christel	University of La Rochelle	F	1	1	1	christel.lefrancois@univ-lr.fr
Leprieur	Fabien	University of Montpellier	F		1		fabien.leprieur@univ-montp2.fr
Marras	Stefano	CNR Oristano	I	1		1	Stefano.Marras@univ-montp2.fr
McKenzie	David	CNRS Montpellier	F	1	1	1	david.mckenzie@univ-montp2.fr
Metcalfe	Julian	CEFAS	GB	1	1	1	julian.metcalfe@cefas.co.uk

Michaelidis	Vasileios	University of Thessaloniki	GR	1	1	1	michaeli@bio.auth.gr
Milazzo	Marco	University of Palermo	I	1	1		marmilazzo@iol.it
Nilsson	Goran E.	University of Oslo	NO	1			g.e.nilsson@imbv.uio.no
Peck	Myron	University of Hamburg	D	1	1	1	myron.peck@uni-hamburg.de
Reardon	Erin	University of Exeter	GB	1	1		E.E.Reardon@exeter.ac.uk
Reid	Donald	University of Glasgow	GB	1	1		d.reid.2@research.gla.ac.uk
Rijnsdorp	Adriaan	Wageningen University	NL		1	1	Adriaan.Rijnsdorp@wur.nl
Rogers	Nicholas	University of Exeter	GB	1	1		njr210@exeter.ac.uk
Sanchez	F. Javier	University of Murcia	ES	1	1		javisan@um.es
Shiels	Holly	University of Manchester	GB	1		1	Holly.Shiels@manchester.ac.uk
Steffensen	John Fleng	University of Copenhagen	DK	1			jfsteffensen@bio.ku.dk
Svendson	Morten Bo	University of Copenhagen	DK	1			mortenbosvendson@gmail.com
Valente	Luisa	University of Porto	P		1		lvalente@icbas.up.pt
Teal	Emma	NIOZ	NL	1	1		Henk.van.der.Veer@nioz.nl
Wang	Tobias	University of Aarhus	DK	1	1	1	tobias.wang@biology.au.dk
Wilson	Jonathan	CIIMAR	P	1			wilson.jm.cimar@gmail.com
