

COST Action FA1004 Conservation Physiology of Marine Fishes

Minutes of the 4th Conference on Conservation Physiology of Marine Fishes.

Hotel Makedonia Palace, Thessaloniki, Greece, 21 – 23 October 2014

The timetable of the meeting is shown in Annex 1.

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

1. review progress of the working groups
2. hold two conference workshops
3. discuss the final conference to be held in Montpellier in May 2015
4. provide opportunities for networking

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

General Overview (David McKenzie)

The meeting started with a welcome by the local organiser and host Basile Michaelidis (Department of Zoology, Aristotle University of Thessaloniki, MC Member for Greece). David McKenzie (CNRS Montpellier, Action Chair) then presented the general objectives for the three-day conference. See programme in Annex 1 for details.

Two conference workshops were held that were common to all 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.

The conference started with a review of progress, over the life of the Action, by WG1 and WG2. This was followed by some short presentations of case studies of applications for physiology in modelling. A **Workshop on the significance of individual variation** was then held in the afternoon of Tuesday 21/10, which was resumed and completed on the afternoon of Wednesday 22/10. The **Workshop on a traits-based approach to conservation physiology** comprised the morning of 22/10. Discussion of the final conference, in terms of structure and scientific programme, occupied the morning of Thursday 23/10. The following minutes provide a general overview of the meeting, then details and minutes of the two workshops.

As for previous years, holding the conference in a hotel at which all delegates were accommodated provided extensive opportunities to network during the entire three-day event. In the afternoon of Tuesday, there was a poster session that was very lively and well attended. On the Wednesday evening we had a very convivial dinner attended by almost all delegates.

On Thursday 23/10, after the discussion of the final conference, there was a brief general discussion around the 4th year budget plan.

The main budget items for the remainder of year 4 are short-term scientific missions, and the final conference. If the budget allows, after funding the 4th conference, a budget amendment will be put before the MC, to hold a small WG3 meeting (see below).

Meetings. The meeting detailed in the budget plan comprise this 4th conference and the final conference. For this latter, see detailed minutes and proposed programme overleaf. Based upon available funding, however, **a small meeting may be organised in January 2015** around how to use the physiological database to feed the traits-based approach.

Short Term Scientific Missions. The COST will fund **at least 4 STSMs** for ESRs in year 4 of the Action. Four STSMs have already been identified, focussed upon populating and completing the database. Further applications should be made through the online tool. They will be evaluated by the STSM coordinator (Gudrun de Boeck, Antwerp University, MC member for Belgium) and the STSM committee. Recipients of funding will be required to prepare a 150 word report of their STSM, plus a suitable photo, which to be put on the Action website.

Other matters. The **COST website** has an intranet area, password CONPHY2012 (case sensitive). In this area, delegates can find minutes of all meetings, COST updates, the annual budget plans, etc.. **If you want to put something on the website**, please email these to the COST website creator/manager, Michael Axelsson (michael.axelsson@bioenv.gu.se).

Remember also to visit and update our **Facebook interest group, Conservation Physiology of Marine Fishes**.

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

The conference was ended by David McKenzie at 14:00 on Thursday 23rd October, the remainder of that day was used for networking by delegates. Warm applause was given for the excellent job by the local organiser, Basile Michaelidis, and his team.

Review of WG progress
WG1 Basic Physiological Knowledge
(21/10/2013)

Chair : Rod Wilson (University of Exeter)

A brief review of WG1 progress was made, in terms of the use of COST instruments over the preceding three years.

WG1 has had two training schools; 'Techniques of Respirometry' at the Marine Biological Section, University of Copenhagen, Denmark, in 2012 (Organiser : John Steffensen), and 'Physiological Telemetry' at the Ifremer Research Station, Plouzane, France, in 2014 (Organisers : Guy Claireaux, Michael Axelsson, Julian Metcalfe, **see programme in Annex 3**).

The WG has had two workshops at annual conferences, namely one on the structure of the Physiological Database in Pula in 2012, and one on Physiological Biomarkers in Olhão in 2013. The WG also participated in the workshop on a 'Traits-based approach for conservation physiology' in London in July 2013.

The WG is producing a Special Issue of the Journal of Fish Biology entitled 'Metabolic Rate in Fishes : Methods and Significance for Conservation'. This SI has an expected publication date of May 2015. A number of contributors are late, at present this publication date is being retained.

Review of WG progress
WG2 Interactions between physiologists and modellers
(21/10/2013)

Chair : Christian Jørgensen (Uni Research Bergen)

A brief review of WG2 progress was made, in terms of the use of COST instruments over the preceding three years.

WG2 has had two dedicated workshops to promote interactions between physiologists and modellers; a first at the International Marine Centre in Oristano in 2012 (Organiser : Paolo Domenici), and a second at Stemphels Hotel, Haarlem, focussed on the Dynamic Energy Budget, in Harlem in 2014 (Organiser : Lorna Teal).

The WG has also had two workshops at annual conferences, namely one on establishing what physiologists and modellers expect from each other, in Pula in 2012, and one on an introduction to the dynamic energy budget in Olhão in 2013.

The WG produced a short article in Biology Letters, deriving from the Oristano meeting, and is working on a review article about the Dynamic Energy Budget for the special issue of Conservation Physiology (see minutes about Final Conference).

This review was followed by a series of short presentations on uses of modelling for conservation physiology. These were :

Myron Peck : Progress on integrating physiology into models for larval fish

Christian Jørgensen: Respiration modelling of climate change in Atlantic cod

Jaap van der Meer : Inference on energetics of deep-sea fish that cannot be aged: The case of the hagfish

Paolo Domenici : Understanding patterns of species invasions using aerobic scope

Conference Workshop

The significance of individual variation for conservation physiology

(21/10 & 22/10/2013)

Chair : David McKenzie (CNRS Montpellier)

The primary objective of this workshop, that combined all WGs, was to discuss the implications of individual variation in conservation physiology. The informal and participative workshop comprised an introductory talk about individual variation. This briefly reviewed some of the different facets of individual variation, the differences that can exist among individuals within a population or species. There can be significant intra-specific diversity in physiology across ontogenetic stages, which needs to be understood. For example, the optimal temperature for growth of larval, juvenile and older stages of fishes may differ. For many physiologists, however, the element of individual variation that is of interest from a conservation perspective, is the standing variation that exists, in a given population, for physiological traits of environmental adaptation. This variation needs to be understood in of itself, as it presumably indicates the capacity of a given population or species to tolerate ongoing environmental conditions. Ultimately, the goal is to understand how such variation links to life history variation, to adaptation and evolution of the population or species, so to underlying heritable genetic variation. We are some way off for marine fishes.

After some discussion among all delegates, five major questions (or sets of related questions) were identified, for each of which a 'facilitator' was identified :

1. *Does the degree of standing variation differ as a function of mode of life, in particular between 'generalist' versus 'specialist' species of marine fish?* Facilitator : Paolo Domenici (CNR Oristano)
2. *Understanding co-variation in traits. What maintains variation?* Facilitator : Jon Svendsen (CIIMAR Porto)
3. *Is individual variation stable and repeatable? Is it context dependent?* Facilitator : Shaun Killen (University of Glasgow)
4. *Which models can incorporate variation, do we need to design new ones? How would we parameterize models?* Facilitator : Jaap van der Meer (VU University Amsterdam)
5. *Do end-users need to care? What are the implications for, eg, stock enhancement, selective mortality, socio-economics side etc..?* Facilitator : Richard Corner (Longline Environment Ltd, UK).

The workshop then used a 'round-robin' system whereby the facilitators each sat at one of five large tables, organised in the conference hall and numbered from one to five. Each delegate received a piece of paper with a random order of numbers from one to five, and visited each table in turn for 20 minutes each, to discuss the topics. This led to lively discussions, with notes taken by the facilitators.

The following day, each animator presented a short (15 to 20 min) powerpoint presentation, structured roughly as follows:

- Intro – the question
- State of the art
- Why does it matter for conservation?
- Conclusions and perspectives

- Conceptual diagram

The workshop was very enjoyable and interesting, and the presentations were excellent and highly informative.

In summary the various discussions concluded that:

Paolo :

- 1) Previous work on terrestrial and marine animals has shown that the critical temperature of organisms that live at low latitudes is closer to the projected magnitude of warming than organisms that live at temperate latitudes (Deutsch et al 2008 PNAS) and thermal tolerance breadths generally increase with latitude (Sunday et al 2010 PRSB).
- 2) What has not been looked at, is how blurry the thermal “edges” are.
- 3) This could have an important impact on the resilience of species to global change
- 4) A literature review could be aimed at testing the following predictions/scenarios:
 - a) If tropical species have lower CTmax variation (based on CV analysis) than temperate species, this would imply lower resilience (and vice versa)
 - b) Even if there is no difference in CTmax variation, the “absolute” value of variation would need to be taken into account in modeling of evolutionary response to global warming.
- 5) Additional issues were identified
 - a) For any given latitude, the species habitat (e.g. intertidal vs open water species) is likely to have an effect on CTmax and associated variation.
 - b) -Various methodologies have been used for CTMax in the past, and such variation in methodology should be taken into account for any review of previous data.
 - c) In addition to the relationship between latitude and variation in CTmax, other traits could be taken into account, such as T_{opt} and aerobic scope.
- 6) Conclusions: Options for exploratory analysis
 - a) If a sufficient number of papers are available from the literature, then some sort of meta-analysis could be carried out.
 - b) if there are not enough relevant papers, then conceptual /modeling work could be undertaken

Jon :

Intraspecific variation in physiological and behavioural traits is a widespread phenomenon. For example, standard metabolic rate may vary 3-fold among individual fish. Intraspecific variation may be caused by several factors at different levels of organization. Sources of intraspecific variation include:

1. Variation in ontogeny and body size, which is often associated with variation in physiological traits.
2. Biotic and abiotic factors causing immediate changes to the physiology of an individual. For example, exercise, pregnancy, temperature and salinity may elevate metabolic rate in exothermic animals. Conversely, animals may to some extent acclimate to biotic and abiotic factors, thereby reducing intraspecific variation caused by such factors.

3. Carry-over effects with exposure to biotic or abiotic factors at one point in time, often during one ontogenetic stage, causing variation in physiological traits at a later stage, even if the exposure is terminated. Carry-over effects in relation to animal physiology are not well understood.
4. Trade-offs may promote variation in physiological traits. Trade-offs can arise when two functional traits cannot be optimized simultaneously, because the two traits cause conflicting demands on the same design feature. Consequently, excellence in one trait will come at the cost of performance in the other trait. Organisms may specialize in one trait at the expense of the other, in which case a trade-off may facilitate phenotypic differentiation.
5. Epigenetic inheritance (i.e. non-genetic inheritance) may cause variation in physiological and behavioural traits. For example, maternal exposure to predation scents may cause dispersing offspring. Epigenetic inheritance related to metabolic rate, hypoxia tolerance and cardiac performance has been reported recently, however, the influence on animal physiology of epigenetic inheritance requires much additional study (Burggren, 2014, JEB).
6. Genetic variation at the levels of race, population or individual is often associated with physiological and behavioural variation. Genetic variation stems from random mutations and recombinations. Subsequently, local adaptation and genetic drift may change the patterns of genetic variation and thereby the physiological variation. Local adaptation is an evolutionary response to environmental conditions that causes and maintains intraspecific variation and allows organisms to increase fitness.
7. Organisms must operate as an integrated whole, so changes in some traits are coupled by changes in other traits that are linked to them through common functional activities, developmental pathways, or genetic linkages and pleiotropy. Such linkages between traits results in correlated evolution and thus co-variation between traits. This integration between traits is important for understanding the mechanisms that explain how variation and co-variation in traits evolves.
8. Organisms exhibit numerous traits. Correlated traits and trait-offs may form strategies or syndromes adapted by races, populations or individuals. For example, the pace-of-life syndrome hypothesis specifies that populations or individuals experiencing different ecological conditions should differ in a suite of metabolic, hormonal and immunity traits that have co-evolved with the life-history particularities related to these conditions (Réale et al., 2010, PRSB). The authors expanded the hypothesis and proposed that consistent behavioural differences among individuals, or personality, co-vary with life history and physiological differences. The integration between traits is likely to cause and maintain intraspecific variation, but the hypothesis has been challenged by recent data sets and requires further testing.

Shaun :

- 1) Variability and repeatability of heritable traits are critical for natural selection. The evidence to date suggests that physiological traits such as metabolic rate and aerobic scope show repeatable variation, but the magnitude of this variation and the degree of repeatability seems to vary among studies and contexts.
- 2) A range of biotic (social environment, predator regime, feeding history, habitat structure, life-stage, exercise, circadian or seasonal effects) and abiotic (pH, temperature, O₂, turbidity, CO₂, salinity) factors may affect the degree of variation

for physiological traits shown within populations. Factors associated with climate change have received the most direct attention. Other novel contexts, never encountered by wild populations, should also have high research priority in the context of global change (e.g. presence of invasive species, novel pollutants)

- 3) Methodological issues may inadvertently diminish or inflate estimates of variation or repeatability. These include the source of fish for study (e.g. cultured vs. wild) and collection bias. Laboratory holding may affect phenotypes through feeding effects, social environment, and homogenous conditions. Measurement error may also confound estimates of repeatability, including errors in respirometer size, measures of background bacterial measurement, improperly accounting for circadian effects on metabolic rate, and habituation during multiple trials in behavioural assays.
- 4) To date, relatively few factors have been studied in terms of their effects on variation in metabolic traits. Temperature, hypoxia, starvation, metal toxicity, seasonality, and parasites have received the most attention and can all affect repeatability and variation of traits. Interactions among traits not well understood, difficult to study. Correlations among traits vary with context, often due to changes in amount of variation, and could be critical in driving correlated selection on traits.
- 5) Repeatability of traits such as SMR diminishes with time (e.g. SMR highly repeatable over days, but less so over months). However, most of this work has been done in the lab while very little work has been done to quantify repeatability in the field and over various timescales.
- 6) Overall, there is much more work needed to understand the context dependency of variability and repeatability of traits. A major question is how are changes in phenotypic variation relevant for genetic change. A hypothesis for future study is that genetic change can occur even when selection is mediated by phenotypic responses to environmental effects. Sensitivity to changes in the environment may itself also be heritable.

A major question in current studies examining the effects of climate change and ocean acidification are whether species will be able to evolve over the course of several generations in response to gradual changes in their environment. This is because most studies studying these issues only consider short-term exposure to changes in temperature or pH. An increased understanding of how trait variation and repeatability is affected by these factors will help us gain a greater understanding of the capacity for adaptation present in populations.

Jaap :

- The following questions concerning the role of mathematical population models in understanding individual variation popped up: Which models can incorporate individual variation? Do we need to design new ones? How would we parameterize models?
- Sketching the state of the art started with classifying the possible sources of individual variation. Individual phenotypic variation within a species can be the result of
 - ontogeny, that is older individuals are often larger than younger ones;
 - different environmental history, that is some individuals may have experienced much better environmental conditions than others, which results in for example different size animals of the same age;

- sex
- genetic differences.

Unstructured population models (UPMs), like the Lotka-Volterra competition or predator-prey model where all individuals are assumed equal, ignore all these four issues. Age-structured models (ASPMs), like the well-known Leslie matrix model, take source (1) into account, but ignore the other points. Animals of the same age are exactly the same independent of time, implicitly assuming a constant and similar environment for all individuals. Physiologically-structured models (PSPMs) do consider (2) a variable environment. Similarly aged animals may strongly differ. The basic physiology and behavior of each individual in these models is characterized by a parameter vector, which thus represents the genotype. The vector of state variables represents the phenotype. For example, in the DEB model of the individual, which may serve as the building block of PSPMs, the parameter vector contains elements like the area-specific intake rate or the volume-specific maintenance rate. The state variable vector contains size, reserve density and maturity. Usually all individuals do have the same parameter vector and thus the same genetic constitution in PSPMs. But studies aiming at understanding the evolutionary stability of the genetic constitution of the population might work with genetic variability. Adaptive dynamics models, for example, aim to find that population where mutants (with a slightly different vector as the residents) can no longer invade. Those models thus cover source 4, but it seems hard to arrive at a stable situation in which different genotypes co-exist. The approach normally assumes clonal reproduction, but sexual reproduction might be incorporated (source 3). Clones and species do not really differ (at least not in models) and a lot of similarity exists with so-called trait-based community models. Here again it is difficult to maintain variability in species composition.

- Why does this all matter? Incorporating individual variability might serve two goals. First, it might be that certain phenomena cannot be understood and are not well predicted if you ignore this variability. Second, one might be interested in this variability itself, for example, one might wish to answer the question why there is so much variability. Compare it to Hutchinson's famous question: Why are there so many kinds of animals? Many population and community models are still of the unstructured type, thus ignoring all types of individual variation. How useful are they? Unfortunately, ecologists are not very good in critically evaluating their models, but since there is a huge difference between a cod larva and a full-grown adult and there is a huge difference in growth rate between a well-fed cod and one deprived of food items, one is tempted to believe that at least sources 1 and 2 should be incorporated into population models.
- Summing up, different models incorporate different types of individual variation, but all sources are covered. There is no need for new models. Much more problematic is parameterizing models. The more sources of variation they want to cover, the more difficult it probably is. A constructive way forward might be to confront alternative models with detailed real data, preferably starting with data obtained under well-controlled experimental conditions. One idea is to start with cohorts growing up together in tanks in which environmental conditions including food availability can be controlled and measured and where for each individual at least behavior, food intake rate, growth rate, and reproduction rate are continuously monitored. Innovative methods to do this should be developed. The

variability that arises may be compared among experiments using different conditions and possibly different species.

Richard :

The overall conclusions were:

- There is probably not a direct link from physiology to policy.
- That it does not specifically matter that physiological research is not mentioned directly in policy discussions and documents, as long as policy is underpinned by the best possible science, based on state-of-the-art physiological knowledge. It is therefore a question of how to link physiology to policy, to ensure that policy stakeholders understand the issues and information provided by physiology and that this is communicated effectively to those that need to know.
- There has been a historic lack of contact with key policy makers, and Physiologists do not work in and have no specific contacts to attune and balance physiology work in policy decisions. In this regard it is a question of how this link can become more tangible.
- However, a link does exist between physiology(ists) and fish ecology(ists), and this is important as ecologists, by the nature of their work, do have the policy link. Therefore are Fisheries Ecologists the sole stakeholder link to policy for fish physiologists? – This was considered, and there was general agreement. And that this should influence who is invited to the stakeholder workshop in 2015.
- It was not thought not possible to provide a definitive link between individual variation and, for example, overall productivity / population disease resistance / fish demographics, where is where the links to policy may be more clear-cut, but nonetheless a need to explore what might be possible, as a way to link physiology to policy in a more clear and structured way.

The powerpoint presentations can each be viewed on the intranet section of the Action website. Some of them may be developed into review articles, among which some may be submitted to the Special Issue of Conservation Physiology that is a deliverable for the Final Meeting (see detailed minutes herein).

Conference workshop
Traits-based approach to conservation physiology

22/10/13

Chair: Julian Metcalfe (CEFAS Lowestoft)

Julian Metcalfe opened this workshop by reminding delegates of the “trait-based approach” to evaluate the relative sensitivity of marine fishes to environmental stressors. This as an approach that could provide advisors and decision-makers with a tool for predicting the relative sensitivity of any particular marine fish species to climate change, based on knowledge of its physiology, ecology and behaviour.

Silvana Birchenough (Cefas Lowestoft) reported on the outcome of a WG3 workshop held in London in July 2014, to develop a framework for using trait-based approaches for fish that concentrates on physiology, ecology and behaviour. This approach would help translate different sources of information and understanding in a simplified manner to inform and support climate change predictions for decision makers. The outputs of this ongoing activity will be presented at the Final Conference and will be prepared as a manuscript for the COST Action Special Issue of Conservation Physiology.

Julian Metcalfe then asked, once again, for all members of nations present to identify suitable people that should be contacted as national representatives involved in advising decision-makers (ministries, government agencies, advisory bodies) and who should be invited to the final high-profile meeting.

Roundtable Discussion
Structure and Content of the Final COST FA1004 Conference
23/10/14
Chair : David McKenzie

The **venue for the final conference** is the public aquarium in Montpellier, France (Aquarium Mare Nostrum, <http://www.aquariummarenostrum.fr>). The two-day conference will take place on the **19 and 20 May 2015**. David McKenzie led a discussion about how the conference should be structured and the combination of presentations that it should comprise.

It was agreed that the **first day** should focus on the state of the art of conservation physiology research in Europe and worldwide. This would therefore involve a series of talks by leading researchers within the COST Action (or by early stage researchers in their group) plus some talks by invited speakers from beyond the COST and the EU. There would also be a one-hour poster session for ESRs in the late afternoon, preceded by a pecha-kucha session for each poster to be introduced. The day would conclude with a one-hour round-table focussing on lessons learned and research priorities for marine fish conservation physiology in the EU.

There was some discussion about the **oral presentations for day 1**. A proposed list of these, based upon suggestions by delegates, was developed. The draft programme will be sent separately. There was also some discussion about the next step, and the need for capacity-building in whole animal experimental biology in the EU, in general, and in research on the environmental physiology of marine fishes, in particular.

It was agreed that the **second day** should focus on 'general' presentations about the major issues that were considered within the COST Action, and their implications. These should be aimed at a somewhat general public and, in particular, our end-users. It was agreed that our end-users are both scientists (fisheries ecologists, especially those with a consultative role for management and policy) and policy-makers themselves. The last part of the afternoon would comprise a structured round-table discussion about how to integrate physiology into fisheries research, and how it can contribute to management and policy.

There was therefore some discussion about the **oral presentations for day 2**. A proposed list of these, based upon suggestions by delegates, will be sent separately. They will be given by experts from within the COST Action and by external experts.

There was discussion about the **Special Issue of Conservation Physiology** that would be a **major deliverable of this Action** and of the Final Conference. The SI will comprise a mixture of research and review articles, it is expected that contributors to the final conference will also contribute to this SI. Conservation Physiology is an open access journal and the Editor for the Animal section, Steve Cooke, has confirmed that there are no page charges for 2015.

David McKenzie suggested that **manuscripts be submitted at the same time as the final conference**. There will be further communication on this matter.

Annex 1

COST Action FA1004 4th Conference on Conservation Physiology of Marine Fishes



Macedonia Palace Hotel, Thessaloniki, Greece

October 21, 22, 23, 2014

Local organiser: Basile Michaelidis, Department of Zoology, Aristotle University of Thessaloniki.

GENERAL INFORMATION

Delegates have received extensive information about venue, travel, etc. We expect up to 40 delegates at the meeting, 35 from afar, 5 local (Aristotle University). It promises to be a lively meeting.

Venue: Hotel Macedonia Palace, Thessaloniki. *Delegates have already booked at this hotel or made their own arrangements. The conference will take place in a meeting room at the hotel.*

Posters: *This informal session is an important part of the conference, to promote networking and reveal opportunities for collaboration.*

There will be a place to set up posters outside the conference hall. These should be in portrait format. They can be set up the first day at lunchtime, the poster session will be at 16h30 on Tuesday 22 October.

Please advise Basile Michaelidis by Tuesday October 14th 2014 if you will be bringing a poster. Presentations by early stage researchers are particularly welcome.

Meeting structure. *The 4th Conference will comprise three full days, the detailed programme is overleaf. The following main activities will take place:*

- Reviews of progress in Working Groups.*** *These will be presented by WG leaders in the morning of day 1*
- Case studies on use of physiology in modelling.*** *Selected case studies will be presented in the morning of day 1.*
- Workshop on the implications of individual variation.*** *This will start in the afternoon of day 1, and continue in the afternoon of day 2. The primary objective of this workshop, that combines all WGs, is to discuss the implications of individual variation in conservation physiology. The informal and participative workshop will comprise an introductory talk about individual variation, and solicit suggestions for up to 8 issues where individual variation requires consideration, for conservation physiology in general, for predictive modelling, and for policy-making. Delegates will then split into an equivalent number of groups to discuss this. No matter how speculative, we just want ideas. Each group will then identify a spokesperson to describe, in 5 slides, their conclusions and perspectives, this to be presented in the afternoon of day 2.*
- WG3 workshop on a Traits-Based Approach of Relative Sensitivity to Climactic Factors.*** *This workshop will take place in the morning of day 2. Following the 3rd Conference in Olhão last year, where this approach was discussed, this workshop will present progress made at a focussed WG3 meeting to develop the approach, held in July 2014 in London. It will then present the next step, which will involve use of the physiological database to develop the approach. The workshop will be open and participatory, to ensure our combined knowledge and opinions lead to the best way forward.*

- ***Poster session.*** This will take place after coffee in the afternoon of Day 1, to ensure that there is plenty of time for discussion in front of the posters.
- ***Preparation of the Final Conference.*** The structure and content of this conference, to be held in Montpellier on 20 & 21 May 2015, will be considered in the morning of day 3.
- ***Summing up and MC meeting*** This will follow on from the above session on day 3, to progress with COST business.
- ***Networking for research collaboration and STSMs*** The final afternoon will be available for people to finalise networking.

PROGRAMME

Tuesday 21 October

09:15 Welcome (Basile Michaelidis; David McKenzie)

09:30 A review of progress made by WG1

10:00 A review of progress made by WG2

10:30 Refreshment Break

11:00 Case studies on applications for physiology in modelling

12:30 Lunch

14:00 Workshop on individual variation (Chair: David McKenzie)

16:00 Refreshment Break

16:30 Poster session

18:00 End of day

Wednesday 22 October

09:30 WG3 Workshop on a traits-based approach (Chair: Julian Metcalfe)

10:30 Refreshment Break

11:00 WG3 Workshop on a traits-based approach (cont.)

12:00 Lunch

14:00 Workshop on individual variation (cont.)

16:00 Refreshment Break

16:30 Workshop on individual variation (cont.)

17:00 End of day

Thursday 23 October

09:30 Preparation of the Final Meeting (Chair: David McKenzie)

10:30 Refreshment Break

11:00 COST Action Business (Chair: David McKenzie)

12:00 Lunch

14:00 Open Networking

17:00 End of conference

Annex 2

Attendance list

Family Name	First Name	Affiliation	email	Role/Interest
Antonopoulou	Euthimia	Aristotle University, Thessaloniki	eantono@bio.auth.gr	WG3
Axelsson	Michael	University of Gothenburg	m.axelsson@zool.gu.se	MC
Baricevic	Ana	Ruder Boskovic Institute		WG1
Birchenough	Silvana	Cefas Lowestoft	silvana.birchenough@cefas.co.uk	WG3
Cooke	Steven	Carleton University	Steven_Cooke@carleton.ca	WG3
Corner	Richard	Longline	richard@longline.co.uk	WG3
DeBoeck	Gudrun	University of Antwerp	gudrun.deboeck@ua.ac.be	MC
Domenici	Paolo	CNR Oristano	paolo.domenici@cnr.it	MC
Grigoriou	Panos	Hellenic Center Marine Research	pgrigoriou@her.hcmr.gr	MC
Guerreiro	Pedro	University of Algarve	pmgg@ualg.pt	MC
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Jorgensen	Christian	University of Bergen	Christian.Jorgensen@bio.uib.no	MC
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Nati	Julie	University of Glasgow		WG2
Nilsson	Goran E.	University of Oslo	g.e.nilsson@imbv.uio.no	WG3
Peck	Myron	University of Hamburg	myron.peck@uni-hamburg.de	WG2
Portugal	Joana	IRD Montpellier/EVORA	jsportugal@fc.ul.pt	WG2
Rogers	Nicholas	University of Exeter	njr210@exeter.ac.uk	WG3
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Annex 3

Telemetry for Conservation Physiology of Marine Fish: A hands-on workshop organised as part of the COST Action FA1004.

12th-16th May 2014

Venue:, Ifremer, Brittany Centre, Brest, France.

Organisers:

Guy Claireaux (Université de Bretagne Occidentale, France),
Michael Axelsson (University of Gothenburg, Sweden)
Julian Metcalfe (Cefas, UK)

Introduction

It remains a central problem to relate how marine fishes perform in laboratory experiments with knowledge of the habitats they choose to occupy and the conditions they experience in their natural environment. There are immense technical difficulties in following the movements of fish in the vast underwater realm, let alone in estimating how this relates to their physiological state, and whether they choose habitats that optimise their fitness.

Telemetry, using electronic devices attached to or implanted into the animal, is a key technology helping to resolve this problem by allowing scientists to gather information on the physiology, movements and behaviour of wild fish whilst responding to, and coping with, the variety of challenges they continually face in their natural environment. Telemetry technology is developing rapidly and there are now many different types of device incorporating both environmental and physiological sensors that are beginning to provide new understanding of how animals function in their environment.

The aim of this workshop is to provide early and mid career fish physiologists and ecologists who have little or no experience of telemetry a comprehensive view of the different technologies available and their past, current and potential applications in a marine fish context. Presentations and demonstrations will be given by internationally renowned experts and from leading device and system manufacturers. It is intended that participants should see how telemetry can enhance their research and, through dedicated hands-on training using acoustic, archival, and satellite telemetry systems, provide them with the knowledge and skills needed to start using telemetry to develop their research as it relates to marine fish ecology and conservation.

Workshop Plan.

The workshop will start at 09:00 on Monday 12th May and run until 17:00 on Friday 16th May.

Participants should travel to Brest during the weekend prior to the start so that we can start promptly on Monday morning. The session after lunch on Friday will largely be dedicated to discussion groups (we will encourage developing ideas for discussion

groups during the workshop) so there will be scope for people to travel home on Friday afternoon if necessary.

Morning sessions will consist of two themed presentations (09:00-10:30 and 11:00 to 12:30) while the afternoon sessions (14:00-17:00) will involve practical, hands-on activities involving devices, systems and data, with either live data gathering and/or pre-gathered data sets. Evenings will be mostly left free but will be available for group discussions between attendees and presenters. Where live fish are used, demonstrations will be given by suitably authorised people, but there will be scope for participants to practice surgical attachment and implantation techniques on cadavers. Coffee and Tea will be provided for the morning and afternoon breaks at no cost to participants.

The COST Action reimburses you at a flat rate of 20€ per meal. Lunches will be at the Ifremer cafeteria and will cost about 7.5 €. On Monday evening we will have a typical Breton dinner (crêpes/galettes/cider) which you will have to pay for yourselves. On Wednesday we will have a more classical dinner and local funding will take care of the bill.

It is our intention that the workshop should be interactive and flexible so we can respond to your specific interests, so please feel free to identify things you would like us to pay specific attention to. I'm hoping the hands-on sessions should provide the scope to do this, but if you have ideas before that, please let us know.

PROGRAMME

Monday 12th May: Kick Off

Morning

09.00 Presentation 1: Welcome, and housekeeping (**Guy**) and an Introduction to the COST Action (**Dave McKenzie**) followed by 5 minutes from each attendee.

10:30 Coffee

11.00 Presentation 2: Julian Metcalfe *“Why telemetry: find answers to questions you didn't know you should have asked?”*. An introduction and personal overview on fish telemetry with a selection of examples from my own experience to provide a context to the rest of the workshop.

12:30 Lunch

Afternoon

14.00 Hands-on session: Device attachment and implantation.

A short presentation on fish surgery and welfare, EU law, ethics and animal use in science, followed by a hands-on session covering external attachment and internal implantation and methods (demonstrations with live fish that will be used later in the workshop, fish cadavers will be available for participants to practice on should they wish). Lead by **Julian/Carl/Kim/Michael** and others with experience.

Evening: Workshop Dinner 1

Tuesday, 13th May: Physiological Telemetry

Morning

Although many biological parameters can be measured using biotelemetry today, simultaneous measurements of multiple channels of pressure and flow have not been commercially available. The EndoGear system allows simultaneous measurement of blood flow, blood pressure, ECG/EMG, 3D acceleration and temperature. It is a 3rd generation biotelemetry system with a bidirectional radiofrequency link that allows the implant to send data and accept commands to perform various tasks. The signal from the implant can be viewed online, and has a transmission range of around 10 meter in air. This is reduced in water, especially sea water, and in these situations a data storing unit can be attached and data stored until recovery of the implant.

09.00 Presentation 3: Astrid Haegens “EndoGear physiological telemetry systems: technology and methods”

10.30 Coffee

11.00 Presentation 4a: Michael Axelsson “EndoGear physiological telemetry: from idea to field tests

Presentation 4b Albin Gräns “EndoGear physiological telemetry: applications with fish”

12.30 Lunch

Afternoon

Hands-on session: the application and use of EndoGear Physiological Telemetry. Lead by Michael, Astrid and Albin.

Wednesday, 14th May, Acoustic Telemetry

Morning

An introduction to active and passive acoustic tracking including costs/benefits of various approaches. Discussion will include various applications for acoustic telemetry and limitations of its use. Some time will be spent explaining data analysis approaches and showing examples of how data can be used and various sensor data can be integrated to learn more about fish behaviour and ecology. This will include discussion of 2D and 3D positioning as well as more complex (VPS) system approaches.

09.00 Presentation 5: Dale Webber, Vemco “Acoustic Telemetry: methods and approaches”

10.30 coffee

11.00 Presentation 6: Michelle Heupel “Acoustic Telemetry: applications with fish”

12.30 Lunch

14th May, Afternoon

Hands-on session: demonstrating the application and use of Acoustic Telemetry equipment and methods. Lead by Dale and Michelle

Evening: Workshop Dinner 2

Thursday, 15th May, Archival telemetry Morning

09.00 Presentation 7: Melinda Holland & Julian Metcalfe “Archival telemetry and geoposition”

Melinda will present an overview of archival and satellite telemetry as it applies to marine studies, providing an explanation of track determination using Argos, Fastloc-GPS and light-based Geolocation. Julian will give a short presentation on the tidal-based geolocation methods.

10.30 Coffee

11.00 Presentation 8: Carl Meyer/ Serena Wright “Advanced” sensor telemetry: Carl will present an overview of some of the more recent developments in tag technology and their application. This will include ingestion/digestion tags, inter-animal telemetry – “Business card” tags and Bioprobe (Vemco’s current mobile receiver version). Videography – new concepts (and cross-calibrating accelerometry with video). Serena will present an overview of the application of 3-axis accelerometer tags to monitor energy expenditure, activity and state.

12.30 Lunch

15th May, Afternoon

Hands-on session: Archival telemetry, setting up and downloading devices, geolocation methods, data handling and presentation. Lead by Serena, Carl and others

Friday, 16th May, Telemetry and conservation Morning

09.00 Presentation 9: Kim Holland – Telemetry & Conservation 1:

This presentation will include: 1) The use of pressure sensitive tags (both acoustic and archival) to investigate ontogenic changes in behaviour of pelagic species and to investigate options for selective fishing strategies; 2) Use of sonic telemetry (both active and passive) in evaluating the design and effectiveness of MPAs and in identifying potential spawning aggregations; 3) Combining telemetry with other assays (e.g. blood chemistry) to determine post-release survival of fish released during fishing operations; 4) Development of telemetry techniques to measure critical habitat parameters such as oxygen concentration and salinity.

10.30 Coffee

11.00 Presentation 10: Esben Olson – Telemetry & Conservation 2: *“Using acoustic telemetry to study behaviour and fate of coastal marine species”*

Using acoustic telemetry to study behaviour and fate of coastal marine species: Many coastal marine systems are under significant pressure from human activities such as fishing and development. Hence, understanding the behaviour and fate of coastal species is relevant for management and conservation. For instance, the usefulness and design of marine protected areas (MPAs) will depend on the spatial ecology of the species in need of protection. Networks of acoustic receivers potentially allow for continuous long-term monitoring of individual fish, revealing their habitat use, survival and dispersal. I will present experiences from ongoing studies on the Norwegian Skagerrak coast, where we use acoustic telemetry as a tool to quantify the behaviour and fate of harvested species such as the Atlantic cod and the European lobster.

12.30 Lunch

16th May, Afternoon

Presentation 11: H  l  ne de Pontual. Migratory behaviour of sea bass in French waters

Group discussion session (There is scope to leave early if you wish)

17.00 (or earlier) Close and farewell