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G. Non-Technical Summary (NTS)

NOTE: The Secretary of State considers the provision of a non-technical summary (NTS) is an essential step towards greater openness and requires one to be provided as part of the licence application in every case. You should explain your proposed programme of work clearly using non-technical terms which can be understood by a lay reader. You should avoid confidential material or anything that would identify you, or others, or your place of work. Failure to address all aspects of the non-technical summary will render your application incomplete and lead to it being returned.

This summary will be published (examples of other summaries can be viewed on the Home Office website at www.gov.uk/research-and-testing-using-animals.

Word limit; 1000 words

Project Title	Fish Physiology in an Era of Climate Change
Key Words	Fish, temperature, dissolved oxygen, pollution, climate change
Expected duration of the project	5 year(s) 0 months

Purpose of the project (as in ASPA section 5C(3))

Purpose	
Yes	(a) basic research;
	(b) translational or applied research with one of the following aims:
No	(i) avoidance, prevention, diagnosis or treatment of disease, ill-health or other abnormality, or their effects, in man, animals or plants;
No	(ii) assessment, detection, regulation or modification of physiological conditions in man, animals or plants;
No	(iii) improvement of the welfare of animals or of the production conditions for animals reared for agricultural purposes.
No	(c) development, manufacture or testing of the quality, effectiveness and safety of drugs, foodstuffs and feedstuffs or any other substances or products, with one of the aims mentioned in paragraph (b);
Yes	(d) protection of the natural environment in the interests of the health or welfare of man or animals;
No	(e) research aimed at preserving the species of animal subjected to regulated procedures as part of the programme of work;
No	(f) higher education or training for the acquisition, maintenance or improvement of vocational skills;
No	(g) forensic inquiries.

Describe the aims and objectives of the project (e.g. the scientific unknowns or scientific/clinical needs being addressed):

Climate change represents a significant challenge for fish. The purpose of this application is to study the pressing environmental challenges facing fish today including rising water temperatures, reductions in aquatic oxygen levels, and the presence of man-made pollution in water systems, to better understand the tolerances of fish so that we can implement better and more timely resource management.

What are the potential benefits likely to derive from this project (how science could be advanced or humans or animals could benefit from the project)?

The aim of this work is to benefit fish populations by determining the impact of environmental challenges on physiology. From an ecological perspective, physiological tolerance thresholds are likely to determine geographical distribution of fish in oceans, abundance in fresh water lakes and rivers, and influence migratory success. However, the environments of fish habitats are changing rapidly. Given the known impact of climate change on fish populations and their geographical distribution, understanding the single and combined effects of environmental change in a vulnerable group of fish (sharks/elasmobranchs) and using a model system to probe specifics mechanisms (zebrafish), is both pertinent and timely.

The short term benefit will be realised by challenging the current 'upper limit-based' models of environmental tolerances. Specifically, by determining the incremental change in the environment where 'things get worse' we believe we can provide better thresholds for environmental policy makers whilst gaining insight into the intrinsic tolerance mechanism of the fish cardiovascular system. The zebrafish studies will also allow us to understand how specific changes in a fish's metabolism or heart function (via short term genetic alterations) will allow us to pinpoint cellular proteins and mechanistic pathways that underlie the environmental tolerance of fishes. This will provide the mechanisms for the organismal tolerances that in the medium term can used to create more bespoke management models.

This will be achieved by sharing our data a conferences and with resource management/stakeholders to help prioritise areas for work. These benefits are conceivable within the 5 year duration of this licence.

Collectively, the longer term benefit of the knowledge generated from this licence will improve survival and welfare of fish populations both in wild systems and in aquaculture. This could occur via better management strategies including cool water refuges, weir adjustments/ and fish passes which take into account realistic physiological tolerance limitations. If the fish are the prime beneficiaries then the millions of people who depend on them for livelihood and nutrition are secondary beneficiaries.

What types and approximate numbers of animals do you expect to use and over what period of time?

Approximately 1000 catsharks and around 1500 zebrafish over the course of the 5 year study.

In the context of what you propose to do to the animals, what are the expected adverse effects and the likely/expected levels of severity? What will happen to the animals at the end?

To understand the environmental tolerance limits of the fish, they will undergo a series of environmental challenge tests. These include non-invasive measuring metabolic rate, swimming biomechanics and looking at how the environment affects behaviours like exploration and decision making. Adverse effects from all of these tests are expected to be minimal. However, in a few cases (<10%) we will examine the effects of the environmental challenges in fish that are instrumented with implanted ECG electrodes or blood pressure cannulas for measuring cardiovascular variables concomitant with environmental tolerances. In this case, the fish may feel discomfort due to instrumentation however, where ever possible

such parameters will be measured under anaesthesia. Similarly, fin clipping, and injection of substances like hormones (i.e. adrenaline) that modulate growth or cardiac function may cause short term discomfort. But we expect fish to recover fully. There are 2 environmental challenges that are expected to be stressful over a short time period as the fish temporarily lose equilibrium at warmest temperatures or low oxygen levels. However, we expect all fish to recover quickly from this when returned to normal water conditions. At the end of the protocol, the fish will be humanely killed and their body tissues will be sampled for further analyses.

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Application of the 3Rs

Replacement

State why you need to use animals and why you cannot use non-protected animal alternatives

Replacement

This work has to be carried out on fish because, as aquatic ectotherms, their vulnerability in relation to climate change differs from other animal models (i.e. terrestrial vertebrates or invertebrates). Additionally, as fish are the prime beneficiaries of the output from this work, understanding tolerance in relation to fish biology is paramount. In all cases the in vivo work covered by this licence will be supported by in vitro, ex vivo and in silico studies of environmental tolerance. Wherever possible, these non-invasive studies will be used to assess tolerances if possible.

Reduction

Explain how you will ensure the use of minimum numbers of animals

Reduction

Experimental design has been discussed with, and approved by, statistical advisor in order to minimise the number of animals required though good design.

Refinement

Explain the choice of animals and why the animal model(s) you will use are the most refined, having regard to the objectives. Explain the general measures you will take to minimise welfare costs (harms) to the animals.

Refinement

Shark populations are in decline world- wide. Therefore we have chosen to work with the lesser spotted catshark, a coastal, intertidal catshark, to understand how their physiology is impacted by climate change. It was important to choose a coastal species as this is changing at a more rapid rate with respect to temperature, hypoxia and pollution than that of the open ocean environment.

We have also chosen zebrafish to deeply probe the mechanisms which confer environmental tolerance in fish due to their fast growth, their ease of care and easy access to genetically altered animals.

Fish will be monitored daily for signs of illness and any animal displaying unexpected signs of distress will be returned to their home tank and monitored closely. If a fish experiences persistent discomfort (as assessed by erratic swimming behaviour, failure to right itself in the water column, or excessive ventilation, or poor body condition) then this will be considered the endpoint and the fish will be killed humanely by schedule 1 procedures.