Institution: University of Chester

Unit of Assessment: 4 Psychology, Psychiatry and Neuroscience

Title of case study: Informing Global Improvements on the Welfare of Fish

1. Summary of the impact

This research programme has provided convincing evidence that fish perceive pain and has been instrumental in directly informing changes to experimental protocols and influencing welfare guidelines.

We use fish in a variety of ways - for food, farming, experimentation, as public exhibits, in recreational angling and as pets. Many of the procedures that fish are subjected to cause tissue damage that would give rise to the sensation of pain in mammals. This research programme uses techniques in neurobiology, physiology and animal behaviour to discover how the fish are affected by these procedures. This has not only improved the welfare of fish, but also influenced how the public views these animals through media dissemination.

2. Underpinning research

Dr Lynne Sneddon is a behavioural neurobiologist specifically addressing questions relevant to the welfare of fish. She was a Senior Lecturer in the Department of Biological Sciences at the University of Chester between September 2008 and August 2013. Dr Sneddon was the first, in 2002, to identify and characterise fish nociceptors that detect painful stimuli and has used an integrative approach since then to prove that fish fulfil the criteria for animal pain (Ashley et al. 2009; Mettam et al. 2011; 2012; Sneddon, 2009; 2011). Pain perception is distinct from nociception (the neural process of encoding and processing noxious stimuli) and includes a psychological component with evidence of discomfort. Sneddon has demonstrated adverse changes in fish behaviour in response to noxious stimuli that are reduced by painkillers. Thus there is the potential for fish to suffer when experiencing tissue damage that gives rise to pain in mammals.

This is currently a major issue of global importance, and pain perception in fish has received media attention worldwide (e.g. BBC, CNN). The results have had important implications, both for our understanding of the evolution of nociception and pain perception in vertebrates, and for applied welfare issues relating to angling and commercial fish production (Sneddon 2009, 2011, 2012).

This fundamental research programme has informed the efficacy of analgesics, the development of robust behavioural and physiological indicators to assess pain in fish, and suggestions to improve practices such as angling, aquaculture and experimentation. With partners in Belgium (Funding Universities Federation for Animal Welfare, UFAW), Norway (Norway Research Committee), Spain; Oxford (The Wellcome Trust), Liverpool, Newcastle and CEH Lancaster (National Centre for the Replacement, Refinement and Reduction of Animals in Research - NC3Rs), a variety of fish species used in fish farming, commercial fisheries and experimentation have been investigated. These include Atlantic cod, common carp, rainbow trout and zebrafish.

These studies allow the development of an intelligent monitoring system that can unequivocally categorise fish as normal, stressed or in pain that will substantially improve welfare assessment in the laboratory and allow researchers to accurately determine the status of experimental fish. The development of an automated tool for the continuous monitoring of fish behaviour has commercial potential since any laboratory undertaking fish experimentation could monitor the animals used in invasive experimental manipulations. This would indicate the scale of likely problems but, if used widely, could be used to monitor every specimen used in a particular experiment or procedure.

Given that the resulting insights relate to the normal behavioural repertoire of the subjects, then this equipment could also be used by aquaculturists and hobbyists, greatly expanding the applicability of this system. This would represent a major advance in the assessment of welfare in

captive fish and would allow carers to intervene more quickly, providing pain relief to the animals, applying humane end points, or euthanasia. The development of this system is underway, funded by a grant from NC3Rs.

3. References to the research

As evidence of the quality of the research, the following references are all in peer-reviewed journals.

Ashley P.J., Ringrose S., Edwards K.L., Wallington E., McCrohan C.R., & Sneddon L.U. (2009). Effects of noxious stimulation upon antipredator responses and dominance status in rainbow trout. *Animal Behaviour*, *77*, 403-410. doi: 10.1016/j.anbehav.2008.10.015

Mettam J.J., McCrohan C.R. & Sneddon L.U. (2012). Characterisation of chemosensory trigeminal receptors in the rainbow trout, *Oncorhynchus mykiss*: Responses to chemical irritants and carbon dioxide. *The Journal of Experimental Biology,* 215, 685-693. doi: 10.1242/jeb.060350

Mettam J.J., Oulton L.J., McCrohan C.R. & Sneddon L.U. (2011). The efficacy of three types of analgesic drugs in reducing pain in the rainbow trout, *Oncorhynchus mykiss*. *Applied Animal Behaviour Science, 133*, 265-274. doi: 10.1016/j.applanim.2011.06.009

Sneddon L.U. (2009). Pain perception in fish: Indicators and endpoints. *ILAR Journal*, *50 (4),* 338-342. doi: 10.1093/ilar.50.4.338

Sneddon L.U. (2011). Pain perception in fish: Evidence and implications for the use of fish. *Journal of Consciousness Studies*, *18*, 209-229.

Sneddon L.U. (2012). Clinical anesthesia and analgesia in fish. *Journal of Exotic Pet Medicine, 21*, 32–43. doi: 10.1053/j.jepm.2011.11.009

Key externally-funded grants that supported the research described in this case study:

- Universities Federation for Animal Welfare, Aug 2008-Sept 2011. Detection and alleviation of pain in fish, £10,600. Transfer of part of grant from University of Liverpool to University of Chester for equipment only.

- NC3Rs, October 2012-September 2015. Detection and alleviation of pain in fish, £44,096. Awarded to University of Chester.

- RSPCA, June 2012-May 2013. Survey of fish pedicure procedures, £1,000. Awarded to University of Chester.

- Wellcome Trust Vacation Scholarship, June 2013-August 2013, £1,440. Awarded to University of Chester.

- Norway Research Committee, £250,000

4. Details of the impact

Dr Sneddon's research on the implications of pain perception for the welfare and behaviour of fish has received global media attention. She has been interviewed on CNN (audience figure: 465,000), ABC Australia, and BBC news[1] (BBC website audience figures approximately 40 million per week) and Countryfile (typical audience figure: approximately 5 million) in the UK, as well as numerous global radio interviews and features in Nature News and New Scientist (circulation average of 23,213 in August 2012).

Her work has led to changes in public and government regulations on the treatment of fish. For example, Sneddon was part of the Committee on Recognition and Alleviation of Pain in Laboratory Animals (National Research Council, USA). Fish were included for the first time in the guidelines for the detection and alleviation of pain in experimental animals in North America that details how researchers can identify and minimise pain, and Sneddon's research was cited extensively in these

guidelines (Recognition and Alleviation of Pain in Laboratory Animals, 2009)[2].

She has also acted as a consultant for the UK Government advisory body, the Animal Procedures Committee, informing humane methods of killing fish (Supplementary review of schedule 1 of the Animals (Scientific Procedures) Act, 1986)[3], and also for the Home Office, providing advice and assessment for project licensees on administration of analgesia in fish.

Fish are now the second most popular experimental model with nearly half a million used in the UK in 2011 and some 300,000 used at the University of Washington alone (2010). Sneddon's work has thus directly informed protocols to enhance the welfare of a large number of experimental fish.

Given the broad implications of the research, Sneddon was an invited speaker at the Science with Impact Symposium, Austria, July 2012 and her expertise has led to her becoming Ethics Committee Chair and Secretary for Association for the Study of Animal Behaviour (ASAB) Council[4]. She is an author on ASAB's updated ethical guidelines (2012) and ensures all prospective authors adhere to these in her editorial role for the journal *Animal Behaviour*[5]. She also holds the position of Neurobiology Convenor[6] for the Society of Experimental Biology (SEB) and in 2012 organised a joint meeting with NC3Rs, ASAB and the SEB to discuss the implementation of ethical experimentation in behavioural and physiological studies[7].

Sneddon has also been invited to discuss her research findings at various conferences in USA, Canada, Europe and nationally and has run workshops for public bodies and veterinary organisations, such as the World Congress on Veterinary Anaesthesia in Sweden, Switzerland, and Denmark, and Pets At Home in the UK.

Not only has this research influenced science, but it also has broader implications on how the public and industry use fish. She co-authored a risk assessment for the Norwegian Committee for Food Safety on the welfare implications of recreational catch and release angling, where fish receive hooking injuries that may give rise to pain (Norwegian Scientific Committee for Food Safety Report on Catch and Release, 2009/10)[8]. This publication made recommendations to improve the welfare of salmonids. She was also invited to contribute a book entitled *Sea the Truth: Essays on Overfishing, Pollution and Climate Change*, which was published by the Nicolaas G. Pierson Foundation to complement the film 'Sea the Truth'. This work examined how fisheries affect individual fish welfare when they are damaged during large scale fish capture (Sneddon & Wolfenden, 2012)[9]. In addition, Sneddon has acted as a consultant for the RSPCA commenting upon the HSE report on the use of *Garra rufa* fish in beauty treatments and is currently investigating salon practices to inform improvements in the well-being of these fish[10].

Additionally, she was invited by La Fondation Droit Animal, éthique et sciences (LFDA), in partnership with the International Research Group in Animal Law (GRIDA), to speak at their international symposium 'Scientific Recognition of Animal Sensitivity to Pain and its Integration into Law', whose audience included legal experts, policymakers, philosophers and animal welfare groups, to address how fish welfare is compromised by many practices and how global laws can protect them (Paris 2012). Finally, the use of fish in vaccine testing by the biomedical industries has increased and Sneddon has co-authored guidelines on the ethical use of fish in vaccine research for the European Committee on Vaccines (ECVAM), since many of these diseases cause tissue damage that could be painful (Midtlyng et al. 2012)[11].

Dr Sneddon's research, therefore, has broad implications and has generated considerable impact within the public domain, both in terms of welfare guidelines and also public perceptions of pain in fish.

5. Sources to corroborate the impact

1. 2012 BBC Interview http://www.bbc.co.uk/news/science-environment-19284063.
***Evidence of media attention in Sneddon's research*.**

2. 2009 National Academies of Science Report on "Recognition and Alleviation of Pain in Animals", http://www.nap.edu/catalog.php?record_id=12526
Evidence for Sneddon's research influencing policy guidelines.

3. 2009/10 Supplementary Review of Schedule 1 of the Animals (Scientific Procedures) Act 1986: Appropriate methods of humane killing for fish, pp19-30; Sneddon named on pp.28. http://www.official-documents.gov.uk/document/hc1011/hc04/0483/0483.asp
Evidence for Sneddon's research influencing policy guidelines.

4. ASAB Ethics Committee Chair and Secretary to Council http://asab.nottingham.ac.uk/ethics/committee.php

5. Ethics Editor for Animal Behaviour for all areas except North America http://www.journals.elsevier.com/animal-behaviour/editorial-board/

6. SEB Neurobiology Convenor http://www.sebiology.org/animal/lynne.html

7. 2012 NC3Rs joint conference with ASAB and SEB http://asab.nottingham.ac.uk/ethics/links.php (see bottom of page for conference links)

8. 2009/10 Norwegian Scientific Committee for Food Safety Report on Catch and Release. http://www.english.vkm.no/eway/default.aspx?pid=278&trg=Content_6424&Main_6359=6424:0:&Content_6424=6393:1820056::0:6425:9:::0:0
Evidence for Sneddon's expertise and research influencing policy guidelines.

9. Sneddon L.U. & Wolfenden D.C.C. (2012). How do large-scale fisheries affect fish: Pain perception in fish? In: *Sea The Truth: Essays on Overfishing, Pollution and Climate Change*. Nicolaas G. Pierson Foundation: Netherlands. http://www.seathetruth.nl/en/

10. Sophie Adwick MSc(Oxon), Scientific Officer (Exotics & Wildlife Trade), Wildlife Department Science Group, RSPCA. E-mail sophie.adwick@rspca.org.uk
Evidence for Sneddon's expertise being used to inform improvements in the well-being of fish.

11. Midtlyng P.J., Hendriksen C., Balks E., Bruckner L., Elsken L., Evensen O., Fyrand K., Guy A., Halder M., Hawkins P., Kisen G., Berit Romstad A., Salonius K., Smith P. & Sneddon L.U. (2011) Three Rs approaches in the production and quality control of fish vaccines. *Biologicals 39*, 117-128. doi: 10.1016/j.biologicals.2011.02.001
Evidence for Sneddon's expertise and research informing policy guidelines.