Institution: Loughborough University

Unit of Assessment: B13 Electrical and Electronic Engineering, Metallurgy and Materials

Title of case study: Porpoise deterrent pinger for the reduction of accidental by-catch in international fisheries

1. Summary of the impact (indicative maximum 100 words)

Loughborough University research led to the development of a porpoise deterrent pinger, which, by generating ultrasonic acoustic signals, deters harbour porpoise from accidental capture in fishing nets. The research of Professor Bryan Woodward has led to the development of a commercially available pinger (AQUAmark100) with over 14,000 system sales internationally.

The impact of the research has:

1) Influenced changes in government / EU policy
2) Influenced worldwide debate around achieving reductions in accidental by-catch by fisheries.
3) Contributed to commercial growth of UK business through sales.

2. Underpinning research (indicative maximum 500 words)

Since the 1970's, by-catch or accidental capture of marine mammals in a wide variety of fisheries has been an international concern. In 1970, the International Whaling Commission reported large numbers of small cetaceans (toothed whales, dolphins and porpoises) were killed in gillnet fisheries each year. Despite being protected by a number of international agreements, such as the Marine Mammal protection Act enacted in 1972 in the USA and under ASCOBANS (Agreement on the Conservation of Small Cetaceans in the Baltic and North Seas), a number of species were still considered to be at considerable risk. The signatory governments to these agreements are committed to reducing the incidental kill of harbour porpoises. To meet legislative, environmental and political goals for the reduction of by catch in commercial fishing significant technical improvements to fishing methods are required. Loughborough University responded to this challenge and developed a wide-ranging body of research between 1994 and 2002 (outlined below) that has led directly to a commercially viable solution **[3.1, 3.5]**. The on-going impact of this research body since 2008 is outlined in section 4 of this document.

In 1994, researchers from Loughborough University led by Professor Bryan Woodward (joined the School of Electronic, Electrical and Systems Engineering (EESE) as a lecturer 20 October 1975 - until 31 March 2008) and David Goodson (joined EESE 1st August 1977 and his position ended on 13th January 2004 as a Chief Experimental Officer) completed a European DG XIV (PEM/93/04) special study contract (92/15) on *"Prevention of the by-catch of cetaceans by exploiting their acoustic capabilities"* **[3.3]**. Following this work the Loughborough group (led by these researchers) were major contributors to the European Commission AIR-III Programme funded project *"Prevention of By-Catch of Small Cetaceans in Pelagic Trawls by Technical Means (CETA-SEL)"* project AIR3-CT94-2423 **[3.2, 3.4]**. As part of this larger study, a wide variety of signal frequencies and waveforms were tested on harbour porpoises both in floating pen enclosures and open water trials. With the rationale to find a commercially viable, practical aversive with a long battery life, whilst minimising risks to habitation and effects on other species **[3.6]**.

From 1997-1999 Professor Bryan Woodward led another collaborative multidisciplinary European Commission project DGXIV supported Special Study Project, "*EPIC".* This project evolved directly from earlier work to improve methods of mitigating the incidental catch of this species in commercial gill-net fishing gear in line with the objectives of the multi-national ASCOBANS agreement **[3.6]**.

Key progressive research programs conducted by Loughborough University:

- 1992 Loughborough University researchers David Goodson & S Datta (joined EESE as a lecturer on 1 October 1987- until 31 March 2008 as Reader) began work on passive acoustic detection capabilities of marine mammals
- 1994 Loughborough University researchers Professor Bryan Woodward and David Goodson lead European DG XIV (PEM/93/04) special study contract (92/15) on *"Prevention of the by-catch of cetaceans by exploiting their acoustic capabilities"*.
- 1995-1997 Professor Bryan Woodward and David Goodson again lead a team of Loughborough researchers in completion of a 3 year European Commission AIR-III Programme funded project *"Prevention of By-Catch of Small Cetaceans in Pelagic Trawls*

by Technical Means (CETA-SEL)" project AIR3-CT94-2423

- 1997-1999 Professor Bryan Woodward led another collaborative multidisciplinary European Commission project DGXIV supported Special Study Project, *"EPIC".*
- 2000-2002 Professor Bryan Woodward and David Goodson lead European Commission DHXIV project "Acoustic Deterrents to Eliminate Predation on Trammels ADEPT, (ref DGXIV 98/019) **[3.5]**.

3. References to the research (indicative maximum of six references)

Details of Loughborough University's publications in this area are listed below (they can be made available at request):

3.1 **Newborough, D., Goodson, A.D. & Woodward, B., 2001,Design and development of an Acoustic Beacon to Reduce the By Catch of Cetaceans in Fishing Nets, *Journal of the Society for Underwater Technology*, 24(3) ISSN 1756 0543 (Print), ISSN 1756 0551 (Online). – peer reviewed**

3.2 Goodson, A.D., Mayo, R.H., Klinowska, M. & Bloom, P.R.S., 1994, Field testing passive acoustic deterrent devices designed to reduce the entanglements of small cetaceans in fishing gear., International Whaling Commission (Special Issue 15)"Gillnets & Cetaceans", W.F.Perin, G.P. Donvan and J. Barlow (eds), IWC Cambridge, 597-605, ISSN 0255-2760

3.3 **Goodson A.D., & Mayo, R.H., 1995, Interactions between free-ranging dolphins (Tursiops truncates) and passive acoustic gill-net deterrent devices. Sensory Systems of Aquatic Mammals, Edited by Kastelein, R.A., Thomas, J.A., & Nachtigall, P.E. 365-379, ISBN 90-72743-50-9 – peer reviewed**

3.4 **Goodson A.D., 1997, Development of acoustic deterrent devices designed to reduce the mortality of small cetaceans in commercial fishing nets, *Marine freshwater Behaviour Physiology*, 29(1-4), 211-236– peer reviewed**

3.5 Datta, S., Goodson, A.D., Di Natale, A. and Dremiere, P.Y., European Commission DG IV FAIR Programme "Acoustic Deterrent to Eliminate Predation in Trammel nets (*ADEPTs*), ADEPT, (ref DGXIV 98/019 final report) Contract DGXIV 98/019, 2003.

3.6 Nakamura K., Akamatsu, T., Goodson A.D., Kagoshima, K., & Shimazaki, K., 1998, Gillnet passive acoustic deterrents: investing inter-reflection spacing with harbour porpoise *Phocoena phocoena*, *Journal of the Japanese Society of Fisheries Science*, 64(4), 648-649, Print ISSN 0919-9268, Online ISSN 1444-2906. **– peer reviewed**

Evidence on the Quality of the Research

The underpinning research was original work carried out by an expert group from Loughborough University lead by Prof. Bryan Woodward and which was published for the first time in the references 3.1-3.6 above, five of which are international journals (or 'internationally recognised journals'). The significance of the work is indicated by the awarding of 7 awarded grants with a total value of greater than £571K since 1993**.**

Relevant grants and contracts:

1993 from Commission of European Communities, "Tracking cetaceans in the vicinity of fishing nets", DG XIV Special Study Contract 92/15, (ELJN3), 32,000 ECU (£25,600), 1 Jan-30 Sep 1993

1994from Commission of European Communities "Prevention of the by-catch of cetaceans by exploiting their acoustic capability", DG XIV Special Study Contract PEM/93/04 (ELJT3), 25,000 ECU (£19,000), 1 Jan – 31 Dec 1994

1994-1997 from the Department of the Environment, "Enhancing the acoustic detectability of fishing nets to prevent the entrapment of cetaceans", Contract CRO129 (ELJS2), £30,000, 1 Apr 1994 – 30 Sep 1997

1994-1997 from the European Commission AIR-III Programme, "Prevention of By-Catch of Small Cetaceans in Pelagic Trawls by Technical Means (*CETA-SEL*)", Contract AIR3-CT94-2423 (ELJV9), 221,000 ECU (£176,000), total for all partners 1,221,314 ECU (EC contribution 718,658 ECU), 1 Oct 1994 – 30 Sep 1997; project partners: RIVO-DLO, Ijmuiden, Netherlands; Hardewijk MAP, Netherlands; IFREMER, France; Kolmardens Djurpark, Sweden; Danish Institute for Fisheries and Aquaculture, Denmark.

1996 from Danish Institute for Fisheries Research – DIFRES (ELJX9), 14,400 ECU (£10,000), 1 Jul-30 Sep 1996

1998-2000 from European Commission DG IV FAIR Programme "Elimination of Porpoise Incidental Catch (*EPIC*)", Contract DGXIV 97/0006 (ELJY3), 81,363 ECU (£65,090), total for all

partners 247,577 ECU, 1 Jun 1998 - 31 May 2000; project partners: Danish Institute for Fisheries Research, Fjord und Baelt Centre, Denmark; Kolmardens Djur & Naturpark, Sweden
2000-2002 from European Commission DG IV FAIR Programme "Acoustic Deterrent to Eliminate Predation in Trammel nets (*ADEPTs*), Contract DGXIV 98/019 (ELJBH), 190,620 ECU (£132,000), 1 Jan 1999 – 31 Dec 2000; plus further 52,644 ECU (£36,455), 1 Jan – 31 Dec 2000; project partners: IFREMER Station de Setes, France; Aquastudio/Acquario di Genova, Italy.
The Principle Investigator on all these grants was Professor Bryan Woodward, Dr S Datta or David Goodson all from The School of Electronic, Electrical and Systems Engineering, Loughborough University.

4. Details of the impact (indicative maximum 750 words)

From 1994 – 1999, Loughborough University developed a series of prototype acoustic deterrent devices named PICE-EX, PICE-97 and PICE-99, generating an ultrasonic acoustic swept signal up to frequencies as high as 160 kHz. Since 1999 this system was then later commercialized under the AQUAmark100™ trade name by the AQUAtec Group based on the underpinning research outlined in section 2.

1) Influenced changes in government / EU policy

The on-going (since 2008) impact on international policy of the underpinning research outlined in section 2 is seen in various amendments / enforcements to European Commission legislation established in 2004 (EC, 2004) concerning incidental catches of cetaceans in fisheries [**5.1**]. This legislation included a requirement to use acoustic deterrents to reduce fisheries by catch. This regulation was influenced by Loughborough University's (LU) research in this area and the specifications for the pingers to be used the AQUAmark product specifications. Mandatory use of pingers with these specifications was also included at this time in the national porpoise action plans of most of the EU countries and in the action plans of ASCOBANS (Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas; www.ascobans.org)**.** An example of international implementation at this time can be seen in the ASCOBANS "The Swedish action plan" ASCOBANS, Document AC11/Doc. 15(P) Harbour Porpoise Action Plan for Sweden. (ASCOBANS 2004) [**5.2**]. The on-going impact of these regulation and subsequent international and national implementations is evidenced below.

In 2010 as part of the Memorandum of Understanding, the European Union requested the International Council for Exploration of the Sea (ICES) to review incidental catches of cetaceans in European waters and to advise on the implementation of certain provisions of the earlier Council Regulations (EC, 2004) No 812/2004. These provisions continued to advise *"acoustic deterrents using basic 10 kHz signals and more complex multi-signal* (such as the LU influenced AQUAmark100 product), *be deployed on static gear are effective in reducing by-catch of harbour porpoise"* (ICES, 2010) [**5.3**]. In 2013 data from Danish fisheries trials using AQUAmark100 systems was published to suggest greater spacing of pingers could be effective for implantation in Danish gillnet and hake fisheries (Larsen *et al.*, 2013) [**5.4**].

From 1st September 2013 the UK's Marine Management Organisation (MMO) has announced its intent to enforce the implementation of the European Commission No 812/2004 regulations for specific UK fisheries. In this statement all vessels measuring 12 metres or over using certain nets are required to fit acoustic dissuasive devices, known as pingers to help reduce cetacean by-catch (MMO, 2013) [**5.5**]. The Aquamark100 system using LU influenced research is specifically listed in this document as a regulation-compliant device.

2) Changed the worldwide debate around achieving reductions in accidental by-catch by fisheries

There has been continued world-wide debate on the use of acoustic deterrent systems for the reduction of by-catch (accidental capture of marine mammals and others in fisheries). This debate has extended to use of such systems to also prevent depredation (prevention of damage to fisheries by marine mammals) (SFGEN, 2002) and extension to a wide range of species including larger whales and sharks (Dawson *et al.,* 2013) using acoustic deterrent devices including the AQUAmark system [**5.6**]. In 2008 when Gazo *et al*, reported in trials in the Mediterranean that nets equipped with AQUAmark pingers using Loughborough developed algorithms received less predation damage (87% fewer holes) than nets with non-functional devices or without pingers (Gazo *et al*, 2008) [**5.7**]. Reducing net damage is a commercial imperative for fisheries. Also in

2008 Brotons *et al*. reported a large scale study of an artisanal gillnet fishery around the Balearic Islands using several pinger types where "the use of active pingers apparently discouraged dolphins from interacting with nets, dramatically so in the case of the Aquatec (AQUAmark100) pingers" (Brotons *et al.*, 2008) [**5.8**].

3) Contributed to commercial growth of UK business through sales of the commercialized systems

The AQUAtec Group Ltd undertook to commercialise Loughborough University's patented technology and have marketed it under the name AQUAmark100™. They also have a series of additional products still using Loughborough's original PICE developed signal suite as the foundation technology. To date, AQUAtec have sold over 14,000 systems internationally at an average unit cost of £80 (Dawson *et al.*, 2013) [**5.6**] making it the market leader in Northern Europe and significantly reducing by-catch in a wide variety of fisheries internationally. In 2007, the World Wildlife Fund (WWF) awarded a 'Special UK prize' to the Aquatec Group Ltd for the AQUAmark systems and its work in by-catch reduction, this reduction continues within the assessment period. In the WWF announcement the contribution of Loughborough University through their longstanding partnership with AQUAtec was also acknowledged.

5. Sources to corroborate the impact (indicative maximum of 10 references)

The following publications / regulations provide independent collaboration of impacts outlined in section 4, and they can be made available at request:

5.1 (EC, 2004) European Commission Regulations EC No 812/2004, EC, Annex II, No. 812/2004 (CR812, http://eur-lex.europa.eu/), 2004

5.2 (ASCOBANS, 2004) (Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas; www.ascobans.org) ASCOBANS, Document AC11/Doc. 15(P) Harbour Porpoise Action Plan for Sweden), 2004

The above two sources corroborate the impact on government and EU policy, which was established in 2004, but has on-going impact on international policy.

5.3 (ICES, 2010) International Council for Exploration of the Sea (ICES), ICES. 2010. Report of the ICES Advisory Committee, 2010. ICES Advice, 2010. Books 1 - 11. 1928 pp. ISBN 978-87-7482-088-8, 2010.

5.4 (Larsen *et al.,* 2013) Larsen, F., Krog, C., Eigaard, O.R., "Determining optimal pinger spacing for harbour porpoise bycatch mitigation", Journal of Endang. Species Res., Vol. 20: 147–152, doi: 10.3354/esr00494, 2013 "In 2013 data from Danish fisheries trials using AQUAmark100 systems was published to suggest greater spacing of pingers could be effective for implantation in Danish gillnet and hake fisheries (Larsen *et al.*, 2013)."

5.5 (MMO, 2013) Marine Management Organisation, "Implementation of Council Regulation (EC) 812/2004 to reduce by-catch of cetaceans information pack, updated 28 August 2013", online http://www.marinemanagement.org.uk/fisheries/monitoring/documents/cetaceansinfopack.pdf accessed on 27th September 2013.

5.6 (Dawson, 2013) Dawson, S. M., Northridge, S., Waples, D., Read, A. J., "To ping or not to ping: the use of active acoustic devices in mitigating interactions between small cetaceans and gillnet fisheries " Journal of Endang. Species Res. Vol. 19: 201–221, 2013, doi: 10.3354/esr00464, pp 201-221, 2013. "extension to a wide range of species including larger whales and sharks (Dowson *et al.,* 2013) using acoustic deterrent devices including the AQUAmark system."

5.7 (Gozo *et al.* 2008) Gazo M, Gonzalvo J, Aguilar A, "Pingers as deterrents of bottlenose dolphins interacting with trammel nets" Fish Res 92: pp. 70−75, 2008. "In 2008 when Gazo *et al*, reported in trials in the Mediterranean that nets equipped with AQUAmark pingers using Loughborough developed algorithms received less predation damage (87% fewer holes) than nets with non-functional devices or without pingers (Gazo *et al*, 2008)"

5.8 (Brotons *et al.*, 2008) Brotons JM, Munilla Z, Grau AM, Rendell L, "Do pingers reduce interactions between bottlenose dolphins and nets around the Balearic Islands?" Endang Species Res 5: pp 301−308, 2008." Brotons *et al*. reported a large scale study of an artisanal gillnet fishery around the Balearic Islands using several pinger types where "the use of active pingers apparently discouraged dolphins from interacting with nets, dramatically"