Aquaculture & Fisheries Development Centre,

University College Cork

2007/2008 Report

OUR VISION:

EXCELLENCE

in AQUACULTURE and FISHERIES

RESEARCH and DEVELOPMENT

CONTENTS

AFDC DIRECTOR'S REPORT

A brief history

The Aquaculture and Fisheries Development Centre was established by the Department of Zoology, Ecology and Plant Science (ZEPS) in 1987 as a centre of excellence for aquaculture research. The first Director was Prof. Tom Cross and Manager was Dr Richard Fitzgerald. Originally called the Aquaculture Development Centre, the subsequent name change reflected the increasing focus on fisheries research. The AFDC aims to support, stimulate and promote the development of aquaculture and fisheries, thereby enabling these sectors to achieve their full socio-economic potential by utilising sustainable natural resources. Research activities at the centre cover five thematic areas, each led by a ZEPS staff member:

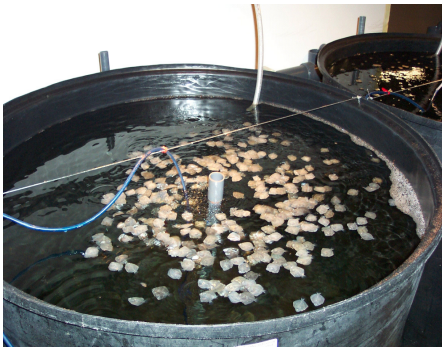
- Aquaculture and the Environment (Prof. John Davenport)
- Marine Mammals and Fisheries (Dr. Emer Rogan)
- Molecular Genetics (Prof. Tom Cross
- Aquaculture (Prof. Gavin Burnell)
- Shellfish and Finfish Health and Disease (Dr. Sarah Culloty)

In 2000 the AFDC merged with three other centres of excellence in UCC to become part of the new Environmental Research Institute (ERI), and in 2002 relocated to a purpose built aquaculture research facility at the Cooperage Building, Distillery Fields, North Mall, Cork but still remained as part of ZEPS. In 2004 a new director (Prof Gavin Burnell) was appointed.

Strategic Significance of Area

Both the aquaculture and fisheries sectors face immense challenges in the 21st century in terms of sustainable harvesting of our fish and aquatic resources. The traditional capture fisheries have over-fished more than 75% of stocks and are now looking to new wild species and aquaculture to maintain production. Rising fuel costs have forced many western fishermen to abandon the profession. Meanwhile expansion of the aquaculture industry faces the challenge of minimising environmental impact, and addressing the issues arising from the intensive farming of carnivorous fish in coastal waters.

Overview of Current Expertise in the Area



- Existing aquaculture species e.g. salmon, trout, mussels, oysters
- Emerging aquaculture species e.g. turbot, Arctic charr, cod, abalone, sea urchins
- Health and disease
- Molecular Genetics
- Fisheries

The expertise, infrastructure and research capacity built up at the AFDC since its opening in 1987, and the resultant research output, have raised the profile of the AFDC in the global research arena and afforded us the opportunity to

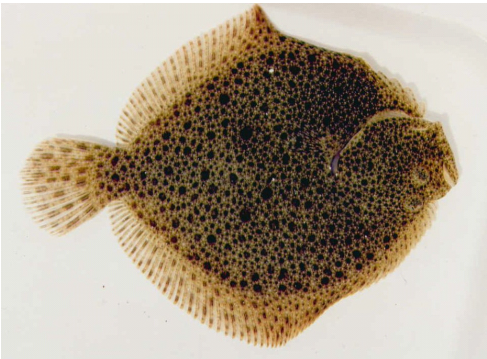
participate in large international proposals for funding. Recent improvements in the facilities available in the Cooperage site include an emergency electrical generator and a walk - in freezer unit. These improvements will make the centre a more competent and competitive organisation when bidding for research grants and consultancy work.

We have also broadened the topics and species base of which we have expert knowledge, thus strengthening our research capacity as we move forward to apply for new funding. Valuable research links have been built with researchers in Europe, North America and New Zealand, which will provide us with further future opportunities. By allowing us to build on our traditional areas of expertise, and diversify into emerging research areas we have maintained our position at the cutting edge of aquaculture and fisheries research.

Funding Track Record

The last five years has seen dramatic changes in the fortunes of the Irish aquaculture industry. Between 2003 and 2007 the shellfish cultivation industry remained static at around 30,000 tonnes production per annum whereas during the same period the salmon farming industry fell from

16,000 to 10,000 tonnes per annum. Despite such a gloomy national picture for the aquaculture industry, research activity in the AFDC was at a peak and nearly € 6.5 million of research funding was secured between 2007 and 2008.



New Director

During the past five years the research emphasis within the AFDC has moved from aquaculture to fisheries which mainly reflected trends in National funding. For the next five years there is unlikely to be any significant national funding for either sector and so winning EU funding will be a priority. It is therefore opportune that the new AFDC Director, Dr Sarah Culloty has an impressive track record in Europe and recently secured an important INTERREG project (***Climate change and Shellfish Diseases***) for the centre. Her challenge will be to use the modest financial resources of the centre to help secure funding for the future. To this end the recent appointment of a part-time Manager (Maria O'Mahoney) is an important and strategic investment in our future. I wish them both well with their appointments

Gavin Burnell

Director (2004 – 2009)

AFDC FACILITIES AND TECHNICAL SPECIFICATIONS

In 2002 the AFDC moved from the Lee Maltings to a purpose built facility on the UCC Distillery Fields Site, housed within the Old Cooperage Building on the North Mall and embedded within ZEPS. The facility encompasses 13,000 square feet of recirculating fish and shellfish systems, laboratories (Wet and Dry) and offices. Being an inland facility, grade A seawater is delivered to the site and stored (20,000 l of storage facilities) until required. It can be used "raw" if required, but the ADFC has the ability to produce large quantities of filtered and Ultra Violet (UV) treated seawater as required.

The freshwater and marine fish rearing areas are complete with a computerised water monitoring and analysis system (OxyGuard), and a video monitoring system. These commercial scale indoor recirculation units comprise water filtration (mechanical and biological), treatment (UV sterilisation and ozonation) and temperature control (conditioning units) to enable full control of environmental parameters/variables. Light intensity and photoperiod (in some areas) are locally controlled on a number of discrete systems.

A range of tank designs and sizes are incorporated which allow fish to be held at each life cycle stage, and also for experimental scale replicated trials to be conducted. Algal culture and live feed production areas are available to support the culture of many species through their larval stages. A recirculating shellfish nursery

system, broodstock holding/conditioning unit, thermally-controlled hatchery and live feed production units are custom designed to provide a series of systems suitable to the needs of a number of shellfish species. This is in addition to an 8.7m^3 Global Ocean Aquacluster system for shellfish culture.

In total there are three Tropical Marine Centre (TMC) 5000 litre Reservoir-Based Filtration Units. There are also a number of smaller scale recirculation systems which can be operated as marine or freshwater. In total, these eight units, ranging between 500 and 5000 litres, can be used as holding facilities or for experiments and trials. There are also two temperature controlled rooms, with photoperiod control available, in which a wide variety of research can be conducted. A range of tanks, pumps and auxiliary equipment is

also available to allow the production of research specific systems/units to suit almost any form of aquatic research. The dedicated AFDC Laboratory houses water quality analysis equipment, trial diet production/processing equipment, a Beckman Z2 Coulter Counter (particle size analyser), and drying oven as well as the standard laboratory equipment. The two tank

rooms of the AFDC are also fully backed-up with a 50KVa Generator fitted with an Automatic Transfer Switch (ATS) and Digi-dialler. On site laboratories provide dedicated research facilities and technical support essential to research at the AFDC.

Facilities available at the AFDC include:

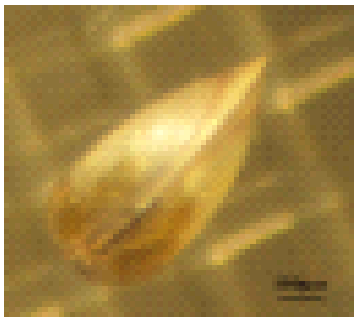
- Fish & Shellfish larviculture and on-growing systems
- Fully environmentally controlled recirculation
- Live food culture areas
- Temperature controlled micro-algal rearing facilities
- Molecular Genetics laboratory
- Water quality testing
- Food technology facilities
- Wet Lab/Post-mortem room
- Temperature and Photoperiod controlled rooms
- Tissue Culture laboratory
- Histology laboratory
- Immunology laboratory
- Molecular Biology Laboratory
- Video monitoring
- Disease diagnostics
- Training in aquaculture

AQUACULTURE RESEARCH GROUP

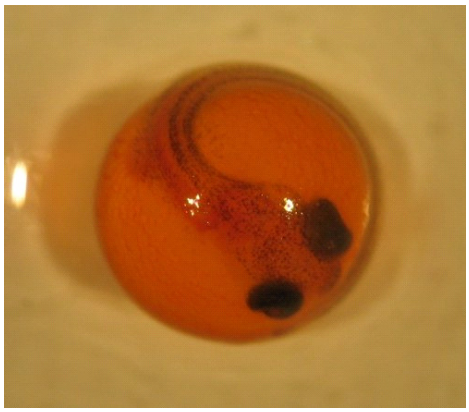
Prof. Gavin Burnell *Principal Investigator*

Under the umbrella of the Aquaculture Research Group several projects were ongoing throughout 2007-2008. A central theme of these projects was sustainable development of aquaculture and fisheries in Ireland. At the outset of this period, the completion of an NDP Marine RTDI funded study to introduce a scientific based management system for sustainable exploitation of seed mussels in the Irish Sea resulted in the publication of a comprehensive project report. Written and led by Prof. Burnell, this project entailed collaboration with UCD, QUB, Letterkenny IT, Galway-Mayo IT, Aquafact International Service Ltd and the South-east Shellfish Co-op with a steering committee of both national and international experts.

A second phase of research funding was awarded to the Atlantic Arc Aquaculture Group (AAAG) under the EU ERDF INTERREG IIIB "Atlantic Area" funding scheme which extended trans-national collaborative research by this group from January 2007 to June 2008. Amongst the diverse projects undertaken, the Aquaculture Research Group played an active role in the development of aquaculture technologies for emerging species including Arctic charr, sea urchins and abalone for broodstock development and on-growing phases of culture.



The AFDC, led by Prof. Gavin Burnell, played a prominent role in securing the prestigious Beaufort Marine Research Award for "Ecosystems approach to fisheries management (EAFM)". This seven year project (2007-2014) will result in collaboration between the AFDC and the Coastal and Marine Resources Centre (CMRC) as well as involving partners from QUB and the Marine Institute and aims to establish a holistic approach to fisheries management through a combination of disciplines involving multi-stakeholder participation and scientific best-practise. The appointment of the dedicated posts in this project (1 Principal Investigator, 2 post-docs, 2 PhD students) has been completed.



Led by Dr Gerry Mouzakitis, the Aquaculture Technologies Group (ATG) undertook several nationally funded research projects for commercially focussed innovation in Irish aquaculture. In total, Enterprise Ireland funding over this period reached €726,000 with an additional €89,000 awarded from the Marine Institute Applied Industry Scheme. Several noteworthy achievements of the ATG as a result of this research are of merit; in 2007, Ms Eimear McCarron was awarded a PhD for a thesis entitled "Development of a novel system for sea urchin aquaculture: application of the UrchinPlatter™ System to the purple sea urchin

Paracentrotus lividus", a worldwide patent for the UrchinPlatter™ System was secured by UCC and a start-up company, called Gourmet Marine Ltd., has been established to bring this technology to market.

Additional research in the ATG focussed on the development of a novel technology for aquatic feed production, the RediBind™ System. Two major applications of the RediBind™ technology were investigated at the AFDC with a view to developing cost-effective commercial feeds for Irish shellfish culture. Firstly, in collaboration with Dunmanus Seafoods Ltd., the RedBind™ System was utilised to develop the first artificial feeds for hatchery stages of sea urchin (*P. lividus*) culture. In the latter stages of this research, the

application of the technology to commercially focussed abalone (*Haliotis discus hannai*) feed development resulted in several new feed formulations that achieved improved abalone growth performance with higher food conversion efficiencies when compared with the natural feed type, *Laminaria digitata*.

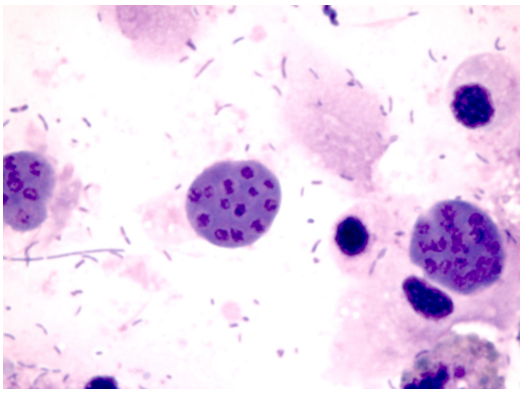
Postdoctoral Researchers – 1

PhDs - 2

SHELLFISH AND FINFISH HEALTH AND DISEASE GROUP

Dr Sarah Culloty *Principal Investigator*

The main research themes within the Health and Disease group are to develop an understanding of the main pathogens and diseases that affect marine organisms. Viral, bacterial, protistan and macroparasite infections are all studied. Research has concentrated on elucidation of the life cycle of pathogens, epidemiology, diagnostics, methods of transmission of pathogens, and host-parasite interactions with an emphasis on host response to infection and on the development of mechanisms to mitigate the impacts of disease such as the development of resistant stocks. Research, which has been funded by both national bodies and the EU, has concentrated in recent years on such projects as aspects of the disease bonamiosis which affects the native oyster *Ostrea edulis*, Brown Ring disease in the Manila clam, summer mortality in the Pacific oyster *Crassostrea gigas* and a study of the health status of the mussel *Mytilus edulis*. The group has ongoing collaborations with research groups throughout Europe and North America.



In 2007 Dr Sarah Culloty and Prof Maire Mulcahy completed a report on the parasite *Bonamia ostreae* and its host the native oyster *Ostrea edulis* which has been published as part of the Marine Institutes report series. Ongoing research within the group included a collaborative study with Letterkenny Institute of Technology, the Marine Institute and the NUIG on molecular based dietary analysis of bivalve molluscs carried out by Mr Aaron Maloy, at Letterkenny Institute of Technology and supervised by Dr Culloty. Two IRCSET funded PhD students Mr Jan Fermer and Ms Katrin Prinz are carrying out studies on macroparasite communities of bivalve molluscs along the coast of Ireland in soft sediment and rocky shores respectively and supervised by Dr Culloty, Dr Ruth Ramsay and Dr Tom Kelly, ZEPS.

In 2007-2008 research continued on a Marine Institute funded project looking at the role of a range of molluscs in the transmission of the protistan parasite *Bonamia ostreae*, the most significant pathogen of the European flat oyster *Ostrea edulis*. This research has resulted in further studies being undertaken with the Virginia Institute of Marine Science, USA and the Centro de Investigaciones Marinas, Galicia, Spain following the discovery of another

protistan parasite in Irish bivalves. Also, at the completion of this project and after carrying out extensive work on aspects of the life cycle of

Bonamia ostreae Ms Sharon Lynch was awarded her PhD into "Investigations in to the life cycle of the protistan *Bonamia ostreae* and the possible role of carriers".

PhDs - 4

MScs - 2

MARINE MAMMAL & FISHERIES RESEARCH GROUP

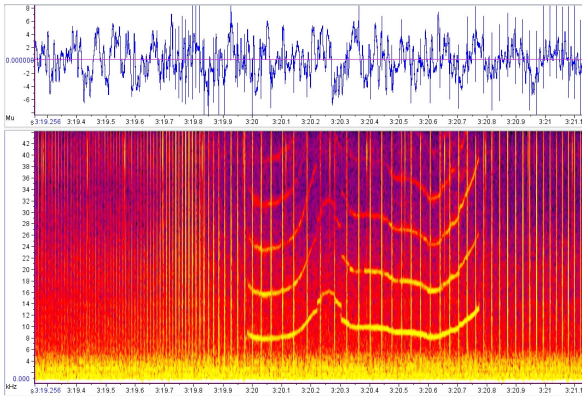
Dr Emer Rogan *Principal Investigator*

The main research focus of the marine mammal and fisheries group is based on conservation biology, ecology and management of marine vertebrates. Of particular interest are aspects of the life history, population dynamics, oceanography, foraging ecology, the development of appropriate fishing methods to reduce discarding and marine mammal bycatch and provide ecosystem based fisheries management advice. The research can be broadly divided into four themes. Research techniques combine fieldwork, laboratory work and modelling to achieve research goals.

Studies continued in 2007-2008 on the ***Health status of marine mammals*** with Ms Ailbhe Kavanagh carrying out her MSc on "Diet studies of the harbour seal (*Phoca vitulina vitulina* L.) in Ireland" funded by the Marine Institute. This MSc was part of a larger study, initiated in 2006, investigating the movements and foraging behaviour of harbour seals in southwest Ireland, using telemetry technology whilst simultaneously investigating the diet of the species.

This study examined the diet of harbour seals using a combination of approaches; hard-part analysis of faecal and digestive tract contents, and fatty-acid analysis to determine the assemblage of prey consumed by the seals. Samples were collected from two locations in Ireland, Glengarriff in Co. Cork and Ballyvaughan in Co. Clare, over a 17-month period.

The second theme involving ***Distribution of cetaceans in Irish Coastal waters*** is currently being undertaken in the form of a IRCSET funded PhD awarded to Ms Anneli Englund on "Investigating variation in whistle structure between parapatric bottlenose dolphin communities". The main objective of this study is to describe the variability of bottlenose dolphin (*Tursiops truncatus*) vocalisations between two habitat types, estuarine and coastal.



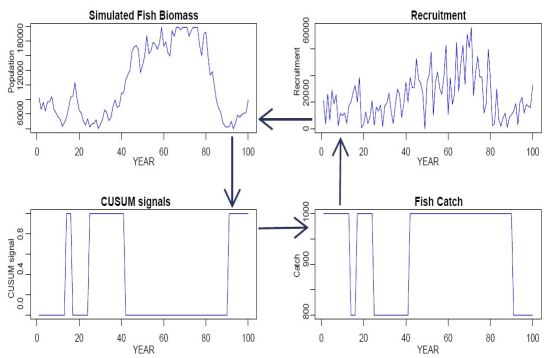
Passive acoustics are being used to record the sounds of resident dolphins in the Shannon estuary and of west coast "transients". Photo identification techniques will be used to investigate the degree of association within and between these communities and of any overlapping ranging patterns. Results from genetic sampling in a parallel study (funded through Science Foundation Ireland, SFI) will provide information on relatedness within and between the studied communities.

It is hypothesised that bottlenose dolphin vocal

repertoires are more similar between groups or communities that show a higher degree of social association than for those who associate to a lesser degree.

Under the ***Marine mammal – fisheries interactions*** theme PhD Student Gema Hernandez Milian is working on a Beaufort (Marine Institute) funded study on "Ecosystems Approach to Fisheries Management (EIFM)" co-supervised by Prof. Burnell and Dr Rogan. As a part of the Beaufort Award on Ecosystem Approach to Fisheries Management Project, this research will develop a food web model (Ecopath with Ecosim-EwE- software will be used) based mainly on dolphin diet and their interactions with fisheries within the Irish waters.

In the final theme – ***Fisheries,*** PhD student Deepak George Pazhayamadom is working on a Marine Institute study on "The Application of Signal Detection Methods to the Fisheries Management System" co-Supervised by Dr Rogan, UCC; Dr C. Kelly, Marine Institute and Dr E. Codling, University of Essex, U.K. The aim of the project is to explore the current application of signal detection methods, relevant to fisheries management.



A typical example of simulated fishery to show how CUSUM control charting can be used in a fisheries management framework. In this example, when biomass of the population reduce beyond a critical level, the CUSUM control chart signals the fishery manager to take an action by reducing fish catch. Decrease in catch keeps the SSB (Spawning Stock Biomass) higher and hence higher recruitment in future years. The plots shows the recovery of simulated fishery following the action trigerred by CUSUM Control Chart.

Currently, the project aims to develop efficient quantitative methods from a theoretical basis used in Statistical Process Control. In particular, the use of CUSUM (Cumulative Sum) Control Charting and its possible application to data limited fisheries will be investigated. Knowledge generated from this PhD will pave the way for the development of an entirely new approach for assessing and advising ocean resource management. Also, currently Ms Anna Santos, a PhD student is working on a Marine Institute funded project on the Black Scabbard.

Postdoctoral Researchers – 2

PhDs – 5

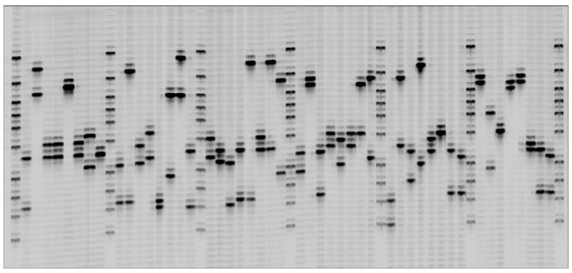
MScs-1

MOLECULAR GENETICS RESEARCH GROUP

Prof. Tom Cross *Principal Investigator*

During 2007/2008 the fish population genetics group progressed its research into Atlantic salmon (*Salmo salar*) focusing mainly on the issue of Genetic Stock Identification (GSI) of mixed stock fisheries and on calibration of the existing Irish genetic baseline with that of participants in the EU Framework 7 funded SALSEA-Merge project. Other work on salmon included detailed investigation of what has become known as the 'south eastern population complex', which has involved expanding the range and type of genetic markers used in an attempt to delineate salmon populations in that area of Ireland.

2008 also saw the commencement of the EIRCOD project funded by the Marine Institute and led by NUIG which will develop the cod farming industry in Ireland over the next seven years. Other projects included a forensic fish identification exercise performed for the Food Safety Authority of Ireland, where the genetics group established that wild salmon offered for sale by a prominent Irish retailer was in fact farmed in origin. This led to a high profile legal action with Dr Eileen Dillane and Dr Phil



McGinnity providing expert testimony. In another project, funded by the Norwegian Research Council, the genetics group is investigating the impact of escaped farmed salmon on the genetics of wild populations. During this time Luca Mirimin completed a PhD supervised by Prof. Cross and Dr Rogan on "Genetics of the common dolphin" and an SFI-funded project on "Genetics and stable isotope study of Irish bottlenose dolphins" commenced.

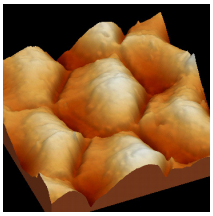
The most significant development in fish population genetics however, was the launch of the Beaufort initiative. This scheme, funded by the Marine Institute, has facilitated the recruitment of a Principal Investigator (Dr Phil McGinnity) in June 2008, and of two Senior Researchers (Dr Jens Carlsson, formerly of the Virginia Institute of Marine Science and Dr Jamie Coughlan) to commence in February 2009. Employment terms on these fellowships are seven years which will allow the research team to develop long term research strategies and forge links with international collaborators. Funding also covers recruitment of a PhD student. The award was funded in conjunction with Queen's University of Belfast, where a further SR will be recruited as well as two PhD students.

Principal Investigators – 1; Postdoctoral researchers – 3; MScs – 2; PhDs –1; Research Assistants - 2

AQUACULTURE AND THE ENVIRONMENT RESEARCH GROUP

Prof. John Davenport *Principal Investigator*

Research interests of the group include marine ecology and ecophysiology, respiratory and osmotic physiology of aquatic animals, low temperature biology of aquatic animals, biomechanics of locomotion and feeding of aquatic animals, fouling and shellfish aquaculture. More specific interests include: biology of the mussel *Mytilus edulis*; biology and biogeography of the end of the cosmopolitan genera *Lasaea* (Bivalvia) and *Tigriopus* (Copepoda); biology of marine, estuarine and freshwater turtles; Island biogeography and conservation.



Currently, IRCSET funded PhD Student Giuliano Greco is working on an anti-fouling study looking at – "How do crabs keep their eyes clean? Lessons for advanced marine antifouling technologies". In this project the behavioural, mechanical, physical and chemical antifouling (antiepibiosis) strategies of the green crab (*Carcinus maenas*) are being investigated. The aim of this PhD project is to develop innovative and environmentally friendly antifouling techniques to be used in all human activities subjected to the marine biofouling problem, in particular in the field of marine sensoring.

PhDs - 1

AFDC RESEARCH COMMERCIALISATION

One of the major achievements of the AFDC in 2008-2009 has been the commercialisation of its sea urchin aquaculture technology, called the UrchinPlatter™ System. Developed over seven years by Dr Gerry Mouzakitis (ex-General Manager, ERI) and Prof. Gavin Burnell, the UrchinPlatter™ System is internationally unique. In 2008-2009, a start-up company, called Gourmet Marine Ltd, headed by Dr Mouzakitis, was incorporated to bring this technology to market.

Although developing novel technologies and commercialisation are nothing new in UCC, the UrchinPlatter™ System and Gourmet Marine are unique in the field of aquaculture in Ireland. This technology is the first aquaculture technology conceived and developed in Ireland. The technology is patented in 19 countries worldwide, covering 88% of sea urchin production and is expected to be licensed for production in Chile in 2010.

The development of a novel aquaculture system is a long process with each sea urchin experiment to develop, assess and optimise the system requiring three to six months. The development of the UrchinPlatter™ System was only possible due to the Commercialisation Fund of Enterprise Ireland which supported this technology from concept to company formation. Open to all fields, this fund is specifically aimed at university researchers wishing to develop commercially relevant technologies.

The development of the UrchinPlatter™ System was also aided by the BioTransfer Unit (BTU) of

UCC. The BTU is a collaboration between Enterprise Ireland and the Technology Transfer Office of UCC that assists researchers in bringing their technology to market. Their constant support over the past seven years has ensured that the UrchinPlatter™ System has been fully developed, validated and ready for the market.

The UrchinPlatter™ System has been validated in Ireland in conjunction with an aquaculture farm in West Cork. To ensure objectivity, the sea urchins produced by this system were tasted by a panel of seafood experts organised by BIM Aquaculture. All the tasters found the sea urchins to be of excellent quality and texture. Additional validation tests are being organised in Chile (the world's largest sea urchin producer), Canada, Malta and Spain (Europe's largest producer) in association with local companies.

NEW APPOINTMENTS

Two appointments have been made during the period 2007-2008 that will enhance the capabilities of the AFDC significantly. Dr Phil McGinnity was appointed in 2008 as a Principal Investigator with the Beaufort Fish Population Genetics group. Dr McGinnity, formerly of the Marine Institute will drive this seven year funded program which will be enhanced with further appointments of Senior Researchers and postgraduate students in 2009.

Prof. John Benzie joined the Environmental Research Institute as the SIF Professor of Marine Molecular Biodiversity in November 2008. His work in aquaculture has focused on reproduction, genetic improvement and genomics of shrimps and bivalves. It is envisaged that Prof Benzie will work closely with the AFDC bringing his considerable expertise to existing and new areas of research within the centre. AFDC researchers also contribute to the overall research activities of the Marine and Freshwater Research thematic area of the ERI, of which Prof. John Benzie is the new thematic group leader and which will provide further opportunities for collaboration.

Prof. J. Benzie

AFDC FUNDING – GRANT CAPTURE

Over the years 2007-2008, research projects funded externally to the value of €7,743,673 were ongoing at the AFDC. Of this €6,497,256 was funding secured and commencing during the 2007-2008 period. Of funding secured, 95% was from national sources, most notably the Marine Institute which had provided 78% of AFDC funding. This was due in large part to the awarding of two prestigious Beaufort awards (Marine Institute) to two AFDC Principal Investigators, Profs Cross and Burnell. The next largest source of income was Enterprise Ireland (8%) which provided ongoing funding for the development and commercialisation of the UrchinPlatter™ System. European Union funding through FP7 accounted for 5% of the AFDC funds. This will provide on-going challenges in the coming years with more effort being required to access non-Exchequer areas of funding.

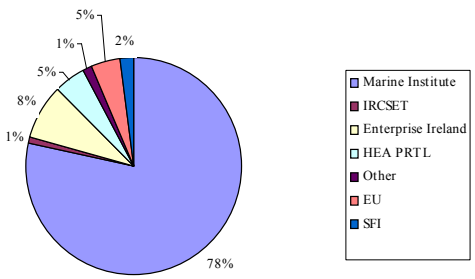


Fig 1 Sources of AFDC funding during 2007-2008

AFDC GOING FORWARD 2009

Our Vision:: Excellence in aquaculture and fisheries research and development

Future plans at the AFDC will focus on further developing the Centre as a focal point for excellence in fisheries and aquaculture research and development. The core objectives identified include participation in international networks of excellence and undertaking of targeted, cost-effective and innovative research. These measures will be supported for example, by the membership of Dr Culloty, in the European Aquaculture Technology and Innovation Platform (EATIP), the main responsibilities of which are to set a strategic research agenda for the aquaculture industry in Europe that will be used by the EU to define projects. Further objectives of the AFDC, looking forward, include providing for PhDs in grant applications wherever possible and increased focus on transfer of knowledge and commercialisation of research output. We aim to meet the upcoming needs of the aquaculture and fisheries sectors through pure and applied research, with increasing focus on commercial opportunities.

The traditional barriers between fishing and fish farming are unnatural as both industries are working in the same environment with the aim of creating a sustainable production of seafood. There are opportunities through the existing Beaufort projects and recently won EU projects (e.g. COEXIST with AQUATT and CMRC) to create a network of Irish expertise in the area of sustainable aquatic production with the AFDC as a centre of excellence in research and training. The critical role of the AFDC in the securing of two prestigious Beaufort awards in genetics and

in ecosystem approaches to fisheries management (with the CMRC) has allowed the centre to increase its capacity in these areas over the next seven years both in terms of researchers (at Principal Investigator, Senior Researchers and Research Assistants level) and students (with a large number of PhD and MSc students). These appointments plus others such as that of Prof. John Benzie will allow new strategic areas to be identified and development of new partnerships both across UCC and its centres and outside the University.

The success of the AFDC in securing research funds during 2007-2008 has been significant but does raise challenges for all at the centre in the coming years. During 2007-2008, 95% of all funding came from National agencies. These sources of funding will be very much reduced in the coming years so the research community at the AFDC will have to build on current strengths and partnerships to access more funding from non-national sources such as the EU and also look to industry for possible collaborations. It will be assisted in this endeavour by collaboration with AQUATT. This is a not for profit company set up in 1992 and co-owned by UCC and NUIG with an expertise in grant applications and project management. The challenge for all in 2009 is to build on existing strengths while maintaining and increasing resources within the centre. The track record of the AFDC community, however, will in no small part enhance these measures and open up new opportunities to allow us to build on our success.

Sarah Culloty,

Director, AFDC, 2009

AFDC AWARDS

Ph.D. Theses – 2007

Brian O'Farrell - "Genetics aspects of brown trout *Salmo trutta* L." (Supervisor: Prof. T. Cross)

Luca Mirimin - "Molecular genetics of three dolphin species occurring in the eastern North Atlantic" (Supervisor: Prof. Tom Cross, Dr Emer Rogan)

Michelle Cronin - "The abundance, habitat use and haul-out behaviour of harbour seals (*Phoca vitulina vitulina* L.) in southwest Ireland" (Supervisor: Dr Emer Rogan)

Natascha Aguillar da Soto - (University of La Laguna) "Acoustic and diving behaviour of pilot whales (*Globicephala macrorhynchus*) and Blainville´s beaked whales (*Mesoplodon densirostris*) off the Canary Islands, with implications for effects of man-made noise and ship strikes" (Registered at the University of La Laguna) (Supervisor: Dr Emer Rogan)

Eimear McCarron - "Development of a novel system for sea urchin aquaculture: application of the UrchinPlatter™ System to the purple sea urchin *Paracentrotus lividus*" (Supervisors: Prof. Gavin Burnell, Dr Joseph Kerry, Dr Gerry Mouzakitis)

PhD Theses – 2008

Sharon Lynch - "Investigations into the life cycle of the protistan *Bonamia ostreae* and the possible role of carriers" (Supervisor: Dr Sarah Culloty)

M.Sc. Theses – 2007

Amy O'Reilly - "The possible role of herpes virus in summer mortality syndrome in the Pacific oyster *Crassostrea gigas*" (Supervisor: Dr Sarah Culloty)

Paula Harrison - "Fishing activity, biological features and suggested management measures for the biologically sensitive area off the Irish coast" (Supervisor: Dr Emer Rogan)

M.Sc. Theses – 2008

Ailbhe Kavanagh - "Diet studies of the harbour seal (*Phoca vitulina vitulina* L.) in Ireland" (Supervisor: Dr Emer Rogan)

APPENDIX 1: AFDC FUNDING – ONGOING AND NEW RESEARCH GRANTS DURING 2007/2008

Burnell G. Atlantic Arc Aquaculture Group 2. EU INTERREG IIIB North. 2007-2008 €95,600

Burnell G. and Cummins V. Beaufort - Ecosystem approach to fisheries management. Irish Government NDP administered by Marine Institute. 2007-2014 €1,860,004.

Cross T. F. Beaufort fish population genetics. Irish Government NDP administered by Marine Institute. 2007-2014 €2,710,236

Cross T.F. Genetic stock identification. Marine Institute 2006 – 2008 €438,040.

Cross T.F. Irish cod breeding programme. Marine Institute 2008-2015 €213,088.

Cross T.F. Molecular ecology of salmon in the river Moy. HEA-PRTLI 3 2002-2008 €228,307.

Cross T.F. Population genetics of salmon in the rivers Barrow, Nore and Suir, Ireland. Marine Institute ACMS Feb to Dec 2007 €14,100.

Cross T.F. SALSEA-Merge: Advancing understanding of salmon at sea: Merging genetics and ecology to resolve stock specific migration and distribution patters. EU RTD FP7 2008-2011 €254,609.

Cross T.F. Genomics as a tool to detect selection in farm Atlantic salmon. Norwegian Research Council Jan to Dec 2008 €37,208.

Cross T.F. International collaboration on trout genetics. HEA-PRTLI 3 2002-2008 €63,698.

Cross T.F. Use of mixed stock analysis to detect farmed Atlantic salmon. Food Safety Authority of Ireland Jan and Feb 2008 €9,917.

Culloty S.C. The possible role of scallops, abalone and the Pacific oyster as carrier species of the protozoan *Bonamia ostreae*. Marine Institute NDP Programme 2006-2008. €197,005.

Davenport J. How do crabs keep their eyes clean? Lessons for advanced technology. IRCSET 2006-2009 €72,009.

Mouzakitis G. Gourmet Plus. Enterprise Ireland Commercialisation Fund 2008. 2008-2009 €201,695.

Mouzakitis G. and G. Burnell. Commercial validation of the RediBind™ System. Enterprise Ireland Commercialisation Fund, 2007. 2007-2008 €94,376.

Mouzakitis G. and G. Burnell. UrchinFarm: Development of commercial sea urchin aquaculture in Ireland

using the UP System. Enterprise Ireland Commercialisation Fund 2005. 2005-2008 €339,425.

Rogan E. and A. Englund. Bottlenose dolphin whistle repertoires in Irish coastal waters. Heritage Council, 2007 – 6 months €10,000.

Rogan E. and E. Codling. Develop and test through simulation a suite of measures that will contribute to rebuilding depleted fish stocks in waters around Ireland. Marine Institute 2008-2014 €625,570.

Rogan E. and E. Codling. Modelling the ecology, population dynamics, assessment and management of Nephrops (*Nephrops norvegicus*) in the waters around Britain & Ireland. Marine Institute 2008-2011 €105,000.

Rogan E. and E. Codling. The application of signal detection methods to the fisheries management system. Marine Institute 2008-2012 €115,000.

Rogan E. and S. Ingram. Bottlenose dolphin site assessment – Connemara. National Parks & Wildlife Service €16,668.

Rogan E. and S. Ingram. Bottlenose dolphins in the Shannon. National Parks & Wildlife Service. 2008 €11,100.

Rogan E. and T. F. Cross. Molecular ecology of small cetaceans in Irish waters. HEA-PRTLI 3. 2003-2008 €80,807.

Rogan E. and Hammond. CODA. National Parks and Wildlife Service. 2008 €8085.

Rogan E. The life history, ecology and dynamics of the Black Scabbard (*Aphanopus carbo*) in the deep water ecosystem of the North East Atlantic. Marine Institute 2008-2012 €115,000.

Rogan E., S. Ingram and T. Cross. Population structure of bottlenose dolphins along the west coast of Ireland. Science Foundation Ireland. 2006-2009 €155,000.

APPENDIX 2: AFDC PUBLICATIONS

deEyto, E., **McGinnity**, **P**., Consuegra, S., **Coughlan**, **J**., Tufto, J., Farrell, K., Megens, H.-J., Jordan, W., **Cross T**. & Stet, R.J.M. (2007). Natural selection acts on Atlantic salmon MHC variability in the wild. *Proceedings of the Royal Society B,* 274, 861-869.

Dillane, **E**. **Cross**, **M**., **McGinnity**, **P**., **Coughlan**, **J.P**., **Galvin**, **P**., Wilkins, N.P. & **T**.**F**. **Cross** (2007). Spatial and temporal patterns in microsatellite DNA variation of wild Atlantic salmon (*Salmo salar*) in Irish Rivers. *Fisheries Management and Ecology*, 14, 209-220.

Dillane, E., **McGinnity, P**., **Coughlan**, **J**.**P**., **Cross, M**.**C**., de Eyto, E, Kenchington ,E, Prodöhl, P, **Cross, T**.**F**. (2008). Demographics and landscape features determine intra-river population structure in Atlantic salmon (*Salmo salar* L.): the case of the River Moy in Ireland. *Molecular Ecology*.17, 4786-4800.

Drummond, **L**., Beaz, R., Balboa, S., **Mulcahy**, **M**.**F**., Romalde, J & **S**.**C**. **Culloty** (2007). The susceptibility of Irish- and Spanish- manila clams *Ruditapes philippinarum* to *Vibrio tapetis* and Brown Ring disease. *Journal of Invertebrate Pathology.* 95, 1-8.

Fontaine, M.C., Baird, St. J. E., Piry, S., Ray, N., Duke, S., Birkun, A. Jr., Bloch, D., Ferreira, M., Sequeira, M., Jauniaux, T., Llavona, A., Oien, N.L., Ozturk, B., Ozturk, A.A., Ridoux, V., **Rogan**, **E**., Siebert, U., Vikingsson, G.A., Bouquegneau, J-M., & Michaux, J.R. (2007). Rise in Oceanographic barriers in continuous populations of a cetacean: the harbour porpoise in old world waters. *BMC Evolutionary Biology*.

Ingram, **S**.**N**., Walsh, L., Johnson, D. & **Rogan**, **E**. (2007). The distribution of fin whales (*Balaenoptera physalus*) and minke whales (*Balaenoptera acutorostrata*) in the Bay of Fundy, Canada: using a tour-boat as a platform of opportunity. *Journal of the Marine Biological Association* 87, 149–156.

Lahaye V., Bustamante P., Law R.J., Learmonth J.A., Santos M.B., Boon J.P., **Rogan E**., Dabin W., Addink M.J., López A., Zuur A.F., Pierce G.J. & Caurant F. (2007). Biological and ecological factors related to trace element levels in harbour porpoises (*Phocoena phocoena*) from European waters. *Marine Environmental Research* 64(3), 247 – 266

Lynch, **S**., **Mulcahy**, **M**.**F**. & **Culloty**, **S.C**. (2008). Efficiency of diagnostic techniques for the parasite *Bonamia ostreae*. *Aquaculture,* 281, 17-21.

Lynch, **S**.**A.**, **Armitage**, **D**.**V**., **Coughlan**, **J**., **Mulcahy M**.**F.** & **Culloty**, **S**.**C**. (2007). Investigating the possible role of benthic macroinvertebrates and zooplankton in the life cycle of the haplosporidian *Bonamia ostreae. Experimental Parasitology,* 115, 359-368.

Malham., S. **Cotter**, **E**., **O'Keeffe**, **S**. **Lynch, S**. **A**.,. Latchford, J.W King, J.W. **Culloty**, **S**.**C**., & A.R.

Beaumont. (2008). Summer mortality of the Pacific oyster *Crassostrea gigas* in the Irish seas: the influence of environmental factors. Aquaculture 287, 128-138.

McHugh, B., Law, R.J., Allchin, C., **Rogan**, **E**., **Murphy**, **S**., Foley, M.B., Glynn, D. & McGovern, E. (2007). Bioaccumulation and enantiomeric profiling of organochlorine pesticides and persistent organic pollutants in the Killer Whale (*Orcinus orca*) from British and Irish waters. *Marine Pollution Bulletin* 54 (11), 1724 – 1731.

McGinnity, **P**., de Eyto, E., **Cross, T**., **Coughlan**, **J**. and Ferguson, A. (2007). Population specific smolt development, migration and maturity schedules in Atlantic salmon in a natural river environment. *Aquaculture*, 273, 257-268.

O'Leary, **D**.**B**., **Coughlan**, **J**., McCarthy, T.V. and **Cross**, **T**.**F**. (2007). Microsatellite variation in cod (*Gadus morhua*) throughout its geographic range. *Journal of Fish Biology*, 70, Supplement C, 310-335.

Philpott, **E**., **Englund**, **A**., **Ingram**, **S**., and **Rogan**, **E**. (2007). Using T-Pods to investigate detection range and echolocation behaviour of coastal bottlenose dolphins. *Journal of the Marine Biological Association* 87, 11–17.

Pierce, G.J., Santos, M.B ., **Murphy**, **S**., Learmonth, J.A., Zuur, A.F., **Rogan**, **E**., Bustamante, P., Caurant, F., Lahaye, V., Ridoux, V., Zegers, B.N., Mets, A., Addink, M., Smeenk, C., Jauniaux, T., Law, R.J., Dabin W., Lopez A., Alonso Farre, J.M., Gonzalez A.F., Guerra, A., Garcıa-Hartmann, M., Reid, R.J., Moffat, C.F., Lockyer, C., Boon, J.P. (2008). Bioaccumulation of persistent organic pollutants in female common dolphins (*Delphinus delphis*) and harbour porpoises (*Phocoena phocoena*) from western European seas: Geographical trends, causal factors and effects on reproduction and mortality. *Environmental Pollution* 153, 401 – 415.

Rogan, E. & **Mackey**, **M**. (2007) Bycatch and discarding in the Irish tuna driftnet fishery. *Fisheries Research*, 86(1), 6 – 14.

Shephard, **S**., Connolly, P., Nils-Roar Hareide &. **Rogan**. **E**. (2007). Establishing stake holder linkages for management of the Irish Orange Rough fishery. *ICES J. Marine Science* 64(4), 841 – 845.

Shephard, S., Trueman, C., Rickaby, R. & **Rogan**, **E**. (2007). Juvenile life history of NE Atlantic orange roughy from otolith stable isotopes. *Deep Sea Research* 54(8) 1221 – 1230.

Watts, P.C., **O'Leary**, **D**., **Cross**, **M**.**C**., **Coughlan**, **J**., **Dillane**, **E**., Kay, S.M., **Wylde**, **S**., Stet, R., Nash, R.D.M., Hatfield, E.M.C. & **Cross, T.F**. (2008). Contrasting levels of genetic differentiation among putative neutral microsatellite loci in Atlantic herring *Clupea harengus* populations and the implications

for assessing stock structure. *Hydrobiologia*, 606, 27-33

Notes

Philpott, **E**., Wall, D. & **Rogan**, **E**. (2007). Records from the Irish Whale and Dolphin Group for 2004. *Irish Naturalists' Journal* 28 (9) 379 – 385.

Philpott, **E**. & **Rogan**, **E**. (2007). Records from the Irish Whale and Dolphin Group for 2005. *Irish Naturalists' Journal* 28 (10) 414 – 418.

Conference Proceedings (editorship)

Davenport, **J**., **Burnell**, **G**.**M**., **Cross**, **T**.**F**., **Emmerson**, **M**., **McAllen**, **R**., **Ramsay**, **R**., & **Rogan**, **E**. (2008). Challenges to Marine Ecosystems. Proceedings of the 41st European Marine Biology Symposium. *Developments in Hydrobiology*, Vol. 202, 211pp./*Hydrobiologia* Vol. 606. Kluwer Academic Press, Netherlands.

Chapter/Article in a book

Cross, T.F., **McGinnity**, **P**., **Coughlan**, **J**., **Dillane**, **E**., Ferguson, A., Koljonen, M-L., Milner, N., O'Reilly, P. & Vasemagi, A. (2007). Genetic considerations for Stocking and Ranching of Atlantic salmon. In Verspoor, E., Stradmeyer, L. and Nielsen, J.L. (eds.) *The genetic nature of Atlantic salmon: implications for management and conservation.* The Atlantic Salmon Trust, 325-356.

Ferguson, A., Fleming, I.A., Hindar, K., Skaala, Ø., **M^c^Ginnity**, **P**., **Cross, T**. & Prodöhl, P. (2007). Farm Escapes. In Verspoor, E., Stradmeyer, L. and Nielsen, J.L. (eds.) *The genetic nature of Atlantic salmon: implications for management and conservation.* The Atlantic Salmon Trust, 357-398.

Cross, T.**F**., **Burnell**, **G**., **Coughlan**, **J**., **Culloty**, **S**., **Dillane**, **E**., **McGinnity**, **P**. & **Rogan, E**. (2008). Detrimental genetic effects of interactions between reared strains and wild populations of marine and anadromous fish and invertebrate species: are all species at risk? In M. Holmer (Ed) Aquaculture and the Ecosystem, Springer, pps.117-154. ISBN: 978-1-4020-6809-6.

Reports

Culloty, **S.C**. & **Mulcahy**, **M**.**F**. (2007) *Bonamia ostreae*: a Review. Marine Environment and Health Series, Marine Institute, Galway. No. 29, 36pp.

Culloty, **S**.**C**. (2008). Recent research on *Bonamia ostreae*: an investigation into the role of Molluscs other than *Ostrea edulis* as possible carriers of this parasite. In Report of the annual meeting of the National

Reference Laboratories for Mollusc Diseases. IFREMER, Nantes France, 18-19 March 2008.

Cross T. F. **Coughlan**, **J**., **Dillane**, **E**., **McGinnity**, **P**. (2008). Genetic stock identification of Irish commercially caught salmon. Marine Institute Report.

Dillane, E., **Cross, T.F**. (2008*). Genetic identification of farmed salmon in smoked product.* Food Safety Authority of Ireland.

Little, D., Collins, K., Cross, J., Cooke, D and **McGinnity**, **P**. (2008). Native riparian woodlands – a guide to identification, design, establishment and management. *Native woodland scheme information note No. 4* – published by Forest Service and Woodlands of Ireland.

Thorstad, E.B., Fleming, I.A., **McGinnity**, **P**., Soto, D., Wennevik, V. & Whoriskey, F. (2008). Incidence and impacts of escaped farmed Atlantic salmon *Salmo salar* in nature. NINA Special Report 36. 110 pp.

Verspoor, E., Kenchington, E., **McGinnity**, **P**., Tysklind, N., Cauwelier, E. and Vasin, O. (2008) To evaluate prospects for the use of genetic monitoring for evaluating conservation status, intraspecific biodiversity, and stock "health" in fishes. ToR e): ICES WGAGFM Report 2008, ICES Mariculture Committee ICES CM 2008/MCC:04 REF. ACOM.

McGinnity P. (2008). Genetic interactions between hatchery and wild Atlantic salmon. Proceedings of IFM Annual Study course 2007. pp9

Informal or Non-refereed publications

Hatfield, E.M.C., Nash, R.D.M., Zimmerman, C., Schon, P-J., Kelly, C. Dickey-Collins, M., McKenzie, K., **Cross**, **T**. **F**. (2007). The scientific implications of the EU Project WESTHER (Q5RS-2002-01056) to the assessment and management of the herring stocks to the west of the British Isles. *Conseils Internationale pour l'Exploration de la Mer C.M.* Doc. 2007/L:11, 23p.

Conference Presentations

Invited Talks

Cross, **T.F**. (2007). ABFNI Belfast: Cod molecular genetics.

Cross, **T**. **F**. (2008). Mixed stock analysis of Irish salmon using genetic methods. Food Conference, Waterford IT, August; Blackwater Anglers Trust, Millstreet, September.

Culloty, **S**.**C**. (2008). Recent research on *Bonamia ostrea*e: an investigation into the role of Molluscs other than *Ostrea edulis* as possible carriers of this parasite. National Reference Laboratories for Shellfish Diseases, Annual Meeting, IFREMER, Nantes, France, 18-19 March 2008.

Oral Presentations

Cross, **T**.**F**. (2007). Genimpact 3 Usefulness of modelling in genetic investigations.

Cross, **T**.**F.** (2008). The use of scales and otoliths as sources of DNA. ICES WGAGFM- working group on the application of genetics to fisheries and mariculture. April. Scottish Freshwater Fisheries laboratory, Pitlochery, Scotland

Cross, **T**.**F**. (2008). Utility of SNPS in salmon genetics. SALMAN 2 – Atlantic Salmon microsatellite analysis network. Paris, February.

Cross, **T**.**F** (2008). SCOTENS. Explanatory talk prior to showing of the Medusae film. Belfast, April.

Culloty, **S**.**C.** and **Lynch**, **S**. (2008). Investigations into the life cycle of a protistan *Bonamia ostreae*: a significant parasite of the native oyster *Ostrea edulis*. Annual Meeting of the Irish Society for Parasitology, Cork 27th June 2008.

Drummond, **L**., **Mulcahy**, **M**.**F**., **Paillard**, **C**. and **Culloty**, **S**.**C**. (2007). Brown ring disease and *Vibrio tapetis* in the manila clam in Ireland: an historical perspective. European Association of Fish Pathologists, 13th International Conference of Fish and Shellfish Diseases, 17th -21st September 2007 Grado, Italy.

Fontaine, M. C., Piry, S., Ray, N., Tolley, K. A. , Duke, S., Birkun, A. Jr., Ferreira, M., Jauniaux, T., Llavona, Á., Öztürk, B., Öztürk, A. A., Ridoux, V., **Rogan**, **E**., Sequeira, M., Siebert, U., Vikingsson, G. A., Bouquegneau, J.-M., Michaux, J.R., Baird, S. J.E. (2007). Rise of barriers in continuous populations of a cetacean: the harbor porpoise in old world waters.

Ingram, **S**., Rendell, L. & **Rogan**, **E**. (2007). Designing repeated monitoring surveys to measure the abundance of bottlenose dolphins using a coastal marine protected area. 17th Biennial Conference on the Biology of Marine Mammals, 29th November - 3rd December, Cape Town, South Africa.

Lynch, **S**., **Mulcahy**, **M**.**F**. and **Culloty**, **S**.**C**. (2007). Are bivalves other than *Ostrea edulis* susceptible to, or possible carriers of, *Bonamia ostreae*? Aquaculture 2007, Sustainable Aquaculture, San Antonio Texas, February 24th- March 2nd 2007.

Lynch, **S**., **Mulcahy**, **M**.**F**. and **Culloty**, **S**.**C**. (2007) Are bivalves, other than *Ostrea edulis* susceptible to or possible carriers of *Bonamia ostreae*? European Association of Fish Pathologists, 13th International Conference of Fish and Shellfish Diseases, 17th -21st September 2007 Grado, Italy.

Maloy, **A**.**P**., **S**. **C**. **Culloty**, J. Slater (2008). Use of PCR-DGGE to study the natural diet of marine bivalves. National Shellfish Association, U.S., Providence, Rhode Island, USA 6-10th April 2008.

Murphy S., S. P. Northridge, Y. Morizur, L. Mirimin, A. Viricel, P. D. Jepson, R.Deaville, R. J. Reid, **E. Rogan**, M. Silva, M. Ferreira, A. López, G. J. Pierce, V. Ridoux, & W. Dabin (2007) Conservation status

of the common dolphin *D. delphis* in the Northeast Atlantic and implications for future management plans 17th Biennial Conference on the Biology of Marine Mammals, 29th November - 3rd December, Cape Town, South Africa.

Murphy, **S**., G.J. Pierce, R. J. Law, M.B. Santos, J.A. Learmonth, M. Addink, W. Dabin, **E. Rogan**, P.D. Jepson, R. Deaville, A.F. Zuur, P. Bustamante, F. Caurant, V. Lahaye, V. Ridoux, B.N. Zegers, A. Mets, C. Smeenk, T. Jauniaux, A. López, J.M. Alonso Farré, A.F. González, A. Guerra, M. García-Hartmann, S. P. Northridge, R.J. Reid, C. Lockyer, J.P. Boon. Assessing the effect of contaminants on reproductive success in small cetaceans in the eastern North Atlantic. ICES/NAFO/NAMMCO symposium "The role of marine mammals in the Ecosystem", 29 September - 1 October 2008**,** Dartmouth, Canada.

Posters

Cronin, M. A., Zuur, A., F, McConnell, B.J., **Rogan**, **E.** (2007). Is it the moon? Factors influencing the haul-out behaviour of harbour seals in southwest Ireland. 17th Biennial Conference on the Biology of Marine Mammals, 29th November - 3rd December, Cape Town, South Africa..

Coughlin, **J.**, **Dillane**, **E**., **McGinnity**, **P**. and **Cross**, **T**.**F**. (2008). Mixed stock analysis of Irish salmon (Three posters). SALMAN 2 – Atlantic Salmon microsatellite analysis network. Paris, February.

Kavanagh, **A**., Cronin, M., **Rogan**, **E**., 2007 Determination of the diet of the harbour seal (*Phoca vitulina vitulina*) in Ireland. 17th Biennial Conference on the Biology of Marine Mammals, 29th November - 3rd December, Cape Town, South Africa.

Lynch, **S**., **Mulcahy**, **M**.**F**. and **Culloty**, **S**.**C**. (2007). An evaluation of diagnostics for *B. ostreae*. European Association of Fish Pathologists, 13th International Conference of Fish and Shellfish Diseases, 17th -21st September 2007 Grado, Italy.

Conference Organisation

Cross, **T**.**F**. Agricultural Biotechnology International Conference (ABIC). Chaired animal genetics session. UCC, September

AFDC

Website: http://www.ucc.ie/en/DepartmentsCentresandUnits/AquacultureFisheriesDevelopmentCentre/

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