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Contact:

*Aquaculture & Fisheries Development Centre
School of Biological, Earth & Environmental
Sciences,*

*The Cooperage
Distillery Fields
North Mall
Cork*

<http://afdc.ucc.ie>

*Director: Dr Sarah Culloty:
Tel: + 353 21 490 4646
Email: s.culloty@ucc.ie*

*Manager: Dr Maria O'Mahoney:
Tel: + 353 21 4904541
Email: m.omahoney@ucc.ie
Fax: + 353 21 4904664*

WELCOME

Welcome to the Autumn-Winter edition of *AFDC News*. The AFDC is now affiliated with the newly established School of Biological, Earth & Environmental Sciences, UCC of which Prof. John O'Halloran is Head. We hope you enjoy the current issue and look forward to your future contributions.

Investigating the pathological & physiological effects of jellyfish on Atlantic Salmon

Ms Emily Baxter

During the marine stage of production, salmonid fish are vulnerable to waterborne irritants, parasites and environmental fluctuations. A poorly understood, though seemingly rising problem in all regions where Atlantic salmon and sea trout are cultivated is that of gill disorders. Gill disorders (physical damage to the gill rakers and filaments or parasitic/bacterial infection of the gills) are thought to be multifactorial often thought to be caused by a primary insult from agents such as phytoplankton and zooplankton (jellyfish) with secondary bacterial infections exacerbating issues. Other gill disorders include proliferative gill disease and amoebic gill disease. Over the last decade a spate of gill disorders termed 'summer syndrome' have caused serious mortalities in marine-farmed salmon in Ireland. The syndrome which often occurs late in the summer, with symptoms typically including burn marks to the gill rakers and flanks of the fish as well as damage to the gill filaments has affected many Irish salmon farms. During the period 2003-2005 the Irish salmonid aquaculture industry suffered average mortalities of 12% due to gill disorders (ranging from 1-79%), emerging as one of the most serious causes of mortality across the farms.



The experimental set-up in the AFDC facility

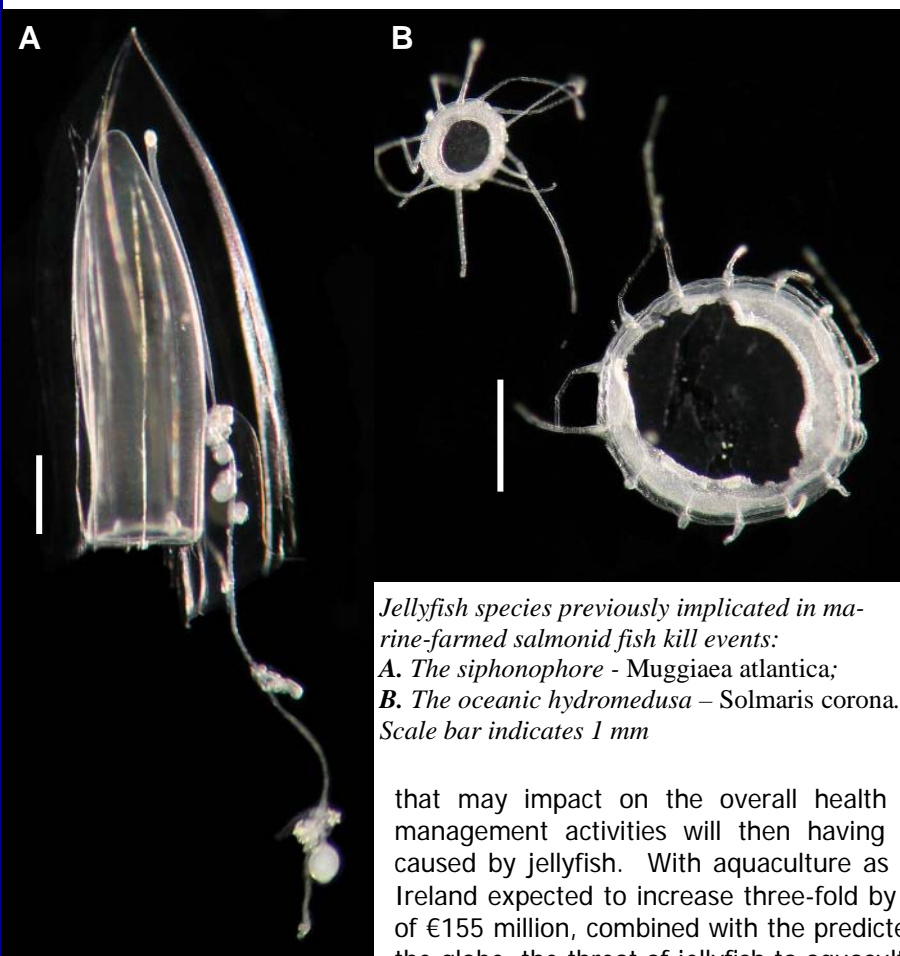
Harmful jellyfish blooms have been linked to a number of mass mortality events across Ireland, Scotland and Norway over recent decades. However, due to insufficient data on the jellyfish communities around aquaculture sites it is often more difficult to identify them as the causative agents of gill disorders. Small hydrozoan jellyfish (hydromedusae, siphonophores and even the hydroid stages of some medusae) are thought to be one of the major threats, with their size allowing them to drift through the aquaculture cages and be inhaled by the fish. They can cause direct damage to the gills through the effects of their nematocysts and toxins. Large scyphozoan jellyfish may also pose a problem when they get washed up against the cages by currents allowing their long, fine, thread-like tentacles to penetrate through the mesh or break off. They may also be broken up into small pieces by rough weather and then manage to get through the mesh much like the smaller jellyfish species. Previously implicated species include the siphonophores *Muggiaea atlantica* and *Apolectia uvularia*, the hydromedusae *Phialella quadrata* and *Solmaris corona* and the scyphomedusae *Pelagia noctiluca* and *Cyanea capillata*.

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Recent research has demonstrated the toxic effect of crude venoms from the scyphozoans *Aurelia aurita* and *Cyanea capillata* on gill cell culture of the Rainbow trout (*Oncorhynchus mykiss*), indicating an 85% loss of gill cell viability in some cases. It is often hard to identify the causative agents of gill disorders from gill samples taken in the field due to many contributing variables, therefore an investigation into gill disorders as a whole was initiated.

The GILPAT project (under the Sea Change Programme), funded and lead by the Marine Institute, Ireland in collaboration with the Coastal & Marine Resources Centre and Department of Zoology, Ecology and Plant Science (both University College Cork), Vet-Aqua International, Agri-Food & Biosciences Institute and the Irish Salmon Growers Association aims to investigate the causative agents of gill disorders and improve the understanding of their aetiology and pathogenesis. The project, which commenced in 2008, has implemented the first monitoring programme for zooplankton (jellyfish), phytoplankton and other waterborne agents in relation to fish health at a number of marine Atlantic salmon farms on the west coast of Ireland.

Further to the monitoring aspect of the project, experimental challenge studies have been conducted at the facilities in the Aquaculture & Fisheries Development Centre since April of this year. The controlled experiments have involved the exposure of Atlantic salmon smolts to a range of jellyfish challenge species harvested from the marine environment. The experiments have helped to identify the aetiology and progression of gill disorders



Jellyfish species previously implicated in marine-farmed salmonid fish kill events:
A. *The siphonophore - Muggiaea atlantica;*
B. *The oceanic hydromedusa – Solmaris corona.*
Scale bar indicates 1 mm

caused by jellyfish over time, as well as the potential for the recovery of gill tissues under favourable conditions. Each trial, which ran over the course of three weeks (using replicate control and test groups), investigated the pathology and histopathology of gill, tongue/buccal cavity and skin/muscle tissues, as well as blood physiology such as haematocrit levels in relation to stress. Environmental parameters, such as dissolved oxygen, temperature, pH, salinity and concentrations of waste products, were monitored throughout the course of each trial and the housing of the fish in the re-circulation system. The results of the challenge trials, which were successfully completed by mid-September, will greatly aid the diagnosis of gill disorders caused by jellyfish as well as identifying issues relating to certain farm management practices that may impact on the overall health status of salmonid farms. Advice on management activities will then have the potential to mitigate gill disorders caused by jellyfish. With aquaculture as a whole on the rise and the industry in Ireland expected to increase three-fold by 2015 (from 2004 production) to a value of €155 million, combined with the predicted increase in jellyfish populations across the globe, the threat of jellyfish to aquaculture has never been more prominent.

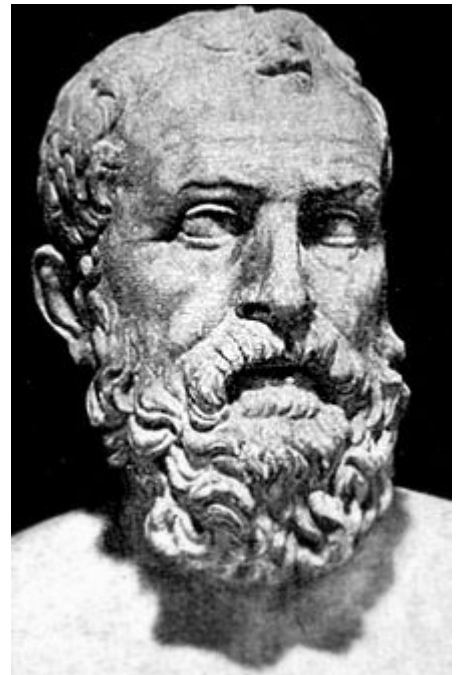
Please note that all procedures were approved by the University College Cork Animal Experimentation Ethics Committee (Review 2009/ #41) and conducted under the Cruelty to Animals Act, 1876 (as amended by European Communities Regulations 2002 and 2005), licence number B100/4280.

Emily Baxter is a PhD student working with Dr Tom Doyle (CMRC, UCC), Dr Rob McAllen (ZEPS/BEES, UCC), Dr Neil Ruane (Project manager, Marine Institute) & Dr Hamish Rodger (Vet-aqua International).



Taking samples from Atlantic salmon for: A. histopathology; & B. blood physiology

Fishers seem to be stuck in the 'Tragedy of the Commons': while they could jointly harvest at a rate that maximises sustainable economic returns to all, they experience incentives that lead to overfishing. Phrased differently, if individual fishers agree to limit their catch today in the expectation of continued future catches, they can never be sure that the catch they have just given up will not be immediately snapped up by competing fishers. Standard economic theory predicts that in such social dilemmas individuals are not willing to cooperate and sacrifice catches in the short term, and that, consequently, the resource is overharvested. However, over the last decade, a multitude of research has shown that humans often achieve outcomes that are "better than rational" by building conditions where reciprocity, reputation, and trust help to overcome the temptations of short-term self-interest. The evolution of the natural human tendency to cooperate under certain conditions can be explained, and its neurophysiological and genetic bases are being unravelled. Nevertheless, fisheries management still often deploys top-down regulation and economic incentives in its aim to regulate fisher behaviour, and under-utilizes the potential for spontaneous responsible fisher behaviour through setting conditions that enhance natural cooperative tendencies. Sarah Kraak recently published a paper introducing this body of knowledge on how to overcome the Tragedy of the Commons to the audience of fisheries scientists, hoping to open up novel ways of thinking in this field. In the article she describes a series of thought experiments, based on actual published experiments, exploring under what conditions responsible and cooperative fisher behaviour can be expected. Keys include reputation-building and indirect reciprocity, face-to-face communication, knowledge on the state of the resource, and self-decision on rules and sanctions. Sarah presented her paper at the 2010 ICES ASC in Nantes in September 2010, where she illustrated the Tragedy of the Commons with an experiment among volunteers in the audience involving real monetary gains.



Solon (Athenian statesman and lawmaker, c. 638 BC–558 BC), drawing up his laws, was laughed at for supposing that his countrymen's greed could be kept within bounds by means of laws. He replied that he was framing his laws in such a way as to make it clear that it would be to everybody's advantage to keep rather than to break them.

Dr Sarah Kraak is a ZEPS/AFDC post-doctoral researcher currently based at the Marine Institute, Co. Galway.

Reference:

Kraak, S. B. M. 2010. Exploring the 'Public Goods Game' model to overcome the Tragedy of the Commons in fisheries management. *Fish and Fisheries*, 11, 119-132.



Pilot Marine Mammal Observer Programme in Irish Pelagic Trawl & Gillnet Fisheries

Dr Alison McCarthy

In accordance with Articles 4 and 5 of EC Regulation 812/2004 of 26/04/2004, there is a requirement for Member States to implement monitoring schemes for incidental catches of cetaceans, using

observers, for certain defined fisheries. Such independent observations of fishing activities are essential to provide reliable estimates of the incidental catches of cetaceans, and to extrapolate the by-catch observed to the whole fishery concerned. To meet Ireland's requirements to the Directive, we are providing observer coverage on Irish pelagic trawl and gillnet fisheries, primarily in ICES sub areas VI and VII. The current, and initial, phase of the project aims to have 10% observer coverage of the Albacore tuna pair pelagic trawl fishery. From December 2010 to March 2011 we will provide coverage on single and pair pelagic trawl fisheries for Mackerel, Herring, Horse Mackerel, and Blue Whiting. In addition, there

will be some coverage of gillnet and tanglenet fisheries.

In order to maximise the overall value of the programme, observers will carry out a number of tasks aboard fishing vessels. These include biological sampling, where possible, of cetaceans for life-history characteristics and diet studies. The incidental catch of Endangered Threatened and Protected (ETP) species, such as sharks, seabirds and turtles will also be monitored. Observers will also carry out constant effort watches for cetaceans, in order to contribute to the mapping of the distribution and relative abundance of cetaceans in Irish waters.

Dr Alison McCarthy is Project Manager & Dr Emer Rogan is the Principal Investigator on the Marine Mammal Observer Programme



Postdoc in Profile: Dr Sharon Lynch

Dr Sharon Lynch is the postdoctoral researcher involved in several collaborative shellfish projects, **SUSFISH** (Shellfish productivity in the Irish Sea: working towards a sustainable future) funded under the ERDF INTERREG 4A Ireland-Wales programme, **OYSTERCOVER** (Establishing the scientific bases and technical procedures and standards to recover the European flat oyster production through strategies to tackle the main constraint, bonamiosis) and **NeuroNano** (Do nanoparticles induce neurodegenerative diseases? Understanding the origin of reactive oxidative species and protein aggregation and mis-folding phenomena in the presence of nanoparticles). Dr Lynch is part of the shellfish health and immunology research team headed by Dr Sarah Culloty. Several PhD students, Emer Morgan, Grace Flannery and Maud Cross, are involved in these projects.

In SUSFISH, looking at the effect of climate change on aquaculture in the Irish Sea, Dr Lynch is investigating the role of oyster herpes virus (OHV) in summer mortalities observed in the Pacific oyster, *Crassostrea gigas*, in the Irish Sea, initially be developing a more sensitive polymerase chain reaction (PCR) method to screen for the virus in Ireland. The European flat oyster, *Ostrea edulis* and *C. gigas* are being screened for haplosporidians, parasites which are the major causes of disease in these species. Historical samples of *C. gigas* are being screened, from the shellfish health unit archive, to determine if *B. ostreae* can be detected in this oyster species and if it may have played a role as a carrier for *B. ostreae* in the past. This is a continuation of the work carried out in a previous project (Lynch et

al., 2006, 2007, 2010). Dr Lynch is investigating the population genetics of *B. ostreae*. A comparison is being carried out between *B. ostreae* populations based on geographical distribution within Ireland and worldwide, carrier/reservoir species and archival material.



In the EU FP7 support for SME's project, OYSTERCOVER, procedures and standards that will allow the recovery of *O. edulis* production and markets are being developed. The objectives of this project are (i) to validate diagnostic techniques currently used in the screening for *B. ostreae*, (ii) to determine if other invertebrates are involved in the life cycle of this haplosporidian, (iii) to investigate if vertical transmission of this pathogen occurs, (iv) to investigate the population genetics of *O. edulis* to determine if certain oyster stocks are more resistant to *B. ostreae* and can be used in future selective breeding programmes and (v) to investigate immune response of *O. edulis* to exposure to *B. ostreae*.

In NeuroNano, the routes of intake of several engineered nanoparticles in the blue mussel, *Mytilus edulis* are being assessed. An assessment of the time course of uptake, uptake destination (target organs) and the importance of mussels in transferring nanoparticle-laden material to the benthos will be determined. The significance of mussel depuration and the interaction with deposit feeders such as the ragworm, *Nereis diversicolor*, will be assessed. The possibility that vertical transmission of engineered nanoparticles, between mussel generations, can occur will also be investigated.

UCC Visit to Shanghai Ocean University – 8th September 2010

Prof. Gavin Burnell & Dr Jeremy Gault

Prof Zhou Ying Qi, former President of Ocean University, hosted a meeting for Gavin Burnell (Professor ZEPS, AFDC), Jeremy Gault (Director, CMRC) and Wu Ying (Senior Post-doctoral researcher, CMRC) at the Shanghai Ocean Campus in Lingang New City. The meeting was set up by Prof Cheng Yongxu, Department of Aquatic Animal Nutrition and was attended by Professor Zhong Junsheng (Vice Director, President's Office), Dr Li Jiale (Vice-Dean, College of Aquaculture and Life Science) and by Associate Professors Dr Jin-Long Yang and Tand Jianye from the Departments of Marine Biology and Marine Policy and Law respectively. The meetings throughout the day were facilitated by Yvonne Wang from the Foreign Affairs Office of Ocean University.

After an initial tour of the faculty of aquaculture was given by Prof Cheng, presentations were delivered by Gavin Burnell and Jeremy Gault to the assembled staff of Ocean University. These covered background on UCC and its recent history of co-operation with Chinese

Institutions and an overview of the College of Science, Engineering and Food Science and the Environmental Research Institute and concluded with details of the research conducted by the Aquaculture and Fisheries Development Centre and Coastal & Marine Resources Centre. In subsequent conversation with Prof Zhou and the assembled staff it became evident that there were definite synergies between the two Universities especially in the fields of aquaculture, integrated coastal management and Geographical Information Systems (GIS).

These opportunities for co-operation were investigated further at a subsequent meeting that evening hosted by the current President of Shanghai Ocean University, Prof Pan Ying Jie, held over dinner at *Yun's*, a prestigious restaurant in Shanghai. During this meeting the mechanism for exchange of staff and students were discussed and it became apparent that President Pan was extremely interested in co-operation with UCC. Given that Gavin Burnell is already scheduled to deliver a lecture series to aquaculture students at Ocean University in Spring 2011

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UCC Trip to Shanghai

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...and the enthusiasm displayed by President Pan for international co-operation, it would appear that Ocean University are keen to discuss formally arrangements for links with UCC. Therefore it was agreed that UCC would make formal contact with the Shanghai Ocean University to discuss how to move this process forward over the coming weeks and Gavin

Burnell and Jeremy Gault agreed to facilitate this where appropriate.

Prof. Burnell presents a gift of appreciation to Prof. Pan, President Ocean University



Seafood CRC Visiting Expert: Prof. Gavin Burnell was invited to Australia during Summer 2010 on a visiting scientist bursary by the Australian Seafood Cooperative Research Centre



Report by Dr Geoff Allan, Industry & Investment, NSW

Background

The mission of the Australian Seafood Cooperative Research Centre is to assist end-users of its research to profitably deliver safe, high-quality, nutritious Australian seafood products to premium markets, domestically and overseas. The Seafood CRC project, Aquaculture Innovation Hub, is designed to increase communication and collaboration among industry and research participants, exchange successful technology and increase training among hatchery operators, identify priorities for training and extension, and develop and manage collaborative projects. One of the planned activities is to investigate the potential for new communication technologies to assist with planning and communication.

Prof. Gavin Burnell was instrumental in establishing the AQUATT network (www.aquatt.ie) established initially to systematise, coordinate and develop the training requirements of the European aquaculture industry but also now actively involved in coordinating technology transfer and information dissemination throughout Europe. Gavin remains involved with AQUATT as a member of its Board.

In addition, he is an expert on mollusc aquaculture, particularly interactions with the environment. This is a key area of challenge to oyster farmers, particularly in parts of Tasmania and the northern rivers in NSW.

Purpose of visit to Australia

During the visit, Prof. Burnell consulted with research providers and industry end users and discussed current best practice in dissemination of information. A European model of knowledge management (AQUATT) was presented in a series of meeting and workshops.

This Visiting Scientist Bursary allowed him to visit a representative cross section of CRC members and advise on how other models for communication among aquaculture stakeholders have been successfully developed.

Prof. Burnell also visited a number of oyster farmers in Tasmania, South Australia and NSW. He was

particularly interested in how various sections of the industry responded to environmental challenges and in the development of environmentally-sensitive farming methods.

Prof. Burnell is in the process of completing his report on his visit. He will evaluate existing practices and advise if there are relevant lessons from AQUATT that might benefit the Australian seafood sector.

Benefits from visit

The visit delivered a number of immediate benefits to Seafood CRC participants and there are likely to be further benefits following consideration of recommendations that will arise from Prof. Burnell's report:

- The first immediate benefit was facilitation of a structured discussion on communication and methods of communication. It is very clear that effective communication is a significant challenge within the Seafood CRC, and that this challenge is similar to that experienced with comparable, large, multi-partner collaborations in Europe. For the Seafood CRC, specific issues/challenges with communication have reduced effectiveness of research, impacted on timely initiation of research programs and impeded adoption of research outputs. There are specific communication difficulties within the companies of some industry participants and between individuals from some industry participants and collaborating research agencies. This situation is common for a large, multi-partner collaboration.
- There are significant parallels with challenges experienced by the Seafood CRC and with the establishment of large research projects in the EU. Over the last few years, the organisation AQUATT has been used to help manage communication, to help interpret stakeholder research priorities and prepare project applications and to disseminate results to stakeholders. A better understanding of AQUATT should assist the Seafood CRC to address some of the ongoing communication challenges.
- It was clear from workshop discussions that one of the common features of "successful" communication was ensuring the method of communication (e.g. face-to-face, phone, email, etc) was appropriate for the all parties and for the type of message. With the massive increase in information from all sources, making sure a message is heard by the intended recipients is a challenge. Some recommendations on how to improve message delivery were presented.



Using Nature and Nurture to Restore the Valentia Harbour

Scallop Population

Dr Maria O'Mahoney & Prof. Gavin Burnell

Towards the end of 2009, Prof. Gavin Burnell, of the Aquaculture & Fisheries Development Centre, became involved in the Valentia Harbour Scallop Project as a marine biology expert and scientific advisor. Valentia Harbour has been the site of a valuable King Scallop (*Pecten maximus*) fishery since the nineteenth century. Increased mechanisation of the fishery since the 1930's resulted in a higher catch per unit effort for this fishery with vessels capable of catching "150 dozen fish per day". Such high catch rates were unsustainable and ultimately led to the collapse of the fishery. This was reflected in consistently poor catch statistics in the 1970's and 1980's.

Attempts to regenerate this fishery since 1991 have included a variety of measures such as restocking programmes, technical conservation measures, scallop stock assessments and the development of hydro-advection models to identify patterns of larval dispersal within the harbour and surrounding locations. However, each strategy, when implemented as a sole regeneration measure, has been ineffective. It has become increasingly clear that several, simultaneously implemented approaches may be necessary to regenerate this fishery. The current "ecosystem approach" by using local broodstock and "going with the flow" of the bay, will try to build a sustainable fishery based upon the carrying capacity of the harbour and in

sympathy with other local stakeholders. It involves a collaborative research project between the Valentia Harbour Fishery Society, three national research centres; The Daithi O Murchu Marine Research Centre (DOMMRC), The Aquaculture and Fisheries Development Centre (UCC), NUI, Galway and Bord Iascaigh Mhara (BIM).

DOMMRC have taken scallop broodstock from Valentia Harbour and successfully spawned them in their Bantry facility. Some of the resulting D-larvae were released in Valentia harbour and their subsequent movement was tracked over several hours to enable validation of the hydro-advection model. Several thousand larvae were also reared to settlement on plastic mesh and then taken for early nursery culture in Crookhaven, Co. Cork. These will be transferred to Valentia Harbour once they are large enough to be placed into protected trays on the seabed for intermediate culture. After about 18 months they will then be released directly onto the seabed to become future broodstock for the fishery. The tracking and modelling of the larval releases has been achieved through bursaries awarded to Tara Griffin and Fearghal O'Donncha under the Beaufort Marine Research Award (An Ecosystem Approach to Fisheries Management). The data generated will be used to modify and fine-tune a hydro-advection model under the supervision of Professor Michael Hartnett of NUI Galway. Eventually this model will inform management of the scallop fishery by allowing the cooperative members to quantify the risks and to place the broodstock in a site that optimises larval retention and therefore improves settlement on artificial collectors.

New Appointments



Dr Susie Brown, a marine biologist, joined the AFDC in July 2010 to work on the Beaufort Marine Research Award "An ecosystem approach to fisheries management". Her research covers two key elements: firstly, an ecological risk assessment framework for the effects of fishing at fishery and area level, and secondly, an examination of the interaction between cetaceans and fisheries modelling spatial and temporal overlap of cetaceans and fisheries and developing plans to mitigate cetacean bycatch.



Dr Alison McCarthy, a marine biologist, joined the AFDC in July 2010 as Project Manager of the pilot marine mammal observer programme in Irish pelagic trawl and gillnet fisheries (with Dr Emer Rogan, AFDC & BEES). This project will implement Articles 4 and 5 of EC Regulation 812/2004, requiring Ireland to monitor incidental catches of cetaceans on various fisheries, such as for Albacore tuna.



Ms Grace Flannery, joined the AFDC as a PhD student with the EU FP7-funded, OYSTERCOVER project. This collaborative research project involves 7 research institutes and aims to establish the scientific bases and technical procedures and standards to recover the European flat oyster production through strategies to tackle the main constraint, Bonamiosis. Grace will be supervised by Dr Sarah Culloty, Prof. Tom Cross, Dr Jens Carlsson & Dr Sharon Lynch.