International Conference on Shellfish Restoration 2011

Shellfish Our Undervalued Resource

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Front cover: Native oyster on West coast of Scotland
Photo by Liz Ashton

Your local team

Clockwise from top left, Janet Brown, Liz Ashton, Melanie Cruickshank and Anda Kirkpatrick

About our sponsors

The organisers are immensely grateful for the sponsorship given by The Crown Estate, Marine Scotland, MASTS, SNH, Seafish, SEPA, The Fishmongers' Company, SARF and Stirling Council. Since these names may mean nothing to visitors from overseas some information on each of the sponsors will be provided in all the gaps in this programme.

Main Contents

Agenda at a glance

Tuesday 23 August 2011	
Throughout day	Golf or fishing can be organised
15.00-18.00	Arrival and Registration
18.30 –19.30	Whisky tasting provided by WoodWinters-£10pp-optional
19.30	Dinner served at the Abbey Craig Restaurant (for extra guests or those in chalet accommodation the cost for dinner is £24.00)
Wednesday 24 August 2011	
07.30 to 09.00	Registration
09.00 to 09.10	Opening Ceremony
9.10 to 10.30	**Theme 1: Evaluation of the habitat of restored and enhanced shellfish reefs**.
10.30 to 10.50	Coffee
10.50 to 12.30	Theme 1 continued
12.10 to 14.00	Lunch at the Abbey Craig Restaurant
14.00 to 15.40	**Theme 2: Evaluation of ecosystem engineers in ecosystem restoration**.
15.40 to 16.00	Tea
16.00 to 17.20	Theme 2 continued
18.00 to 19.00	Welcome drinks reception at Crush Hall, Pathfoot Building with Provost of Stirling.
19.30	Dinner served at the Abbey Craig Restaurant (NB Reserve a place for £24 if not already booked through conference at MC, or at ACD and AS Halls)
Thursday 25 August 2011	
07.30 to 09.00	Registration
9.00 to 10.40	**Theme 3: Restoration and Management of mobile shellfish**
10.40 to 11.00	Coffee
11.00 to 12.40	Theme 3 continued
12.40 to 14.00	Lunch at the Abbey Craig Restaurant
13.45	Field trip by coach and boat on the Firth of Forth. Or free to explore sites of Stirling
19.30	Dinner served at the Abbey Craig Restaurant
21.00 2nd coach leaves 17.15	Optional excursion into Edinburgh for the Military Tattoo provided bookings (£40 per person are made) (limited numbers). Free coach will leave straight from Boat Trip and return after event.
Friday 26 August 2011	
07.30 to 09.00	Registration
09.00 to 10.40	**Theme 4: All about oysters**
10.40 to 11.00	Coffee
11.00 to 12.20	Theme 4 continued
12.20 to 14.00	Lunch at the Abbey Craig Restaurant
14.00 to 15.40	Theme 4 continued
15.40 to 16.00	Tea
16.00 to 17.20	Theme 4 continued
19.00	Scottish gala conference dinner and ceilidh
Saturday 27 August 2011	
10.00	Check out

The Story of ICSR 2011

Janet Brown on how its conception came about.....

Janet H Brown has a long established interest in shellfish having done her PhD on lobsters and after a business venture with brine shrimp she worked in Indonesia for 4 years developing shrimp aquaculture and marine biology in the University of Diponegoro, Semarang. She came to the Institute of Aquaculture, University of Stirling 27 years ago to establish work on tropical shrimp and prawns and in recent years has worked more with the Scottish shellfish industry, particularly in her capacity as Editor of The Grower, the newsletter of the Association of Scottish Shellfish Growers. Her work has covered a wide range in all aspects of shellfish, both crustaceans and molluscs and in recent years she has become more involved with problems of shellfish movement and in native oyster restoration. In April she was made redundant along with 16 other colleagues at the Institute which made her choice of this title for the conference oddly prescient!

If you are glad at the end of this week to have come to ICSR in Scotland first of all you should thank Visit Scotland, proud suppliers of the basic folder of the conference materials. Visit Scotland host an Ambassador Programme in which they invite academics to rather fine social events held in nice places, such as Argyll's lodgings, Dunblane Hydro, or even the Stirling Management Centre. At some point in the evening they ask the academics enjoying their hospitality "Are you planning a conference?" Attending several of these events I practised the response, "Oh yes, I may host an International shellfish conference any day now....." until I began to believe my own story!

So the ground work in preparing for help from Visit Scotland was already in place when last year I decided to bite the bullet and pitched for the next ICSR to be held in Stirling at last year's meeting in Charleston.

The theme for the conference was not finalised at that point however. First plans on oyster restoration in the Firth of Forth were mooted by Paul Shave in The Grower some years ago now. I then wrote a proposal for funding from an organisation that had been embarrassed by a sewage spill in the Firth. Subsequently SNH, The Crown Estate, SARF, and Stirling University funded a study for a pilot oyster restoration project for Scotland and I worked on this with Dr Liz Ashton and David Scott.

Liz Ashton's recent find of the 2 live oysters in the Firth of Forth attracted a lot of publicity but also serves to highlight to visitors from overseas that when we are looking at "restoration" it can be on an altogether different scale - in other parts of the World people are working to re-establish commercial levels of shellfish – we are working to "restore"!

It was in the course of this work we realised than normal "restoration" where large numbers of spat are introduced to an area mitigates against the natural reef building propensities of native oysters, a characteristic so long absent from the intensively "managed" UK stocks that it remains a subject of controversy here. This, again, a fact possibly surprising to visitors from overseas. The reef forming and its potential benefits became the main thrust of a major project written by Liz and myself forming a consortium with other universities; many of these partners are here at the conference this week, Delphine Lallias and Jonathan King from Bangor University, Chris Hauton and Antony Jensen from Southampton University and Dai Roberts from Queen's University Belfast. Unfortunately this project still has to find funding and this failure is probably the main force behind the decision to pitch for this conference.

If people do not appreciate the importance of shellfish and reefs what can we do to highlight this? Obviously hold a conference called "Shellfish Our Undervalued Resource" and get top speakers to come and prove the value of shellfish.

Hence Melanie Austen will talk on how to actually value all the attributes and functions of shellfish, Luca van Duren will emphasise the ecosystem engineer functions of shellfish, Robert Rheault will talk about the role of the shellfish farmer in providing some of these same benefits that can be provided by wild populations (and take the pressure off wild stocks anyway) while on Friday the emphasis will be directly on oysters with Mark Spalding talking about oyster reefs and their restoration and Sarah Culloty will talk about some of the disease issues that plague all oysters. Any restoration work has great difficulties in getting funding as we have already proved time and time again so the planning included ending the conference with Gef Flimlin who can give everyone some guidance on how to generate the community support and effort that is essential for success in this area.

We couldn't expect people to travel so far just for talk so we hope our discussions can be helped along by the social activities, the civic reception on the first night, the pre-conference whisky tasting, the field trip on the Firth of Forth, the optional trip to the Edinburgh Military Tattoo and for the grand finale, a true Scottish dinner and ceilidh including ceremonial piping in of the haggis.....

Welcome to all of you – but please remember – it is all for the sake of improving shellfish populations and the benefits they can provide!

Important Conference Information

Registration Information

To participate in any aspect of the conference, you must be registered. Badges are required for all technical and social events. The registration centre is located in the conference room lobby of the Management Centre on Tuesday afternoon from 3 to 6 pm and on Wednesday, Thursday and Friday morning.

Message Centre

A message board and general information centre will be maintained at the ICSR Registration desk. Messages can be displayed on the board near the registration desk. Taxi shares for return to departure points at the end of the conference can also be arranged by this means.

Oral Presentations

Twenty minutes are allotted for a contributed paper, including discussion and change over time between speakers. Session moderators will adhere strictly to these time limitations. Projection equipment available will include PowerPoint projectors and screen. Speakers should provide PowerPoint presentation on a memory stick or CD at registration to Dr Liz Ashton. Projection equipment will be available for try outs in one of the 2 amenity rooms available as part of the conference.

Poster Presentations

Each poster presenter will be provided with a blue baize board 1m high by 1.5 m wide. Posters should be set up on Tuesday 22nd August from 3pm to 6pm in the Silver Glen Room. Poster authors should be present during the tea and coffee breaks. There is also an opportunity for poster presenters to give a talk of up to 2 minutes in length to "sell" their poster and to encourage delegates to come and see their poster. (To whet their curiosity rather than to tell everything that is in the poster!) Posters should be removed Friday evening.

Conference Facilities

The main conference hall will be the Blair Atholl room and the tea and coffee will be served during the scheduled breaks in the Silver Glen room alongside. Additionally we have exclusive use of 2 amenity rooms, the Fintry Erskine room and the Dollar Callendar room. One will be set up for computer use, the other can be used for meetings and can be booked at the registration desk.

Right the conservatory, Management Centre

Technical Programme

Aims and Themes

The overall aim of the conference is to highlight the wider value of shellfish in the environment and we have sought papers that reflect this greater value of shellfish resources and their ecosystem services.
Conference sessions will focus on the following four programme theme areas;

Theme 1: Evaluation of the habitat of restored and enhanced (artificial or man-made) shellfish reefs.

One of the principal ecosystem services supported by dense assemblages of shellfish is the provision of habitat that provides food, nursery and shelter. As such the abundance and diversity of organisms associated with these structurally-complex habitats often exceeds that of surrounding soft sediment habitats. Comparisons of associated fauna can therefore be used as a metric of the success and value of restored and enhanced shellfish habitats. Such studies that include the evaluation of these fauna and reef types will be presented here.

Theme 2: Evaluation of ecosystem engineers in ecosystem restoration.

This session will focus on the physical aspects of shellfish restoration in terms of shoreline protection, altered hydrodynamics, increased sedimentation and improvements in water quality. Shellfish restoration, enhancement and management in this session will include a number of different species of bivalves.

Theme 3: Restoration and management of mobile shellfish.

This session will focus on the more mobile shellfish such as crabs, lobsters, scallops and shrimp. However, papers will also be accepted for echinoderms and gastropod molluscs.

Theme 4: Focus workshop on oyster restoration in Europe – what can we learn from the USA experience?

The oyster workshop will take a broad view including possible interactions between *Crassostrea gigas* and *Ostrea edulis* (or their equivalents), the value of community actions, and disease risks but will cover some of the benefits and pitfalls from the US experience.

Keynote Speakers' Abstracts and Biographies

Mel Austen

Plymouth Marine Laboratory/Marine Management Organisation, Prospect Place, Plymouth PL1 3DH, UK

Ecosystem services – adding value to shellfish resources

The diversity of organisms in marine habitats provides a wide range of ecosystem services and benefits that are essential for the maintenance of the social and economic wellbeing of our society. The benefits, which are of significant value, include food (fish, shellfish); reduction of climate stress (carbon/biogas regulation); genetic resources; biotic inputs to develop blue biotechnology; fertiliser; coastal protection; waste detoxification and removal; disease and pest control; tourism, leisure and recreation opportunities; a focus for engagement with the natural environment; physical and mental health benefits; and cultural heritage and learning experiences.

Some of these services are supplied directly from natural and cultured shellfish populations, either intentionally (food) or as a by-product. Delivery of services could be enhanced through management of shellfish resources. This provides added direct and indirect value to the shellfish that can be measured in both market and non-market metrics.

To achieve added value it is important to consider tradeoffs both between different services and with services provided by other marine habitats that might be affected by shellfish management. Methods to quantify and value ecosystem services are developing. They will improve understanding of the trade-offs in managing different and sometimes conflicting activities in the marine environment.

Biography

Dr Melanie Austen is Head of Science at Plymouth Marine Laboratory leading the Sea and Society area of science and its broad spectrum of interdisciplinary research projects from the socio-economics of marine ecosystems and their services through to environment and human health, and marine biodiscovery. She is also Chief Scientific Advisor to the Marine Management Organisation. She is a marine ecologist leading interdisciplinary research that integrates marine biodiversity, ecosystem functioning, ecosystem modelling, ecosystem services, and environmental economics. She is currently coordinating an EU project: Vectors of Change in Oceans and Seas Marine Life, Impact on Economic Sectors (VECTORS). Over the last 10 years she has developed and led novel collaborative marine research, in EU and UK funded projects, which directly interfaces marine ecology with environmental economics to support management for sustainable ecosystems (e.g. EU COST-IMPACT - Costing the Impact of Demersal Fishing on Marine Ecosystem Processes and Biodiversity; MARBEF - Marine Biodiversity and Ecosystem Functioning, an EU funded Network of Excellence; EMPAFISH - European Marine Protected Areas as tools for Fisheries management and conservation; NERC Oceans 2025; Marine Aggregates Levy Fund, etc.)

Mel Austen is on the Expert Panel of the UK's National Ecosystem Assessment and was coordinating lead author of its Marine Habitat Chapter.

Mel was originally a benthic ecologist and her research interests include: links between marine biodiversity, ecosystem function and ecosystem services and benefits and their monetary and non-monetary values; natural and human impacts on marine ecosystems and their provision of marine ecosystem goods and services; benthic-pelagic coupling; field and experimental benthic ecology in coastal habitats, nematode taxonomy using traditional, molecular and computer-based techniques.

Luca Van Duren

Deltares, PO Box 177, 2600 MH Delft, The Netherlands

Shellfish as ecosystem engineers: small-scale processes and large-scale consequences

Ecosystem engineers are organisms that directly or indirectly control the availability of resources to other organisms by causing physical changes in biotic or abiotic materials. We can differentiate between two types of ecosystem engineering functions: either the biogenic structures themselves form part of the habitat for other species (i.e. provide shelter or create attachment surface area), or the species alter the abiotic environment and thereby change the suitability of the habitat for other species (i.e. changes sediment dynamics or nutrient dynamics). Nearly all shellfish are known to be ecosystem engineers to some extent, but the ability to influence habitats, i.e. their ecosystem engineering capacity, is species specific.

For shellfish, we can make a distinction between epibenthic and endobenthic species. Epibenthic species such as mussels and oysters transform soft sediment into a complex 3-dimensional reef structure with a hard surface. These reef structures are substrate to totally different species communities than soft sediment substrate. Endobenthic species tend to change the soil composition, sediment mixing and the penetration of oxygen into the sediment, but do not form themselves structures that can be inhabited by other species.

Nearly all shellfish have some effect on the near bed hydrodynamics. This is due to a combination of topographical changes in bed roughness and the effect of the exhalent jets, increasing near-bed mixing. The hard rough structures of epibenthic species have clearly much more effect than the rather subtle topographical changes caused by endobenthic species, such as cockles or razor clams (*Ensis)*. The effects of the exhalent jets depend on the individual characteristics of the jets (jet speed and diameter of the siphon) and the density of individuals per unit surface area. The changes in near-bed hydrodynamics in turn also change the local sediment dynamics.

Particularly the effects on sediment dynamics have recently gained a lot of interest from ecosystem managers that have to balance safety against flood risk and coastal erosion with conservation issues and natural values of ecosystems. In the Netherlands large-scale experiments are ongoing looking into the possibilities of using artificially created reefs of Pacific oysters to mitigate the effects of sediment starvation in the Oosterschelde.

Keynote Speakers' Abstracts and Biographies-Continued

Last but not least, the large filtration capacity of shellfish beds can have a major impact on water clarity and nutrient dynamics, i.e. the two prime factors influencing primary production. Initial model runs have indicated that paradoxically, the presence of shellfish beds can have a positive influence on carrying capacity of ecosystems for shellfish, although there is also a danger of limitation of carrying capacity by overgrazing. Better understanding of the large-scale effects of ecosystem engineers, such as shellfish, can be helpful in optimising ecosystem services.

Biography

Dr. Luca A. van Duren is a marine ecologist specialised in the interaction between biota, fluid dynamics and sediment. She received her PhD in marine Biology at the University of Groningen on the subject of low Reynolds number hydrodynamics of copepod swimming. She subsequently worked at the Netherlands Institute of Ecology in Yerseke (the Netherlands) on several projects relating to benthic boundary layer hydrodynamics and ecosystem engineering by aquatic species. In addition to several research projects, she headed a European network comprising 18 institutes with flume tanks designed for eco-hydrodynamic purposes. She subsequently worked for a brief period at the Dutch Coastal and marine Institute, a research institute of the Ministry for Transport, Waterways and Public works on various ecosystem projects. She is currently employed as a senior scientist at Deltares, working on integrative projects in coastal basins in the South-West part of the Netherlands, as well as the Wadden Sea.

Robert Rheault

East Coast Shellfish Growers Association, 1121 Mooresfield Rd., Wakefield, RI 02879 USA

Ecosystem Services Rendered by Shellfish Aquaculture

There is broad recognition of the ecosystem services rendered by natural and restored shellfish populations. These include mitigation of excess nutrients, improvements to water quality and clarity, and increases in habitat richness and diversity associated with increased vertical structure and niche complexity. From a functional ecology standpoint the ecosystem services provided by cultured shellfish are essentially indistinguishable from those provided by natural reefs.

Shellfish farmers have long maintained that their farming practices are sustainable, and that shellfish culture is one of the most environmentally benign methods of producing fresh, nutritious protein. Shellfish farming requires few inputs and consumes relatively little energy. The industry uses no chemicals, drugs or feed inputs and since shellfish feed off the base of the food chain, it is difficult to envision a form of protein production with fewer environmental impacts. Groups that weigh the relative sustainability of different seafoods typically give cultured shellfish their highest rating.

Shellfish farmers in the US are working with economists to develop models that derive a monetary value for the ecosystem services associated with their farms. The goal is to develop a system of payments for ecosystem services in the hopes that this would incentivize production increases. Growers are looking at these models as marketing tools that will help them sell their products to consumers who are increasingly environmentally conscious. Perhaps even more important, growers are hopeful that these models will help them gain a social license to establish new farms in areas where affluent waterfront homeowners might prefer that their aesthetic values were untarnished by farms.

Biography

Bob Rheault was an oyster farmer and shellfish dealer in Narragansett, RI for 26 years. A few years ago he decided he was getting too old to work on an open skiff busting ice to harvest oysters, so he sold his farm and he now serves as the Executive Director of the East Coast Shellfish Growers Association. He is a passionate advocate for the shellfish industry and he claims he is better at lobbying than he ever was at farming.

He has a Ph.D. in Biological Oceanography and is an adjunct faculty member in URI's Department of Fisheries & Aquaculture. His research interests include documenting and valuating the environmental services provided by shellfish aquaculture and using nutrient credit trading as a means to limit coastal eutrophication.

Mark Spalding

Rediscovering baselines and rebuilding reefs – understanding the challenges of ecosystem-scale restoration in North America

Mark **Spalding**[1,2] Philine zu Ermgassen[2], Robert Brumbaugh[1], Boze Hancock[1], Michael Beck[1]

[1] Global Marine Team, The Nature Conservancy

[2] Conservation Science Group, Department of Zoology, University of Cambridge

Oyster reef declines in North America began later than in Europe, but were nonetheless precipitous, leading to the virtual extirpation of reef habitats in large parts of the Atlantic and Pacific coastlines. In stark contrast to Europe however, there have been massive recent efforts to restore natural oyster reefs across the USA, from federal projects to local initiatives. A primary driver behind many of these efforts has been the enhancement of ecosystem service benefits such as filtration,

Keynote Speakers' Abstracts and Biographies-Continued

denitrification, non-oyster fisheries enhancement, or coastal protection. Remarkably however, few restoration efforts have defined meaningful goals.

We have compiled a comprehensive review of the rich historical record of US oyster reefs, largely gathered around 1890 to 1910 by natural resources managers keen to manage, and profit from, this rich economic resource. For the first time we have developed relatively reliable measures of extent and density of oysters across the country, and are able to compare this to modern data. Our results confirm the dramatic losses in many areas, but also highlight what are undoubtedly some of the last remaining extensive natural oyster reefs, perhaps world -wide. Building on knowledge of extent and density we can estimate how these resources impact water quality and fisheries production across US estuaries and to assess the wider potential benefits of restoration to biodiversity and human society.

Biography

Dr Spalding is a senior marine scientist for The Nature Conservancy, and is based in the Conservation Science Group in Zoology, University of Cambridge. His expertise is in building large-scale reviews of marine ecosystems – synthesising very large volumes of data to tell the story of distribution, condition, threat and conservation effort, using maps and models. He has played a leading role in multiple publications including the World Atlas of Coral Reefs (2001), the Pilot Analysis of Global Ecosystems (2003), The World's Protected Areas (2008), The World Atlas of Mangroves (2010), and Reefs at Risk (four publications from 1998 to 2011). The Nature Conservancy has played a leading role in shellfish restoration projects across the USA, working in close collaboration with federal and state partners, and especially NOAA. Dr Spalding, working with Dr Philine zu Ermgassen, a post-doc also at Cambridge and a co-author on the current presentation, has been working with multiple partners to characterise and quantify the ecosystem services delivered by oyster reefs, to map change over time, and to develop models for expected benefits from ongoing and projected restoration efforts.

Sarah Culloty

Aquaculture and Fisheries Development Centre, School of Biological, Earth and Environmental Sciences, University College Cork, Ireland.

Conservation of the native European oyster *Ostrea edulis* through control of its main pathogen *Bonamia ostreae*

The native European oyster *Ostrea edulis* has been severely impacted by the spread of the pathogen *Bonamia ostreae* in Europe since the 1970s. As a result of the severe losses in the native oyster the Pacific oyster *Crassostrea gigas* has been introduced into many European countries but in recent years this species has also been affected by mortality events, in part due to oyster herpes virus and various Vibrios. Detrimental effects have been compounded by the uncontrolled spread of the Pacific oyster in a number of regions. Control of *Bonamia ostreae* has been difficult due to the severe impact on oyster stocks when initially introduced into an area and the lack of available methods to eradicate it. Recent studies have looked at the evolution of the disease in areas that have now been affected for over 30 years. Research has also concentrated on study of aspects of the life cycle of this haplosporidian to inform control of the pathogen within oyster growing areas. Methods to develop resistant stocks are on-going. The recent discovery of *Bonamia exitiosa* in Europe has further complicated the search for an effective method of ameliorating the impact of this severe pathogen on the European oyster industry and on a native European oyster.

Biography

Sarah Culloty is a lecturer within the School of Biological, Earth and Environmental Sciences and Director of the Aquaculture and Fisheries Research Centre within that School. She has worked on various aspects of shellfish health and disease since the late 1980s when she carried out her PhD on the pathogen *Bonamia ostreae* in the native oyster in Ireland. She has produced over 50 peer reviewed papers, books and book chapters. She leads a research group on shellfish health currently working on variety of species and topics and with many national and international collaborations.

Gef Flimlin

Marine Extension Agent, Rutgers Cooperative Extension, Toms River NJ 08755., USA

Putting the bight in shellfish

The area from Cape May, New Jersey to Montauk, New York is called the New York Bight. Within this area are Long Island and the entire coastal region of New Jersey, the Hudson and Delaware Rivers, and Long Island Sound; bodies of water that once teemed with shellfish, but have seen strong declines. This is the area of the Sopranos, The Jersey Shore, The Hamptons, and The Big Apple, but the love of clams and oysters is deeply seated in the minds and memories of its citizens. The history of shellfish here begins with the Native American tribes who used the coastal waters for sustenance, only to have those waters degraded by growing populations and their waste. Those who grew up harvesting or consuming these shellfish focus on helping the resource and protecting their environment.

Within these waters, numerous programs focus on shellfish augmentation and restoration. Some have been ongoing for many years and some are fairly recent. The goals, partners, participants, outcomes, scientific rigor and *raison d'etre* are as

Keynote Speakers' Abstracts and Biographies-Continued

varied as the diversity of the area. Some are finite in scope and some expand exponentially, only confined by the imaginations of the participants.

The link between all of these projects is that at one point in time, a decision was made, for whatever reason, to do something. That is what can be learned from the US experience. It's a Nike attitude. "Just do it!"

Biography

Gef Flimlin, MS.: Professor and Marine Extension Agent with Rutgers Cooperative Extension, Ocean County, NJ, has been working with commercial fisheries and aquaculturists in NJ for over 33 years. He worked to form the New Jersey Aquaculture Association and East Coast Shellfish Growers Association, and initiated the Barnegat Bay Shellfish Restoration Program (BBSRP). That program has the public focusing on shellfish restoration while learning how their behaviors in the watershed can improve the water quality in the bay. He also designed the Clam Trail, a combination of public art and science education where 5 ½ foot tall painted fiberglass clams help kids learn about the bay and the shellfish in it. He also has worked on offshore weather forecasting, satellite imagery for catching large pelagic fish, seafood processing and marketing, the development of best management practices for shellfish farmers, and ornamental aquatic plant culture. His program has a website dedicated to assessing seafood risks and benefits (http://njaes.rutgers.edu/seafoodsafety/).

About our sponsors

The Crown Estate

There is no organisation in the world quite like The Crown Estate. With a property portfolio encompassing many of the UK's cityscapes, ancient forests, farms, parkland, coastline and communities, The Crown Estate's role as employer, influencer, manager, guardian, facilitator and revenue creator is unique. Its interest covers extensive marine assets throughout the UK, including over half of the foreshore and all the seabed out to the 12 nautical miles limit. This marine domain is also becoming more relevant in terms of offshore engineering and alternative energy sources. One paragraph cannot represent such an organisation so see www.thecrownestate.co.uk/

Marine Scotland

The purpose of Marine Scotland is to manage Scotland's seas for prosperity and environmental sustainability. Its main responsibilities are working towards achieving good environmental status, through planning, licensing and other functions, to help ensure a healthy and sustainable environment.

It promotes sustainable, profitable and well managed fisheries and aquaculture industries in Scotland and ensures a sound evidence base to inform the development and delivery of marine policy, planning and services.

It also has a regulatory role to ensure effective compliance and enforcement arrangements.

MASTS

The Marine Alliance for Science and Technology, Scotland is a consortium of University and Government departments working together to synergise research outputs in the field of biodiversity, marine aquaculture, which are the areas that converge with this conference but also in all aspects of marine science to provide strong strategic collaboration to maintain marine science in Scotland at an International level. www.masts.ac.uk

SNH

Scottish Natural Heritage is the Government funded body responsible for looking after all of Scotland's nature and landscape. They are currently working flat out following the Marine (Scotland) Act 2010 which aims to achieve better protection of the marine environment and more stream lined regulation for the use of the sea. It included proposals for a marine planning system and new marine nature conservation provisions, including Marine Protected Areas.

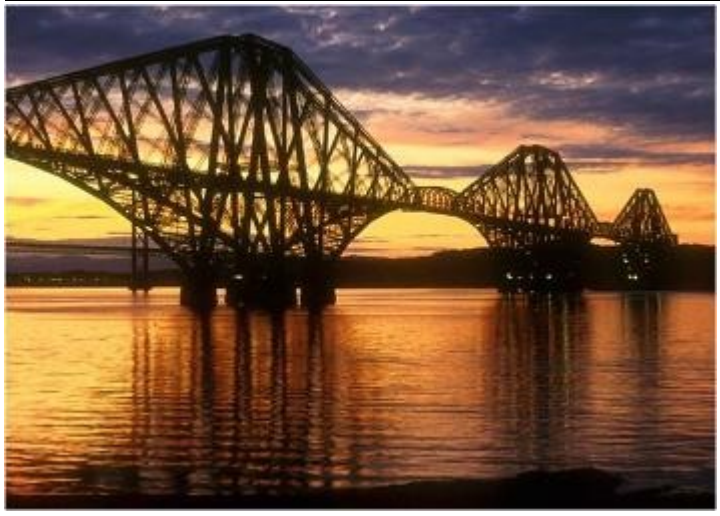
www.snh.gov.uk/

Schedule of Presentations and Activities

Tuesday 23 August 2011	
15.00-18.00	Arrival and Registration
18.30-19.30	Whisky tasting arranged by WoodWinter £10pp in Management Centre (optional)
19.30	Dinner served at Abbey Craig Restaurant (For extra guests or those in chalet accommodation the cost for dinner is £24.00)
Wednesday 24 August 2011	
07.30-09.00	Registration and full Scottish breakfast; in Management Centre or Pathfoot for those in halls
09.00 -09.10	Opening Ceremony
Session 1	**Theme 1 Evaluation of the habitat of restored and enhanced shellfish reefs**.
9.10-9.50	**Keynote Speaker Melanie Austen** Ecosystem services – adding value to shellfish resources.
9.50-10.10	**Doug Lipton** Payment for Ecosystem Services From Shellfish Restoration: Examples From Chesapeake Bay.
10.10-10.30	**Earl J. Melancon** The Importance of Constructed and Natural Intertidal Oyster Reefs to the Future of the Subtidal Oyster Fishery in Louisiana, USA, as it Relates to Coastal Wetlands Restoration.
10.30-10.50	Coffee
10.50-11.10	**Jose Fariñas-Franco** Temporal changes in biotic communities on artificial reefs deployed for the regeneration of *Modiolus modiolus* biogenic reefs in Strangford Lough, Northern Ireland.
11.10-11.30	**Rayner Piper** Shellfish populations within the Eastern English Channel Dredging Licence Areas. Confounding factors 5 years on.
11.30-11.50	**Lisa Kellogg** Bivalve restoration and aquaculture: The role of associated organisms in enhancing ecosystem services
11.50-12.10	**Dai Roberts** The world is their oyster: Differences in epibiota on sympatric populations of native (*Ostrea edulis*) and non-native (*Crassostrea gigas*) oysters.
12.10-12.30	**Michelle Price-Hayward** Sanitary surveys in the Scottish context – a tool for informing site selection and optimisation of water quality.
12.30-14.00	Lunch at the Abbey Craig Restaurant
Session 2	**Theme 2 Evaluation of ecosystem engineers in ecosystem restoration.**
14.00-14.40	**Keynote Speaker Luca van Duren** Shellfish as ecosystem engineers: small-scale processes and large-scale consequences.
14.40-15.00	**Norbert Dankers** The wane and wax of intertidal mussel-beds in the Dutch Wadden Sea.
15.00-15.20	**Jasper Donker** Predicting survival chances of mussel beds using hydrodynamical models calibrated by field measurements.
15.20-15.40	**Dara H. Wilber** Sedimentation impacts on restored intertidal oyster reefs in South Carolina, US and the implications for secondary consumers.
15.40-16.00	Tea
16.00-16.20	**Brenda Walles** The use of an ecosystem engineer in coastal defense.
16.20-16.40	**A.M. Waser** The role of littoral mussel beds of different size and age for birds and shore crabs.
16.40-17.00	**Jeroen M. Jansen** The fate of ephemeral structures in the Wadden Sea: exploitation, protection and reconstruction of sublittoral musselbeds.
17.00-17.20	**Karin Troost** Changes induced by expansion of the ecosystem engineer and invasive species *Crassostrea gigas* in continental NW European estuaries.
18.00-	Welcome drinks reception at Crush Hall, Pathfoot Building with Provost of Stirling.
19.30	Dinner at Abbey Craig restaurant (NB Reserve a place for £24 if not already booked through conference at MC, or at ACD and AS Halls)

Schedule of Presentations and Activities continued

Thursday 25 August 2011	
Session 3 Theme 3 Restoration and Management of mobile shellfish Chair Dai Roberts	
9.00-9.40	**Keynote Speaker Robert Rheault** Ecosystem services rendered by Shellfish Aquaculture.
9.40-10.00	**Tom McCowan** Genetic Approaches to Reseeding in New Zealand's Blackfoot pāua (*Haliotis iris*)
10.00-10.20	**Christopher Hepburn** Pathways to fisheries restoration: community management, science and traditional Ecological Knowledge
10.20-10.40	**Posters session** Introductions to the poster presentations; two minutes to explain why your poster has to be seen!
10.40-11.00	Coffee
11.00-11.20	**Peter Kingsley-Smith** The role of oyster reefs in the provision of habitat for diverse assemblages of nektonic organisms with varied life history strategies
11.20-11.40	**Steven Scyphers** How does oyster reef design and setting affect fish community structure in the Northern Gulf of Mexico
11.40-12.00	**Bruno Ens** Bird Predation on intertidal mussel beds
12.00-12.20	**Alvares G. F. Benga** Traditional exploitation and wise skills' management of a bivalve: *Anadara senilis* L. (1758) in the Saloum Delta.
12.20-12.40	**Iratxe Menchaca** Subtidal edible sea urchin (*Paracentrotus lividus*) populations in the Basque Country (Northern Spain). Facing the future exploitation.
12.40-14.00	Lunch at the Abbey Craig Restaurant
13.45	Departure for field trip by coach and boat on the Firth of Forth, discussions, or free to explore sites of Stirling.
17.15	Departure of coach for collecting delegates from field trip and delivery to Edinburgh for tattoo.
18.15	One coach leaves from South Queensferry to Stirling and one coach takes us to Edinburgh
19.30	Dinner at Abbey Craig Restaurant for those not going to Tattoo
Evening see timings above	Optional excursion into Edinburgh for the Military Tattoo provided bookings £40 per person are made (limited numbers). Free coach will leave straight from Boat Trip and return after event.



Field trip to the Firth of Forth plus Tattoo

We will drive by coach from Stirling to South Queensferry, the southern base of the historic Forth Bridge which opened for rail traffic in 1890 and until 1917 was the longest cantilever bridge span in the world. From South Queensferry we will take a boat to Incholm Island where there is an historic abbey and wartime fortifications as well as much marine life. After the boat trip you can if you wish take the trip to the Edinburgh Military Tattoo. Some seats were remaining at the time this programme went to press but NONE are available from the Tattoo itself—all tickets for 2011 are sold out! The Tattoo is never cancelled, whatever the weather, so please if you are coming, bring waterproofs (we will also consult the weather forecasts with great attention and feed back the information). Cushions can be hired there but please dress for warmth. The theme for this year's Tattoo is "of the Sea". This was certainly not known when we booked our tickets back in January. It also takes in Scottish engineering so no doubt the Forth Bridge will feature. But it is a truly International event. Among this year's performers are The Band of the Royal Netherlands Army Mounted Regiments -The Music Corps of the Bicycle Regiment, The Brazilian Marine Corps Martial Band, The German Mountain Army Band as well as the Gurkhas, and the Omani army plus a contingent from the Caledonian Society of South Australia. The field trip is provided as part of the registration but the Tattoo trip is an extra £40pp.

Schedule of Presentations and Activities
continued

Friday 26 August 2011	
Session 4 Theme 4 All about oysters Chair Peter Kingsley-Smith	
9.00-9.40	**Keynote Speaker Mark Spalding** Rediscovering baselines and rebuilding reefs – understanding the challenges of ecosystem-scale restoration in North America.
9.40-10.00	**Mark Luckenbach** 20 years of oyster restoration in the Chesapeake Bay USA What we have learnt and where we go from here?
10.00-10.20	**Steven Allen** Large scale Hatchery based oyster restoration in the Maryland portion of the Chesapeake I: Overview and goals
1020- 10.40	**Kennedy Paynter** Large scale hatchery based oyster restoration in the Maryland portion of the Chesapeake II: Results and Progress.
10.40-11.00	Coffee
11.00-11.20	**Sammy Ray** Shellfish reef restorers: adjusts goals to current, not by-gone conditions.
11.20-11.40	**Francis O'Beirn** Environmental factors that influence the local establishment of Pacific oysters: modeling occurrence data from a coordinated sampling programme.
11.40-12.00	**Tristan Hugh-Jones** Loch Ryan oyster beds (*Ostrea edulis)* Scotland
12.00-12.20	**Lisa Kamphausen**, Restoration potential of a wild *Ostrea edulis* fishery with a very low proportion of female phase oysters
12.20-14.00	Lunch at the Abbey Craig Restaurant
Session 5 Theme 4 continued Chair Mark Luckenbach	
14.00-14.40	**Keynote Speaker Sarah Culloty** Conservation of the Native European Oyster *Ostrea edulis* through control of its main pathogen *Bonamia ostreae*
14.40-15.00	**Jens Carlsson** The use of genetics in oyster restoration
15.00-15.20	**Ryan Carnegie** Confronting disease in oyster restoration: the case of *Crassostrea virginica* in Chesapeake Bay, USA.
15.20-15.40	**Kimberley Reece** Genetic Monitoring of Selectively Bred oysters deployed for broodstock enhancement in a Chesapeake Bay Tributary
15.40-16.00	Tea
16.00-16.20	**Hein Sas,** Spreading and ecological function of the Pacific oyster *(Crassostrea gigas)* in the Dutch Wadden Sea.
16.20-16.40	**Joseph Mazurie** Towards restoration of endangered oyster aquaculture in a French subtidal bay through control of predators.
16.40-17.20	**Closing Keynote Speaker Gef Flimlin** Putting the Bight in Shellfish
19.00	Drinks served prior to dinner
19.30	Scottish gala conference dinner and ceilidh. Abbey Craig Restaurant
Saturday 27 August 2011	
08.00 to 10.00	Full Scottish Breakfast at the Abbey Craig restaurant or Pathfoot for those in campus accomodation
10.00	Check out

Abstracts of plenary speaker talks in alphabetical order

Steven Allen*[1], Kennedy T. Paynter Jr. [2,3], Stephan Abel[1], Don Meritt[4]
[1]Oyster Recovery Partnership, Annapolis, MD, USA, [2]Department of Biology, University of Maryland, College Park, MD, USA, [3]Chesapeake Biological Laboratory, University of Maryland Center for Environmental Science, Solomons, MD, USA, [4]Horn Point Laboratory, University of Maryland Center for Environmental Science, Cambridge, MD, USA

Large Scale Hatchery Based Oyster Restoration in the Maryland portion of the Chesapeake I: Overview and Goals

With oyster populations in the Maryland portion of the Chesapeake Bay at critically low levels, restoration activities have been undertaken to rebuild reefs with hatchery-produced seed. Since 1994, the Oyster Recovery Partnership (ORP) has worked together with its partners to steadily build Maryland's oyster restoration capabilities and capacity. As a result since 2000, the Maryland has produced and planted nearly 3 billion spat on shell on over 1,400 acres. With the announcement of President Obama's Executive Order 13508, an expanded effort for restoration is underway. Working with our partners both State, Federal and academic agencies, as well as not for profit groups, Maryland watermen and volunteers, we constantly refining our methodology to improve the efficiency and effectiveness of oyster recovery efforts. Relying on past methods and coupling them with state of the art technologies, we are now gleaning a better understanding of our recovery efforts and their ecological and economic ramifications and learning from both our successes and failures.

Alvares G. F. Benga
Geography Department, Université de Ziguinchor, Associated researcher / Biogeography Laboratory, Geography Department, Université Cheikh Anta DIOP de Dakar

Traditional exploitation and wise skills' management of a bivalve: *Anadara senilis* L. (1758) in the Saloum Delta

In the Saloum Delta, live the islander people called niominka. Centuries passing by, women of this farmers fishermen community have conceived unsuspected techniques of exploiting and valorizing mollusks. Owing to its availability, *Anadara senilis* L. (1758) is the most exploited This activity is a real source of financial income for them in the sense that it plays an important role in the cultural and socio-economic levels in a country characterized by a multidimensional crisis. A certain specificity characterizes the collecting of the bloody cockle. Unlike many living resources which exploitation is regulated by the law on state property, the collection of this resource demands an expertise. It is practiced in an area where the traditional system on property is still in force.

The crisis of agrarian systems consequence of the climatic changes has imposed new realities which have generated the development of new practices. The demographic boom, the wind of migration and the economic crisis have increased the pressure on the tidal reservoirs in search of *A. senilis* L. (1758) to the extent that many authors fear an overexploitation in view of the extraction rate. Yet, unlike the appearances, certain fundamental natural, cultural and economic determining factors combine to control discreetly but surely the exploitation of this resource. They could make it possible to demolish these pessimistic arguments and lead to their relativization. These reasons do not also prevent initiatives for biological rest to support the production.

Ryan B. Carnegie
Virginia Institute of Marine Science, College of William & Mary, P.O. Box 1346, Gloucester Point, VA 23062, USA

Confronting disease in oyster restoration: the case of *Crassostrea virginica* in Chesapeake Bay, USA

Diseases frequently loom as impediments to restoration of natural oyster populations. Overcoming disease is a fundamental restoration challenge. Recently in the Chesapeake Bay region of the eastern USA, where parasites *Perkinsus marinus* and *Haplosporidium nelsoni* infect oyster *Crassostrea virginica*, consideration has been given to introducing a non-native oyster species, and to the restoration application of domesticated, disease-resistant native oyster lines, to avoid disease effects. Significant drawbacks to both strategies led to their abandonment. More recently, it has been suggested that restoration efforts should focus on reefs in lower salinities, which inhibit diseases. It has been assumed that reproduction by oysters in low-salinity refugia supports oyster populations in disease-intense waters of higher salinity, where oysters are thought to be too diseased to reproduce.

Mounting evidence suggests, however, that oysters in disease-intense waters are increasingly resistant to *P. marinus* and *H. nelsoni*, fully reproductive, and probably more important than oysters adapted to low-salinity waters for maintenance of the populations as a whole. This argues for specifically focusing restoration in waters where disease pressure is greatest, in recognition of the reproductive value of oysters in these waters and to promote the deepening of disease resistance. This strategy is increasingly being advocated and adopted.

Jens Carlsson, Tom F Cross, Sarah C Culloty
School of Biological, Earth and Environmental Sciences/Aquaculture and Fisheries Development Centre, University College Cork, Distillery Fields, North Mall, Cork, Ireland

The use of genetics in oyster restoration

Many of the world's shellfish stocks have been severely impacted by overfishing, diseases and habitat degradation. For instance, overfishing and fishing methods (altering habitats) and, more recently, diseases have devastated the native Eastern oysters (*Crassostrea virginica*) and the associated industry in the Chesapeake Bay and elsewhere along the US eastern Seaboard. Similarly, the native flat oyster (*Ostrea edulis*) stock in Europe has experienced a collapse in census numbers across its native range, caused by disease and overfishing, and now the industry is severely hampered. The severely depleted stocks of shellfish have led to a number of research projects and restoration efforts, ranging from disease mitigation to habitat, fisheries and stock restoration. Genetics is a valuable tool that can help elucidating causes for diseases including detecting genetic differences among strains/populations in disease causing organisms and agents and for disease diagnostics (real time PCR and species/strain/population identification). In addition, genetics is the only available tool for inferring population structure, which enables identification of management/conservation units. Many of the restoration efforts are focused on restoring census number through supportive breeding of native strains of wild origin or deployment of aquaculture selected "disease tolerant" strains/ lines. Genetics is an invaluable tool for monitoring how these strains/lines are performing (e.g. survival and growth in the wild environment), and is the only available tool to ascertain if deployed shellfish are reproducing in the wild and enables

Abstracts of plenary speaker talks in alphabetical order—continued

estimations of reproductive success. Here we outline how genetics has been and can be used in shellfish restoration efforts with specific focuses on the American Eastern oyster and the European flat oyster.

Jan F. Cordes and **Kimberly S. Reece**
Virginia Institute of Marine Science, The College of William and Mary, Gloucester Point, VA, USA 23062

Genetic Monitoring of Selectively Bred Oysters Deployed for Broodstock Enhancement in a Chesapeake Bay Tributary

One strategy employed for oyster restoration in Chesapeake Bay, USA is the addition of selectively-bred or wild-derived oysters produced in hatcheries onto reefs to serve as spawning stock. During 2005-2006 there was a large-scale deployment of oysters selectively bred for resistance to parasitic diseases to a bare, historic oyster reef in the Great Wicomico River, Virginia. Previous genetic studies conducted using both mitochondrial and nuclear genetic markers suggested that these oysters contributed little to the genetic make-up of spat collected in 2007 at sites surrounding the deployment reef. There are several possible reasons for this relatively low genetic contribution including predation (low survival), poor adaptation of the hatchery stocks to the natural environment (low reproductive/recruitment success), or insufficient temporal sampling following the deployments (experimental error). Therefore, we undertook additional analyses including determination of persistence of deployed oysters on the restored reef, an estimation of the number of oysters on neighboring reefs derived from deployed animals, and additional sampling of adults and sub-adults at a later time (2009) at more distant sites to determine the longer-term recruitment contribution to the system. Approximately 40% of deployed animals persisted on the restored reef. Analyses of the additional oysters collected from surrounding sites and from throughout the system are ongoing and results of these analyses will be presented.

Norbert Dankers, Frouke Fey, Jeroen Jansen, Arno Kangeri (Imares) and Jaap van der Meer
(Royal NIOZ), Texel

The wane and wax of intertidal mussel-beds in the Dutch Wadden Sea; *hypothesis development for an integrated research project*

Intertidal musselbeds almost completely disappeared in 1991. Several attempts were undertaken in order to restore them, but these failed. Some good spatfalls increased the area of beds again to above 2000 hectares but in recent years the area is decreasing again. The low acreage is most prominent in the western part of the Wadden Sea.

Before new attempts for restoration are undertaken the factors which are responsible for survival have to be clear. The beds have been studied since the earliest development in the 1990ties. From all (more than 100) beds general information (areal size, biomass, location) is available for a period of 15 years. For a limited number very detailed information on size, exact boundary, location, percentage cover and population and community characteristics is available for the same period. The data will be presented and hypothesis developed on the major factors which influence survival of beds of different ages. Results are available of beds ranging in age between 1 and 17 years. They indicate that about half of the area of seed beds disappears in their first year. After the first year the decrease in area slows down and many beds maintain themselves by spatfall within the bed, even in years when spatfall outside the bed is minimal. In general, beds deteriorate further until a major spatfall rejuvenates them. Patch formation is prominent, and older beds show a clear pattern of hummocks rising well above the surrounding area or channels draining the bed. It is hypothesised that storm events, build-up of substrate and predation are the major factors responsible for deterioration.

Based on the hypotheses an integrated research project has started in which physical factors (wave and currents), biological characteristics (mussel population dynamics, byssus strength, substrate characteristics, patch formation) and predation pressure (by birds and crabs) will be studied

Jasper Donker, Maarten van der Vegt, Piet Hoekstra
Department of Physical Geography, Utrecht University

Predicting survival chances of mussel beds using hydrodynamical models calibrated by field measurements.

The Mosselwad project, studies the stability and opportunities for restoration of mussel beds in the Wadden Sea. In this context we seek to predict mussel bed stability with respect to hydrodynamic forcing. To make accurate predictions with models, field experiments are needed to determine relevant processes and to establish representative estimates for model parameters. To determine these parameters a six week campaign was performed on a relatively young mussel bed in the Wadden Sea. During this period wave height, period, propagation velocity, dissipation and currents were measured. From these measurements the wave energy dissipation rate is determined, which is subsequently used to estimate the bed-shear stress and friction parameters. Results show that bed friction, due to the absence of wave breaking, is the dominant process for wave dissipation. The bed friction parameter is found to be 5 times larger than on an uncovered flat. Results of the field experiments are used to calibrate a wave model (SWAN). The calibrated model is subsequently used to make predictions of bed-shear stresses on mussel beds during stronger wind conditions than observed. Model results show that area's where mussels have disappeared were subjected to the largest bed-shear stresses.

Bruno J. Ens[1], Jaap van der Meer[2], Andreas Waser[2]
[1] SOVON [2]NIOZ

Bird predation on intertidal mussel beds

Around 1990, intertidal mussel beds were heavily overfished and disappeared almost completely from the Dutch Wadden Sea. A new fishery policy in 1993 restricted fishery on intertidal mussel beds and as a result the beds gradually reappeared. However, restoration of intertidal beds was mostly restricted to the eastern part of the Dutch Wadden Sea and very few beds reappeared in the western part of the Dutch Wadden Sea. As part of a major project on mussel bed restoration, called "Mosselwad", we investigate the probable cause of this discrepancy. In particular, we investigate the hypothesis that bird predation on mussel beds is much higher in the western part of the Dutch Wadden Sea compared to the eastern part of the Dutch Wadden Sea. To this end we review the literature on mussel predation by birds and the processes governing the intensity of predation. For Oystercatchers, we can employ a model that calculates predation pressures on different stocks of shellfish on the basis of Oystercatcher counts, data on tide and weather, and Wadden Sea wide shellfish surveys. Finally, we will present the first results of measurements on bird predation under current conditions.

Abstracts of plenary speaker talks in alphabetical order—continued

Jose M. Fariñas-Franco[1], D. Roberts[2], D. Smyth[3], A.M. Mahon, E. Gorman[1], and L. Kregting[1]

[1] Queen's University Belfast Marine Laboratory, 12, The Strand, Portaferry, Co. Down, BT22 1PF, UK. [2]Queen's University Belfast, School of Biological Sciences, Medical Biology Building, 97 Lisburn Road, Belfast, BT9 7BL UK. [3]British Antarctic Survey, Rothera Research Station, Rothera Point, Adelaide Island, Antarctica.

Temporal changes in biotic communities on artificial reefs deployed for the regeneration of *Modiolus modiolus* biogenic reefs in Strangford Lough, Northern Ireland

In 2009 the MRRG constructed an experimental artificial reef in Strangford Lough, Northern Ireland as part of trials to regenerate biogenic reefs of the horse mussel, *M. modiolus,* which had been impacted by dredging. The aim of the study was to test the hypotheses that the artificial reef would accelerate succession, enhance natural recruitment of *M. modiolus* spat, and that these effects would be greater on elevated cultch. The reef was constructed using king scallop *Pecten maximus* shell as cultch and adult *M. modiolus* collected locally were re-laid over experimental plots within the reef. Experimental plots consisted of elevated and non-elevated cultch; mussels re-laid on unmodified substratum served as controls. After six months dive monitoring surveys revealed high survival rates in the translocated mussels which formed tight clumps in the different treatments. Pseudo-faeces and sediment accumulated in the crevices increasing habitat complexity and attracting numerous species to an otherwise barren area within the historic range of *M. modiolus*. This presentation provides a progress report on the experiment describing the effect of elevation on mussel survival, faunal assemblage succession and natural recruitment.

Christopher Hepburn[1], Stephen Wing[1] Henrik Moller[2], Nigel Scott[3]

[1]Department of Marine Science, University of Otago, [2]Centre for Study of Agriculture, Food and the Environment, [1,2]University of Otago PO Box 56. [3] Toitū Te Whenua, Te Rūnanga o Ngāi Tahu, PO Box 13-046 Christchurch

Pathways to fisheries restoration: community management, science and Traditional Ecological Knowledge

A multidisciplinary, cross-cultural approach was used to inform a strategy for how to restore the black-foot abalone or pāua (*Haliotis iris*). This is a 'cultural keystone' species for Māori (New Zealand's Indigenous people) and provides a significant commercial and recreational fishery. An alarming collapse of readily available abalone on the intertidal and shallow subtidal zones has led to changes in local community-led fishery closures and reduced catch limits. Some customary abalone fisheries will likely be unable, or slow to recover without reseeding with juvenile abalone raised in aquaculture facilities. Proposed reseeding programmes will be focussed on key local areas and rely on an understanding of the ecology of juvenile abalone stages from a combination of Traditional Ecological Knowledge of Māori, marine science and state-of-the-art technology to raise pāua and test the efficacy of different reseeding techniques. Targeted reseeding programmes where the fishery is managed at scales more appropriate to abalone life history and to local management of stocks could play a major role in restoring abalone fisheries in New Zealand for all stakeholders.

Tristan Hugh-Jones

The Loch Ryan Oyster Fishery Co Ltd, The Thatched Cottage, Penberth, St Buryan, Penzance, Cornwall, TR19 6HJ

Loch Ryan Oyster Beds (*Ostrea edulis*), Scotland

The Loch Ryan Oyster Beds, in South West Scotland, have been actively farmed since they were presented to the Wallace family by King William III in 1701. The oyster beds have had a "boom and bust" history, from about 110,000 dozen (130,000Kg) harvested in 1910, to being closed due to over fishing in 1958. Since 1996, the Loch Ryan Beds came under the control of David and Tristan Hugh-Jones who have been actively restoring them using aquacultural techniques developed over the last 32 years.

In 1996 a programme of only harvesting the largest 5% of the crop was started, and the smallest 95% of the crop were re-laid densely into small areas, to explore the growth rate variations in the Loch and also to improve fertilisation rates. A study was undertaken to determine the potential benefits of different cultch types to facilitate capturing the larvae, with sites examined over the entire Loch. Dredge and dive surveys have been carried out to determine the stock densities and the benthic type, which has enabled better management. Over the last 15 years a much better understanding of the hydrography of the Loch has been obtained, which explains both the growth rates and the larval retention. Loch Ryan Shellfish was a finalist in the, "Crown Estate Aquaculture Awards, 2009", and was the winner of "Scotland's Best Native Oyster, 2010" This paper will outline the history of the Loch Ryan Oyster Beds, and will explore the ways in which the beds are being managed and restored back to their former productive days, with the challenges that are being met on the way. The presentation will focus on the need to be able to sustain a population by being financially viable, so that both the restoration needs of the oyster, and the financial stability for the business can both be met.

Jeroen M. Jansen[1*], Norbert Dankers[1], Aad Smaal[1], Antonio Aguera[1], Frouke Fey[1], Tim Schellekens[1], Sanjeevi Rajagopal[2], Marnix van Stralen[3] and Kees Kersting[4]

[1]IMARES, department of Ecosystems, PO box 57, 1780 AB Den Helder, The Netherlands, [2]Radbout university Nijmegen, Faculty of Science, Institute IWWR, Toernooiveld 1, P.O. Box 9010, 6500 GL Nijmegen, [3]Marinx, Elkerzeeseweg 77, 4322 NA Scharendijke, [4]Kersting Ecosystem Research, De Dageraad 51, 1797 SK Den Hoorn (Texel)

The fate of ephemeral structures in the Wadden Sea: exploitation, protection and reconstruction of sublittoral musselbeds.

Musselbeds are considered important ecological structures in the Wadden Sea. Inhabiting numerous invertebrate species and benthic fishes, benthic biodiversity increases when the associated communities develop over time. Sublittoral musselbeds in the Wadden Sea are of economic value as well. Fisherman harvest from natural seedbeds to stock their culture lots. Annual recruitment events result in the formation of new seedbeds in the Wadden Sea that become visible during summer. Due to external forces, such as storms or swarming starfish populations, young seedbeds may disappear again before or during their first winter. Sensitivity to storms and seastar predation-risk are expected to be largely site-dependent, but not very well understood.

Several research projects join forces to unravel musselbed development and survival in relation to external and internal variables. The common aim of these studies is to develop a model that predicts the faith of a newly formed seedbed, based on the beds' location, time of the year, mussel density and predation pressure.

Abstracts of plenary speaker talks in alphabetical order—continued

Since fisherman, NGO's and the government agreed on a transition from fishing on wild seedbeds to the use of suspended seed collectors, part of the sublittoral seedbeds is closed for fisheries every year. Predicting where seedbeds will survive may hold the key to successful sustainable aquaculture in the Wadden Sea, since it will determine how efficient musselbed restoration in the sublittoral will be.

Lisa Kamphausen, Antony Jensen, Lawrence Hawkins
National Oceanographic Centre, University of Southampton, UK

Restoration potential of a wild *Ostrea edulis* fishery with a very low proportion of female phase oysters

Between 1972 and 2006 the Solent contained Europe's largest self sustaining *Ostrea edulis* fishery, supporting a local fleet of around 60 boats. From the 1980's onwards there was a slow decline in the population but since 2006 this decline has accelerated because of recurrent recruitment failures. Without a successful spatfall, the commercial extinction of the population in the coming years is likely.

To inform potential restoration strategies we studied the reproductive processes in the population, and discovered a very low proportion of female phase oysters (13.4-14%).

The reproductive status of 362 individuals sampled in 2009 and 2010 was determined by histological and visual examination. In both years significantly more male phase oysters than females were found (chi-squared, $p < 0.001$). Monthly analysis of gonad development between June 2008 and September 2009 showed that despite the skewed sex ratio the reproductive development in each gender was as expected and animals were developing and spawning sperm and eggs, peaking towards the end of June.

This skewed sex ratio has important implications for restoration efforts, and shows that examination of population reproductive processes is a vital component of assessing restoration potential.

Lisa Kellogg
Virginia Institute of Marine Science, College of William & Mary

Bivalve restoration and aquaculture: The role of associated organisms in enhancing ecosystem services

Many studies have demonstrated that both bivalve restoration and aquaculture can provide habitats that enhance the abundance and diversity of macrofauna and, in some cases, flora. Fewer studies have examined the role that these associated organisms play in enhancing the ecosystem services provided by these habitats. Data from recent studies in Chesapeake Bay, U.S.A., reveal that macrofaunal organisms associated with a restored oyster reef enhance nutrient sequestration, denitrification and filtration. Though they account for only 14% of total biomass on this reef, the non-oyster reef residents sequester 37% and 35% of the nitrogen and phosphorus, respectively. A review of current knowledge of the role that associated organisms can play in enhancing ecosystem functions illustrates gaps in current knowledge and suggests directions for future research.

Peter Kingsley-Smith[1], Joyce[2], R., Arnott[1], S.A., Roumillat[1], W.A. & Reichert[1], M.
[1] Marine Resources Research Institute, South Carolina Department of Natural Resources, 217 Fort Johnson Road, Charleston, South Carolina USA 29422., [2] Grice Marine Laboratory, College of Charleston, Graduate Program in Marine Biology, 205 Fort Johnston Road, Charleston, South Carolina USA 29412.

The role of oyster reefs in the provision of habitat for diverse assemblages of nektonic organisms with varied life history strategies.

Once primarily viewed as a fishery resource, since the 1990s oyster reefs have been more widely appreciated as "ecosystem engineers" that create and modify habitat and support a number of critical ecosystem services. Such ecosystem services include the improvement of water quality through filter-feeding, enhanced benthic-pelagic coupling and denitrification, shoreline protection and reduced erosion, and the provision of habitat for finfish, crustaceans and other invertebrates. Indeed within the southeastern United States, the South Atlantic Fishery Management Council (SAFMC) has designated oyster reefs as essential fish habitat (EFH). Data presented here will demonstrate two main themes in this regard: 1) oyster reef habitats support more abundant and more diverse assemblages of nektonic organisms (defined as those organisms capable of moving independent of currents primarily, finfish, swimming crabs and shrimp) than soft sediment habitats; 2) finfish species frequently found in close association with oyster reefs vary considerably in their life history strategies, such that oyster reefs are important to estuarine-dependent, marine-migratory, freshwater-migratory and diadromous species. Data will be derived both from recent graduate student work comparing nekton utilization of different reef types and also from long-term SCDNR monitoring efforts that target recreationally and commercially important species.

Doug Lipton[1], Geret DePiper[1], Stephan Abel[2] and Matt Parker[3]
[1] Department of Agricultural & Resource Economics, University of Maryland, College Park, MD 20742, [2] Maryland Oyster Recovery Partnership, Annapolis, MD 21401, [3] University of Maryland Extension, Glen Burnie, MD 21061

Payment for Ecosystem Services from Shellfish Restoration: Examples from Chesapeake Bay

The current situation in the Chesapeake Bay demonstrates the opportunities and challenges in monetizing ecosystem services provided by shellfish. Due to violating the provisions of the Clean Water Act by having impaired waters, the Chesapeake is under a regulatory regime known as a Total Maximum Daily Load (TMDL). The TMDL sets a cap on the annual loadings of nitrogen and phosphorus from the watershed. In addition, all the major jurisdictions impacted by the TMDL have established or are in the process of establishing nutrient trading systems. These two components, cap and trade, provide the necessary ingredients for either aquaculture operators or oyster restoration activities to receive payment for nutrient removal and sequestration. However, there may be legal challenges to allowing trading between land -based (pre-discharge) sources and waterbased (post-discharge) nutrient removal. An alternative is to anticipate the recalculation of the TMDL in future years and establish a market for shellfish production and restoration that increases assimilative capacity of the ecosystem leading to a higher TMDL. We calculate examples of what likely payments would be for ecosystem services of Chesapeake oysters, and give examples of how municipalities might be willing to pay for oyster ecosystem services to allow growth and development.

Mark Luckenbach
Virginia Institute of Marine Science, College of William & Mary

20 Years of Oyster Restoration in the Chesapeake Bay, U.S.A.:What have we learned and where do we go from here?

Efforts to reverse the depletion of oyster populations and

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enhance oyster fisheries in the Chesapeake Bay and other U.S. estuaries date back over a century. Only within the past few decades have these efforts been expanded to include the explicit goal of recovering the ecological functions provided by oysters and the biogenic reefs they form. Oyster reef restoration in the U.S. generally involves one or more the following activities: (1) restricting harvest, (2) planting of shell or other substrate as a base for natural recruitment, (3) planting hatchery-produced oysters and (4) introducing a non-native species. In the Chesapeake Bay, following a decade of deliberation, a decision was made not to introduce an exotic oyster species and to focus instead on ecological restoration and aquaculture development with the native oyster. While oyster aquaculture is expanding rapidly, restoration practices have advanced little beyond fisheries enhancement approaches. Theoretical and empirical underpinnings for guiding restoration goals, approaches, and evaluation remain underdeveloped. A coherent approach to restoring ecological functions provided by oysters will require clarification of the relationships between (*i*) structural and functional parameters, (*ii*) monitoring results and management decisions, and (*iii*) one -time and recurring costs and benefits for both wild populations and aquaculture.

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Towards restoration of endangered oyster aquaculture in a French subtidal bay (Baie of Quiberon) though control of predators

A research programme, devoted to restoration of oyster culture in a subtidal bay (Baie of Quiberon, South Brittany, France) was undertaken, after 5 years of abnormal mortalities. This study ("Risco"), implicating both industry, socio-economic experts and biologists, was funded by the Regional Council of Brittany, for 3 years (2010-2012).

In parallel to environmental characterisation of this bay (3000 of concessions exploited by 80 enterprises), including bottom video images, the effort in 2010 was oriented towards an experimental protocol for rearing performances evaluation on 2 age-class oysters, *Crassostrea gigas* : this protocol was applied on 15 spatial stations, for discriminating (1) mortalities on-bottom and off-bottom, (2) mortalities from predators or not. Concerning adult oysters mortalities, the most harmful in this bay where spat seeding is not much practiced, the predominant cause was identified as predators : starfish (*Asterias rub*ens and *Marthasterias glacialis*) in North-East sector, and boring snails (*Ocenebra erinacea* and *Pterophora inornata*, former *Ocinebrellus inornatus*) in South-Centre area. This spatio-temporal distribution remains to be understood ; on the other hand, cost effective control methods have to be developed with experienced oyster farmers (2011, 2012).

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Genetic Approaches to Reseeding in New Zealand's Blackfoot pāua (*Haliotis iris*)

New Zealand's Blackfoot Abalone or pāua (*Haliotis iris*) is a fishery of significant commercial, recreational and customary value. High fishing pressure and poaching of this species has caused a decline in stocks, raising concerns over the long-term sustainability of this resource. Reseeding has been trialed with promising outcomes in pāua. We are currently investigating how genetic approaches can be used to improve pāua reseeding management practices. We have undertaken a reseeding trial in Tory Channel, Marlborough Sounds, New Zealand where comprehensive genetic surveys using a panel of ten microsatellite markers have been made of hatchery broodstock and juveniles, of adults and juveniles from the wild target population, and from recaptured hatchery and wild pāua. This has provided a means for overcoming two challenges inherent in reseeding programs: 1) Tracing survival rates of released hatchery stocks, and 2) Monitoring genetic compatibility between hatchery and wild stocks. Further, our approach will allow for conclusions to be made regarding recruitment relationships existing in the wild population, the understanding of which is central to reseeding management strategies. These methods can ultimately be used to ensure the viability of reseeding programs and to monitor downstream genetic effects on wild populations.

Earl J. Melancon,
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The Importance of Constructed and Natural Intertidal Oyster Reefs to the Future of the Subtidal Oyster Fishery in Louisiana, USA, as it Relates to Coastal Wetlands Restoration.

Oysters, *Crassostrea virginica*, are a significant presence in the northern Gulf of Mexico state of Louisiana. From a commercial perspective, the fishery has produced annually over the past 40 years about 40% of the domestic supply for the United States. The fishery is a subtidal fishery, but much recent ecological focus has been on its intertidal populations as a living buffer to marsh loss through shoreline erosion reduction. This intertidal focus has become a central topic only in the last decade here in Louisiana because of the historical dominance of the commercial fishery and the more recent documentation of coastal land loss.

The juxtaposition of the subtidal fishery with its intertidal population is becoming increasingly important to document as Louisiana addresses coastal marsh loss. Currently, Louisiana has 30% of the total coastal marsh in the United States but accounts for 90% of the nation's annual loss. Proposed government coastal restoration strategies could have significant influence on the existence of the oyster's habitats. In this presentation, we focus on the ecological needs of the intertidal oyster population, the importance of where to strategically construct intertidal reefs, and how such populations may have a bearing on the future of the subtidal fishery.

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Subtidal edible sea urchin (*Paracentrotus lividus*) populations in the Basque Country (Northern, Spain). Facing the future exploitation.

The purple sea urchin *Paracentrotus lividus* (Echinodermata: Echinoidea) is widely distributed in the Mediterranean Sea and along the North-eastern Atlantic coast, from Scotland and Ireland to southern Morocco. This sea urchin lives on rocky substrates and in seagrass meadows, from shallow waters down to about 20 m depth. It is a species of commercial importance, with a high market demand for its roe, particularly in the Mediterranean Basin and more recently

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in other European non-Mediterranean areas. In recent years, its populations have shown a wide scale decline in many European countries due to over fishing. Failure to manage a fishery appropriately can have disastrous effects on social and economic conditions. The reasons for failure can be attributed to many factors, including inadequate or erroneous scientific information, poor management decisions, and inability of policy-makers to act. Some industrial initiatives in the fishery and commercialisation of sea urchin roe in the Basque Country (Northern, Spain) have motivated since 2007: (i) the monitoring of the spatial distribution, population structure and stock assessment of this echinoderm in the subtidal zone of the Basque coast and (ii) the proposal of a future management scenario for the sea urchin populations in the Basque coast according to the monitoring results.

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Environmental factors that influence the local establishment of Pacific oysters: modelling occurrence data from a coordinated sampling programme

Population data from the early stages of marine invasion are rarely available in the literature but are important for understanding and managing the invasion process. Pacific oysters (*Crassostrea gigas*) are invasive in many parts of the world but have been farmed for over 30 years in Ireland without becoming established in the wild. However, our extensive sampling programme in 2009 revealed small and moderate numbers of oyster individuals outside aquaculture. This programme was designed to be cost-effective and repeatable and to enable assessment of factors associated with establishment of the oysters. It involved close cooperation among a number of state agencies and universities. Based upon the data gathered a logistic model was applied and demonstrated that oysters were more likely to be found in proximity to aquaculture, on hard substrata and in large intertidal areas and were less likely to be found in the presence of macrophytes. The findings are being used as the basis for experimental tests of mechanisms affecting establishment, to improve prediction of further spread and to directly inform management action.

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Large Scale Hatchery Based Oyster Restoration in the Maryland portion of the Chesapeake II: Results and Progress

The University of Maryland (UMD), Oyster Recovery Partnership (ORP), and Maryland Department of Natural Resources (MDNR) and partners comprised of Federal, State, academic, non-profit and industry participants have been rebuilding oyster reefs in Maryland waters for over 10 years. The objective has been to recreate dense assemblages of oysters on historical natural oyster bars using juvenile oysters (spat) produced at the UMD hatchery. Sites are located in different river systems each with different water quality and disease pressures. Bottom type is highly variable between sites. Early survivorship of newly planted spat appears to be related to bottom type where sites exhibiting more exposed shell were positively correlated with spat survival. Deployment techniques and natural early spat mortality also influence the overall survival of oysters on these restored sites. In addition to substrate issues, mortality of juvenile oysters may be influenced by local conditions related to water quality, sedimentation, disease and harvest activity. Reefs with patchy distributions of dense oysters have been created. Many of these restored reefs are composed of unique cohorts and have been used to learn more about fundamental oyster biology including sex ratios, predation, egg lipid contents, and the biological and physical aspects of oyster reef function.

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Shellfish populations within the Eastern English Channel Dredging Licence Areas: Confounding factors 5 years on.

In 2005 an eastern English Channel offshore monitoring programme was initiated to investigate the effects of marine aggregate extraction on the commercial shellfish species *Pectin maximus*, *Aquipectin opercularis* and *Buccinum undatum*. The sampling sites were distributed over the region, into four pre-determined zones; Active Dredge Zone (ADZ), Primary Impact Zone (PIZ), Secondary Impact Zone (SIZ) and suitable reference areas (REF). Annual monitoring surveys investigated target species abundance and population structure within and between zones. Results indicate that Pectinidae populations increased in both number and size, post dredging onset. Factors affecting population aspects are considered in terms of bioturbation increasing particulate matter and dredge tracks resulting in heterogeneous bedforms thus mesohabitat refugia from predation and fishing activity. The biological findings of this study are discussed in relation to their wider environmental significance.

Michelle Price-Hayward
Centre for Environment, Fisheries & Aquaculture Science (CEFAS), Weymouth Laboratory, United Kingdom

Sanitary surveys in the Scottish context – a tool for informing site selection and optimisation of water quality

Since 1 January 2006, the European Food Hygiene Regulation (EC) No. 854/2004 has required that a sanitary survey be undertaken to assess sources of pollution to bivalve mollusc fisheries before an area is classified for production. These surveys have been undertaken for a mix of new and existing Scottish shellfisheries since 2007.

A sanitary survey identifies potential sources of faecal contamination in the vicinity of a bivalve mollusc production area and the ways in which these may affect the microbiological status of the shellfishery. The primary objectives are to determine production area boundaries and assign a representative monitoring point(s). The sanitary survey reports also provide:

1. a record of the potential sources of faecal pollution
2. an objective basis for classification monitoring
3. a useful baseline from which to assess future changes in bacteriological status
4. information to help the harvester optimise use of the growing area with respect to water quality

The reports are used to provide background information for management actions related to pollution events and outbreaks of illness and are useful as a basis for considering the action(s) required to improve water quality at shellfisheries.

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Sammy M. Ray
Professor Emeritus Texas A&M University at Galveston,

Shellfish Reef Restorers: Adjust Goals to Current, not By-Gone Conditions

Most Shellfish reef restoration projects begin with the premise: the current conditions of declining shellfish populations are due to over-harvesting and pollution. Other major causes such as diseases and predation as well as reduced freshwater inflow and increased salt water intrusion brought on by navigation, flood control and other projects that have resulted in vast changes in the physical nature of estuarine systems. Such changes are often ignored when planning projects to return shellfish populations to "levels of the good-old-days." Such lofty restoration goals are often doomed to failure along with the waste of time, substrate and money. Repeated failures will result in loss of confidence by the supporting public. A more prudent approach appears to be that of using "aquaculture" as employed in Virginia and other states, as well as using all factors (not just the easy ones to blame) in planning restorations. The "aquaculture" approach may result in "limited success" as enjoyed in Virginia and the Northwest USA, rather than the "sanctuary" approach that has led to the failures achieved by the state of Maryland in their efforts to restore Chesapeake Bay oyster populations. Perhaps "improving" shellfish populations is a more achievable goal than "restoring." Examples of proposed restoration projects in Texas and Maryland will be discussed.

C. Guy, A. Blight, **Dai Roberts**
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The world is their oyster: Differences in epibiota on sympatric populations of native (*Ostrea edulis*) and non-native (*Crassostrea gigas*) oysters.

The continued spread of non-native species is thought to be one of the greatest threats to biodiversity worldwide with current research concentrating on the impacts exerted by well established non-native populations. This study aimed to assess how biodiversity might be altered if native oyster (*Ostrea edulis*) populations were displaced by the invasive oyster *Crassostrea gigas*. Epibiota and vagile species on the upper and lower valves of both *C. gigas* and *O. edulis* from the same tidal height at Paddy's Point, Strangford Lough were compared.

Epibiont species richness was found to be significantly lower on *C. gigas* than on *O.edulis* although species diversity of associated biota was not significantly different between the two species. Epibiotic communities associated with the two oyster species were also significantly different from each other.

The continued spread of *C. gigas* potentially may have major impacts on the biodiversity of epibionts associated with oyster species in Strangford Lough. It is important to maintain management strategy to ensure that sustained population expansion does not occur and that resultant changes in habitat due to continued colonisation are prevented.

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Spreading and ecological function of the Pacific oyster *(Crassostrea gigas)* in the Dutch Wadden Sea

The Pacific oyster (*Crassostrea gigas*) started spreading in the Wadden Sea about 20 years ago and the population increased ever since. The species mainly occurs in the zone around low tide, alongside tidal channels. It was probably introduced as seed oysters, imported from France to the Dutch Wadden Sea and from the British and Irish isles to the German Wadden Sea.

Being an alien species and given the experiences elsewhere in the world, the risks of negative ecological impacts of this species are often emphasized. In the Wadden Sea the oyster competes with native species, like blue mussels for space and food (phytoplankton), while oysters themselves are less suitable as food for birds. Most shellfish eating birds are not capable to swallow or crack the oyster shells.

But there may be positive effects of the presence of oysters as well. Oyster beds form a habitat for species living on hard substrate, including mussels and consequently for birds feeding on these associated species. Oyster beds appear to be more resistant to storm impacts and may therefore in time be a more reliable (feeding) habitat than mussel beds. This is, however, not well documented yet. Our research project makes a first move to fill that gap in our knowledge, by mapping the development and spreading of the oysters in the sub littoral as well as the littoral zone of the Dutch Wadden Sea and by performing a tentative, qualitative survey of the spectrum of ecological functions of oyster beds in the Wadden Sea.

The project is funded by the programme 'Towards a Rich Wadden Sea' and executed by a research consortium consisting of MarinX, Stichting Geintegreerde Visserij (Foundation for Integrated Fishery) and Imares. Marnix van Stralen, MarinX; Jaap Vegter, Stichting Geïntegreerde Visserij; and Karin Troost, Imares.

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How does oyster reef design and setting affect fish community structure in the northern Gulf of Mexico?

Oyster reefs are broadly recognized for elevated densities of numerous species of infauna and epifauna, including fishes, worms, and other crustaceans that serve as important prey items for larger transient and demersal fishes. However, as several recent studies have demonstrated, fisheries enhancement is difficult to predict and is highly dependent on reef design and proximity to other structured habitats. To continue this discussion, we will present the findings of four different oyster reef restoration studies conducted in coastal Alabama waters over the past eight years. These four studies examined the habitat value of high and low relief reefs, reefs restored in saltmarsh tidal creeks, and two different studies of oyster reef breakwaters along eroding shorelines. All projects utilized the same multi-gear sampling approach to collect a broad range of sizes and species. From one of our breakwater projects, we found blue crabs were the most clearly enhanced (+297%) near breakwater reefs, while red drum (+108%), spotted seatrout (+88%) and flounder (+79%) also benefited. Our results provide convincing evidence that certain species could be enhanced by a variety of reefs designs and settings, but other species display more complicated responses.

Karin Troost
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Changes induced by expansion of the ecosystem

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engineer and invasive species *Crassostrea gigas* in continental NW European estuaries

Since the 1960s, the Pacific oyster *Crassostrea gigas* has been introduced for mariculture at several locations within NW Europe. The oyster established itself everywhere and expanded rapidly throughout receiving ecosystems, forming extensive and dense reef structures. It became clear that the Pacific oyster induced major changes in NW European estuaries. The case of the Pacific oyster in NW European estuaries is only one example in an increasing series of biological invasions mediated by human activities. This presentation shows how invasions by ecosystem engineers, that sometimes appear a threat, can also contribute to ecological complexity.

Changes induced by the Pacific oyster are mainly related to its ecosystem engineering activities, its relative lack of natural enemies and high filtration rate. Development of oyster reefs may compensate for habitat loss and biodiversity loss in estuarine environments that were caused by human activities in previous decades. Oyster reef development may also lead to a reduced carrying capacity for bivalve filter feeders in general, with cascading effects on other trophic levels. Induced effects differ between ecosystems with different characteristics. Case studies of the Oosterschelde estuary and Dutch Wadden Sea will therefore be presented.

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The use of an ecosystem engineer in coastal defense

Ecosystem engineers, are organisms that change the abiotic environment by physically altering structure. As a consequence they often, have effects on other biota and their interactions, and on ecosystem processes. The physical ecosystem engineering concept interconnects a number of important ecological and evolutionary concepts and is particularly relevant to environmental management. In this study the use of ecosystem engineers (Pacific oysters), for the reduction or prevention of tidal flat erosion in the Oosterschelde estuary, is investigated.

The application of oyster reefs is mostly needed in places subjected to severe erosion. As most of these places lack natural oyster reefs, artificial reefs can be constructed, using empty oyster shells, which provide suitable substrate for natural oyster settlement. The use of such artificial reefs as coastal defence will be successful when the reefs become living and self-sustainable structures and stabilize tidal flats. Therefore, artificial oyster reefs have been constructed in the Oosterschelde to monitor and evaluate the effectiveness of the concept.

First results show that artificial reefs indeed can reduce erosion and provide suitable substrate for oyster larvae, but the success of these reefs will depend on local environmental conditions. This study is part of the innovation programme Building with Nature (www.ecoshape.nl).

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The role of littoral mussel beds of different size and age for birds and shore crabs

Blue mussel beds are important ecological communities on the tidal flats of the Wadden Sea. Under favourable conditions individual beds become very old and may persist over decades. In the Dutch part of the Wadden Sea nowadays several hundreds of mussel beds occur. They differ in age, size and shape, in the associated benthic species diversity and in the size spectrum of the mussels. These different bed characteristics highly influence the predator abundance and the composition of the predator community. In this context, we initiated a semi-annual monitoring programme on a selection of mussel beds, spread out over the entire area of the Dutch Wadden Sea. Additionally, the numbers of birds foraging on the same beds at low tide are monitored six times per year. A combination of both data sets will give insights about the prevailing predation pressure on each of the mussel beds. The role of the mussel bed age for the predation success of shore crabs was experimentally tested under laboratory conditions, where crabs were allowed to prey upon simulated mussel patches. In this contribution, first results of the monitoring programme as well as of the laboratory experiments will be presented.

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Sedimentation impacts on restored intertidal oyster reefs in South Carolina, US and the implications for secondary consumers

Resident faunal densities and sedimentation (digitized percent surface coverage) were used as assessment metrics on five community-based oyster restoration sites constructed in South Carolina, US. By three years after reef construction, the associated community of resident crabs and mussels was well established at all five sites, however oyster population development among sites varied considerably. Average sedimentation coverage at the five sites ranged from 4 to 60% and was negatively correlated with both crab and mussel abundances. At a site with light sedimentation (samples ranging from 1 to 30% coverage), percent sediment cover was not related to the abundances of any associated resident fauna. The site with the highest sedimentation (samples ranging from 42 to 77% coverage) exhibited a negative correlation with mussel density and no significant correlations involving crabs. Negative relationships between sediment cover and resident crab distributions were most evident at sites with intermediate sediment cover. Resident crabs and mussels are important prey items for a diverse array of secondary consumers, therefore sedimentation of oyster reefs can be quantitatively linked to reduced food availability for these higher trophic levels. These results can be used to more completely quantify biological impacts caused by sedimentation on oyster reefs from activities such as dredging, vessel traffic, and coastal development.

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Underwater video to assess starfish density effect on mussel bed stability

Interest in conservation of marine benthic biodiversity and habitats has rapidly increased in the last decades as a result of awareness of the degradation of marine environments.

Underwater video is widely used for monitoring benthic ecosystems in conservation and management works. Video recording allow to obtain information that is inaccessible by other sampling systems.

During four years, two musselbeds have been monitored by means of underwater video in the Wadden Sea, aiming to assess the effects of starfish predation. Video recording allowed us to assess the relative abundance of starfish and mussels, observe spatial distribution and monitor the evolution of the effects caused by starfish in the monitored mussel beds.

Recently the set-up have been upgraded to a high resolution stereo video system that improved the quality and the class of data that can be obtained. Quantitative data on size distributions, covered areas, higher resolution and quality are added to what was obtained using traditional video.

This presentation will focus on the effects of the presence of starfish in the changes of relative biomass of mussels in mussel beds. At the same time will introduce the advantages and potential of using of high resolution stereo video over traditional video/photography and other widely used monitoring systems.

Janet H. Brown, **Elizabeth C. Ashton**,
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Restoration of the native oyster *Ostrea edulis*

The UK native oyster, *Ostrea edulis,* Biodiversity Action Plan (BAP) was launched in 1996 with the target to maintain and expand the existing geographical distribution and abundance of native oysters within UK inshore waters, where biologically feasible. Since its launch progress on the BAP has been restricted by limited investment and a need for a concerted coordinated and collaborative approach. Primer funding in 2009 from the Scottish Aquaculture Research Forum (SARF), The Crown Estates and Scottish Natural Heritage SNH to the Institute of Aquaculture (IoA) to develop a proposal for pilot scale re-establishment of a native oyster population in Scotland led to a number of interesting findings and proposals.

The discovery of two live individuals on the Firth of Forth after they were thought to be biologically extinct for over 50 years and commercially extinct for 100 years gained a lot of media coverage and support. However, our plan to place oysters (100) into suspended oyster baskets (100) (Aquapurses,/BST oyster bags) suspended on boat moorings, disused piers etc. at sites within the Forth Estuary downstream of the Forth Bridge has yet to gain funding. We suggest that by growing the oysters in bags the initial stocking numbers can be considerably lower than if they were broadcast to the sea bottom, monitoring will be feasible, an essential part of this project, but it should also allow for "critical mass" that could allow breeding if the oysters do thrive and the potential for natural spat settlement.

Wild oyster agglomerations were also found on the West Coast with a large diversity of marine life associated with them. Research on the historical distribution and abundance of *O. edulis* and recent experimental evidence of spat preferring live oysters infers that they could form reef structures. Could *O. edulis* reefs and the many benefits that accrue be a missing marine habitat in marine waters? We are looking for support for testing this hypothesis and the ecosystem benefits.

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An investigation into the optimal stocking density of bay scallops, *Argopecten irradians,* in spat collector bags.

As the reliance upon natural shellfish populations for human consumption grows, it is increasingly important that areas of stocks known to be declining are preserved. One of the major factors contributing to the decline in natural shellfish stocks is Harmful Algal Blooms (HABs) (Shumway, 1990). The application of aquaculture as a means of restoration following these HABs has become of great interest to scientists across the globe. This study focuses on the aquaculture of the bay scallop, *Argopecten irradians*, as part of the restoration project being carried out by Cornell Co-operative Extension of Suffolk County. The aim of this study is to investigate an optimal stocking density of juvenile scallops in spat collector bags. Three different densities were established: low density- ~650 scallops/ spat bag-1, medium density- ~1000 scallops/ spat bag and a high density of ~1500 scallops/ spat bag-1. Spat bags set up under regular conditions by the restoration were used as a comparison (~1000 scallops/ spat bag). Shell heights were used to measure growth and were recorded over the three week period the scallops spent in spat bags. Data was also gathered on mortality and the percentage retention in 6mm diameter lantern nets used after spat grow-out. A significant difference in shell height was observed between all densities, except between the medium and control. The control was of closer density to the high density experimental bag and as they did not show similar growth it is possible that environmental factors influenced growth. Mortality was found to be unrelated to stocking density. The percentage retention values between the stocking densities were insignificantly different and by the second week had reached >90%. For future management, -stocking densities may be increased to levels used in this study and still have successful retention by the second week of spat grow-out. However, this data is based on the assumption that the investigation was carried out under average environmental conditions and changes should not be made until this has been established.

Robert A. Fisher
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Cownose ray (*Rhinoptera bonasus*) predation relative to bivalve ontogeny

The cownose ray, *Rhinoptera bonasus* is a coastal pelagic ray that travels in large schools along the East Coast of the United States and inhabits the Chesapeake Bay from May-September for reproducing efforts. Cownose ray predation on commercial bivalves in the Bay has been a concern for shellfish industries for over 40 years, and more recently with shellfish restoration efforts with 95% predation reported. The purpose of this study was to determine the ability of the

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cownose ray, *R. bonasus* (Mitchill, 1915), to manipulate oysters and clams, test for relative prey preference, and to investigate whether susceptibility to cownose ray predation changes with bivalve ontogeny. We investigated patterns of predation for captive adult and young of year cownose rays on four species of bivalves including *Crassostrea virginica* (Gmelin, 1791), *C. ariakensis* (Fujita, 1913), *Mercenaria mercenaria* (L. 1758), and *Mya arenaria* L. 1758. In oyster (*C. virginica*) trials, predation probabilities by adult rays were highest at shell heights of 30-70 mm and shell depths of 8-22 mm. The rates of predation by adult rays in trials where a single size oysters were used were higher than rates in most comingled trials. Adult rays showed no differences in predation between native oysters (*C. virginica*) and non-native oysters (*C. ariakensis*) ($p > 0.05$). Adult rays selected hard and soft shell clams (Manly-Chesson Index *M. mercenaria*, $\alpha = 0.736 \pm 0.002$, electivity $= 0.473 \pm 0.007$; *M. arenaria* $\alpha = 0.742 \pm 0.003$, electivity $= 0.485 \pm 0.013$) over oysters (*C. virginica* $\alpha = 0.263 \pm 0.002$, electivity $= -0.473 \pm 0.007$; $\alpha = 0.257 \pm 0.003$, electivity $= -0.485 \pm 0.003$). In young of year feeding trials, oysters with shell heights of 10-35 mm and shell depth of 3-12 mm had the highest probability of predation. Native oyster and hard clam peak force or load crush tests resulted in forces of 200-1500 N and 400-1400 N across shell depths of 10-35 and 21-34 mm, respectively, before valve failure. The results of this study indicate that cownose ray predation on shellfish is limited by shell size and is likely related to ray jaw gape and bite force.

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Aquaculture & Fisheries Development Centre, School of Biological, Earth & Environmental Science, University College Cork, The Cooperage, Distillery Fields, North Mall, Cork, Ireland.

The current status of the pathogen *Bonamia ostreae* in the European flat oyster *Ostrea edulis.*

The protozoan parasite *Bonamia ostreae* has had a significant impact on the European flat oyster, *Ostrea edulis*, with significant losses occurring since the 1970's in Europe. Since the pathogens introduction into various sites some evolution of the host parasite relationship has occurred, the extent of which has depended on anthropogenic and other influences. *O. edulis* populations are being studied at three sites along the Irish coast to investigate the current status of *B. ostreae* in Irish waters. Live oyster samples are collected quarterly from Clew Bay on the west coast, where infection of the parasite was first diagnosed in 1998, and from Lough Foyle on the north coast, recently diagnosed in 2005. Also, some sampling has occurred in Cork Harbour, on the south coast, where the pathogen has been present since the 1980s. Prevalence of infection in the oysters is determined by conventional PCR (cPCR) with *B. ostreae* specific primers (Bo Boas) and by heart smear screening. The oyster population of Lough Foyle was expected to display a significantly higher prevalence of infection, due to its recent exposure to *B. ostreae* and its higher stocking density, compared to Clew Bay. In October 2010, 33.2% of oysters sampled from Lough Foyle were positive for *B. ostreae* while 7.3% prevalence of infection was detected in Clew Bay oysters in that same month. By January 2011 the prevalence of infection in Lough Foyle oysters decreased to 10.2% and in Clew Bay oysters it decreased to 6%. The influence of environmental parameters such as temperature and salinity on infection rates are also being investigated in this study.

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Population genetics of the Pacific oyster *Crassostrea gigas* in the United Kingdom and Ireland inferred from microsatellite markers.

The Pacific oyster, *Crassostrea gigas*, native to Japan, is economically one of the most important cultured shellfish in Europe. It was assumed that the species would not reproduce in cold waters, however, naturalised oyster populations are now well established in France, Germany, The Netherlands and Denmark and *C. gigas* occurs as far North as Norway. In the United Kingdom, the initial introduction of *C. gigas* in the 1970s was controlled by the Ministry of Agriculture, Fisheries and Food and seed production for aquaculture was subsequently restricted to two UK hatcheries. In the UK and Ireland, *C. gigas* has a patchy distribution, forming locally dense populations, but there are concerns that its range may expand. Eighteen wild populations of *C. gigas* from England, Wales, Northern Ireland and Ireland were sampled in order to assess the genetic diversity and population differentiation based on 12 microsatellite markers. The mean number of alleles ranged between 17 and 31. Preliminary results showed a small but significant global F_{ST} (0.012), indicating genetic structuring among populations. This study highlights the potential of microsatellite based- studies to trace the origin of non-native populations and estimate gene-flow between them.

Angeline LeBlanc, Thomas Landry.
Dept. of Fisheries and Oceans – Canada.

The use of shells to increase recruitment and survival of quahogs (*Mercenaria mercenaria*) and soft-shell clams (*Mya arenaria*)

The soft-shell clam is an important resource along the Atlantic coast of Canada, both from an ecological and economical perspective. Ecologically, it is a keystone species in the benthos because of its burying and filtering activity. From a socio-economical point of view, the soft-shell clam fishery is a critical industry for the inshore fishing community. However, with increase demand for this resource and increase pressure on its habitat, landings continue to decline throughout its natural range. Recent statistics from Nova Scotia suggest that landings have declined by over 50% in the past 3 years. With all these factors in mind, this species has been identified as an alternate species for aquaculture development by the Department of Fisheries and Oceans (DFO). A key challenge in establishing a sustainable clam farm is the survival of clam seed, following seeding of hatchery-produced seed or wild seed collection (improved natural recruitment strategies). It is well established that the presence of adults or shells increases recruitment of juvenile bivalves. One intriguing possibility is that their presence alters sediment chemistry, and more precisely decreases acidity in the pore water. The primary objective of this project is to determine practical methods (i.e. addition of shell, cultivating) to change chemical parameters of the sediment, thereby increasing the recruitment and survival of juvenile clams, and possibly the growth of older clams. The chemical parameters that were measured are sulfide, calcium carbonate and pH. The density of clams was also measured. Results will be presented.

Poster Presentation Abstracts in Alphabetical order—continued

Sharon A. Lynch ,*M. Cross, E. O'Grady, E. Morgan, R. O'Riordan, S.C. Culloty

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Shellfish productivity in the Irish Sea: working towards a sustainable future (SUSFISH).

The Irish Sea is a rich source of shellfish species, both in terms of abundance and species diversity. The shellfish industry has concerns about the biological, environmental and economic impacts of climate change on aquaculture in this region. The SUSFISH project, a collaborative project between University College Cork, Ireland and Bangor University, Swansea University and Aberystwyth University, Wales, UK, will identify the effects that climate change will have on shellfish stocks in the Irish Sea and from these findings will produce guidelines for future fisheries management. The shellfish species being investigated are the Pacific oyster, *Crassostrea gigas,* the European flat oyster, *Ostrea edulis*, the soft shell calm, *Mya arenaria*, the razor clam, *Ensis* spp., the edible cockle, *Cerastoderma edule* and the blue mussel, *Mytilus edulis* all found in the Irish Sea. The influence of temperature, salinity and acidification on bivalve growth, density, reproduction, immune response and disease are being investigated. Population genetics of the bivalves and the parasites that infect them will be undertaken. Mathematical modelling of host parasite interactions is being undertaken on the collated data. SUSFISH will identify strategies for exploiting potential opportunities from the changing climate as well as identifying how best to mitigate economic losses.

Clyde L. MacKenzie, Jr.[1], Mitchell Tarnowski[2]

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How a Climate Shift Resulted in Large Changes in the Landings of Mollusks, Lobsters and Finfish on the Northeastern Coast of the United States

In most of the northeastern United States, the commercial landings of several wild bivalve mollusks and also lobsters, *Homarus americanus*, winter flounders, *Pseudopleuronectes americanus*, and cod, *Gadus morrhua*, have declined sharply in the past three decades, 1980 to 2010. The declines contrast with their landings in the previous three decades, 1950 to 1980, when landings were nearly level among years. It also contrasts the landings of northern quahogs, *Mercenaria mercenaria*, in Connecticut and lobsters in Maine that have risen sharply. While the landings have changed, there has been a corresponding scarcity of seed (juveniles) in the beds in which the landings have declined and a large abundance of seed where they have increased. The changes in species landings correlate with a major shift of the North Atlantic Oscillation (NAO) that had been in mostly a negative mode from 1950 to 1980, but then shifted to mostly a positive mode afterward. When the NAO is in the negative mode, winters are relatively cold and wet, and when in the positive mode winters are warm and dry. Separate studies in the U. S. and Europe have shown that major changes in the ecology of coastal environments have taken place as the waters have been warming after about 1980. The presentation will describe a history of the landings of each species, show maps that illustrate where specific changes have occurred, and then discuss how the NAO mode shift has been the driving force that has affected the commercial landings

Rayner **Piper**

Emu Ltd, Trafalgar Wharf, Unit 16, Hamilton Road, Porchester, PO6 4PX

A review of the brown crab (*Cancer pagurus*) fishery and ecology at Hastings

A dredge licence for Hastings Shingle Bank was granted in 1989 with renewals granted in 1996 and 2001. As part of the current licence conditions, a crab catch monitoring programme has been in place since 1996. Despite many years worth of compliance monitoring data, the cause of observed declines in the Hastings Shingle Bank (HSB) brown crab (*Cancer pagurus*) fishery remains unexplained. The fishery is highly variable, both temporally and, to some extent, spatially. This adds further complexity to data interpretation when coupled with the Hastings *C. pagurus* population dynamics which are largely unknown. As a result, the need, design and imposition of meaningful management measures relating to anthropogenic activities potentially affecting the population has not been possible.

This poster evaluates available physical, biological and human activity data and uses any new interpretations to develop and explore hypotheses for the Hastings crab fishery decline. Importantly, it identifies knowledge gaps thus enhancing accurate assessment of nearby aggregate extraction effects at HSB Licence Area 366 - 370 and of potential future dredging at Hastings South (Area 460) on the local brown crab fishery.

Ghazala Siddiqui, Zarrien Ayub, [2]David Roberts, and [3]Janet H Brown

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Restoration of *Crassostrea gryphoides*, the native oyster of Pakistan

Pakistan borders the north-western Arabian Sea.with a coastline of about 1000-km. It is bestowed with numerous living/non-lining marine resources. The coast of Pakistan is semi-arid with few mangrove covered areas and is consequently adversely affected by geomorphological changes occurring at the land water interface due to oceanic currents, waves and tidal oscillation. These changes are aggravated by strong winds during the monsoon season which results in shoreline erosion/accretion bringing sand into the creeks. As a result, turbidity increases which reduces primary productivity presumably affecting benthic filter feeders such as oysters, mussels and clams. Furthermore upsloping, increased salinity, reduced oxygen levels, shifting of the Indus Delta eastward and man-made stresses have added to the problem.

Nine species of edible oysters, six representing the genus *Crassostrea,* two of *Saccostrea* and three of *Ostrea* are known to occur in the coastal waters of Pakistan. Despite the absence of commercial exploitation or mortality due to disease, edible species of *Crassostrea* are on the verge of extinction on both the Sindh and Balochistan coasts where they used to be abundant. In addition, spatfall of these oysters is very low and consequently the natural development of new stocks is highly unlikely in future. There is considerable information on the reproductive patterns and the spawning seasons of Pakistani oysters. Thus the restoration of self-sustaining oyster populations will initially depend upon hatchery production targeting. The project will involve initiating baseline surveys to establish the current status of *Crassostrea gryphoide*s and its associated biodiversity and developing techniques for producing oyster spat for restocking on an experimental scale in a pilot hatchery.

Poster Presentation Abstracts in Alphabetical order—continued

Belinda Vause,
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The Chichester Harbour Oyster Partnership Initiative (CHOPI)

The oyster *Ostrea edulis* population in Chichester Harbour has recently declined. There is evidence to suggest recruitment failure and it is believed that the low density is restricting fertilisation success. In February 2010 CHOPI was born and a unique partnership between Sussex IFCA, Chichester Harbour Conservancy, Natural England and the local fishermen was established. The initiative was to create pockets of broodstock by relaying adult oysters at high density in a number of areas hopefully boosting fertilisation success and kick-starting wider repopulation (these areas being voluntarily closed to fishing). In November 2010 the local fishermen participated in catching 2.3tonnes of broodstock and relaying at approx 30m2. During spring/summer 2011 Southampton NOC will be providing an assessment of reproductive potential and Cefas continue to provide valuable guidance. The final alliance is with the local Council Environmental Health teams who are enabling CHOPI to gather CPUE and population size structure information during their classification monitoring regime, long-term this will monitor the success of the initiative. The finance and resource burden has been spread between the CHOPI partners and through well structured collaboration it is believed all parties may see the desired outcome; a revived oyster stock in Chichester Harbour.

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Preparing Florida Hard Clam, *Mercenaria mercenaria*, Culture for Climate Change

Increasing ocean temperatures and sea level rise occurring from climate change will affect worldwide coastal fisheries, oyster-based ecosystems and aquaculture. Models predict that average surface temperature of the Earth could increase 1.8-4.0ºC by 2100. Organisms that are currently near temperature thresholds are likely to suffer increasing mortality. Shellfish growers across Florida, USA have experienced losses of market-size clams when summer water temperatures exceed 32°C, especially on the Gulf of Mexico coast where temperatures have increased by 0.3 to 2.0ºC in the past 20-30 yrs. In light of recurring summer mortality events, as well as increasing ocean temperatures, it is clear that the Florida clam aquaculture industry needs a heat-tolerant clam strain to reduce summer mortalities, adapt to future climate change, and continue to contribute to global food security. Preliminary results indicate that oxidative-stress protection by heat shock proteins shows intraspecific variation and could be heritable. Other studies indicate that metabolic response to thermal stress may play a role in survival and could also be heritable. This information will have broad implications, not only for invertebrate aquaculture, but also marine ecology as we face the prospect of increasing ocean temperatures associated with global climate change.

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Supports the seafood industry for a sustainable profitable future; it covers all aspects of the industry from capture fisheries through to aquaculture and serving seafood. It is funded by a levy on all seafood landings at point of first sale in UK.
www.seafish.org.uk

SEPA

is the Scottish Environment Protection Agency, Scotland's environmental regulator, with the role of protecting and improving the environment. www.sepa.org.uk

SARF

The Scottish Aquaculture Research Forum is a registered charity and an independent company whose main aim is to support research into aquaculture and related areas.
www.sarf.org.uk/

Fishmongers' company

is one of the Twelve Great Livery Companies of the City of London, and among the most ancient of the City Guilds. For over 700 years, they have been responsible for upholding standards in the trading of fish and shellfish and have supported the fisheries industry. Many students have reason to be grateful for their support through their bursaries for postgraduate studies and they have supported the Shellfish Association of Great Britain for very many years.
www.fishhall.org.uk/

Stirling Council

Stirling is one of Scotland's newest cities but possibly one with the greatest history. The Council is the political and executive body that oversees the rich and varied activities in the area. The Council are jointly hosting the Civic reception to be held on Wednesday evening.
www.stirling.gov.uk/

"Shellfish: our Undervalued Resource", theme of the 14th International Conference on Shellfish Restoration

Dot Leonard

If we consider shellfish only as a food source we would miss its outstanding value as an ecosystem architect or the beds as massive filter systems clarifying the water to allow eelgrass and other highly valued vegetation to flourish. There are numerous books that elaborate on the pleasure of consuming oysters and other molluscs but miss their most important value as the very basis of aquatic life in our estuaries.

The first ICSR, held in Hilton Head, South Carolina in 1996 was designed to recognize the importance of shellfish as indicators of environmental quality and to examine how the health of coastal ecosystems could be improved through shellfish restoration. The second conference attracted over 200 scientists, resource managers, and government officials who met to consider how community, regional, national and international partnerships can help the shellfish restoration process. The focus was on successful techniques and how they could be applied to multiple estuaries throughout the world.

ICSR meetings differ from many scientific conferences as they feature opportunities to exchange ideas and form partnerships. At the ICSR, the tea breaks, lunches and evening social events are important because much of the collaborations between scientists, managers and community activists begin in these settings. This year the ICSR in Stirling from August 23 to 27 includes an excursion to the Edinburgh Festival featuring the Military Tattoo, a field trip to the Firth of Forth and is topped off with Scottish gala conference dinner and ceilidh.. Replete with interesting presentations the ICSR in Stirling will also be entertaining and an opportunity to meet friends from around the world.

The ICSR has been held in many countries - Ireland, the Netherlands, France and twice in Canada but never before in the United Kingdom. Although the themes vary, most meetings have focused on the environmental and social aspects of molluscs. In the case of the UK, some literature claims that the only focus is the consumption of oysters and cockles. However, in the case of Scotland we can challenge that theory. Restoration of the native species has increased in importance worldwide and is preferred to the introduction of exotics that can become an expensive invasive species as in *Crassostrea gigas* fouling the valuable mussel beds of the Waddensea estuary. In Scotland, Tristan Hugh-Jones has successfully expanded the population of *Ostrea edulis* in Loch Ryan, an outstanding example of how carefully managed aquaculture can provide ecosystem services while providing an option to the non-native *Crassostrea gigas*.

Dorothy L. Leonard (Dot) pictured above at a recent ICSR meeting in Charleston

Dot is one of the founders of the ICSR and has played an invaluable ongoing role as adviser to this year's conference in Stirling

As President of Ocean Equities LLC, Dot consults on shellfish restoration and aquaculture projects, currently developing Best Management Practices for Shellfish Restoration and a marketing plan for Chesapeake Bay watermen entering shellfish aquaculture. Following 20 years with the U.S. NOAA Fisheries and Ocean Service she now provides consulting services in risk communication, shellfish restoration, aquaculture development, natural resource management and land use planning services. She Co-Chaired seven U.S. conferences of the International Conference on Shellfish Restoration, serves on the International Advisory Committee of the International Conference on Molluscan Shellfish Safety, the Advisory Board of the East Coast Shellfish Research Institute and chaired the 2004 International Workshop on Molluscan Shellfish Safety. For the Interstate Shellfish Sanitation Conference, Dot chairs Restoration and Resolutions committees and serves as advisor to six states developing Vibrio vulnificus (Vv) Risk Management Plans.

Tristan is a speaker at the ICSR in Stirling. The challenging theme of the conference is "Shellfish: our Undervalued Resource". Chaired by Janet Brown the meeting features such speakers as Melanie Austen who will address *Ecosystem Services – adding value to shellfish resources*; Luca van Duren on *Shellfish as Ecosystem Engineers: small-scale processes and large-scale consequences*.; Robert Rheault: *Ecosystem Services rendered by Shellfish Aquaculture* and Mark Spalding *Rediscovering Baselines and Rebuilding Reefs – understanding the challenges of ecosystem scale restoration in North America.*

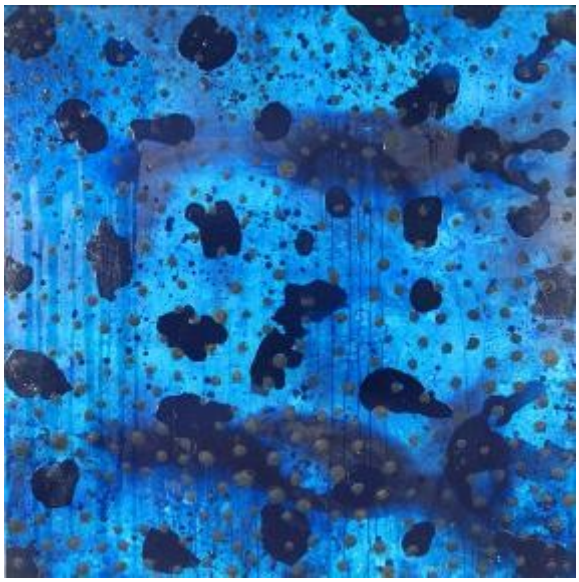
This article was first published in The Grower, July 2011. The Grower is the Newsletter of the Association of Scottish Shellfish Growers and is published quarterly in both hard copy for members and online at the ASSG website www.assg.org.uk

Pictured above; The Wallace Monument rises majestically above the University buildings. The Monument is open for visitors from 10-18.00 each day but last admission is 45 mins before closing. You can still get a terrific view just from the base of the Monument but an even more spectacular one if you climb the 246 spiral steps inside, as well as taking in the story of Sir William Wallace and see his mighty sword. The Monument was constructed in the 1860s to commemorate one of Scotland's great heroes.

Art flavoured Civic reception

Janet Brown sets the scene.....

In delegates' conference packs they will find a formal invitation to a Civic Reception hosted by the conference organisers and the Provost of Stirling on the Wednesday evening at 6pm. There will be guides on hand to escort the delegates to the other side of the campus to the event. Why, might everyone ask, is it necessary to trek across what is reputedly the most beautiful University campus in the UK? A little gentle exercise may be good for us after a day sitting listening to talks but the real reason for hosting the event in the Pathfoot building is so the delegates can take the opportunity to see the art collection housed there. As you enter the Pathfoot Building you will see some of the famous Scottish Colourist collection gifted to the University by Margaret Morris, the widow of the artist J.D.Fergusson and herself a gifted artist, in the medium of dance. These are often away on loan to other exhibitions but are happily all here for the period of the conference. In contrast on the left as you enter is the newest acquisition, "and listing deep" - a mixed media painting (*pictured above right*) inspired by the poem "The Bower" with its suitably aquatic theme for our purposes. Once you arrive at the Crush Hall you will see my particular favourite, pictured here *(right*) "Stay Blue" by Olivia Irvine.



Above; Polyphony by Diane Tulloch

You may also wonder why the garden to your right as you enter the Crush Hall has an oyster catcher theme – you would better understand had you arrived in May when the oyster catchers are rearing their young in this and other quadrangle gardens around the building! The current curator of the Collection is Jane Cameron who hopes to be on hand to provide further information should anyone require this but it was not possible to say definitely at the time of going to press.

For further information on the Stirling University art collection please visit **www.artcol.stir.ac.uk/ArtatStirling.html**