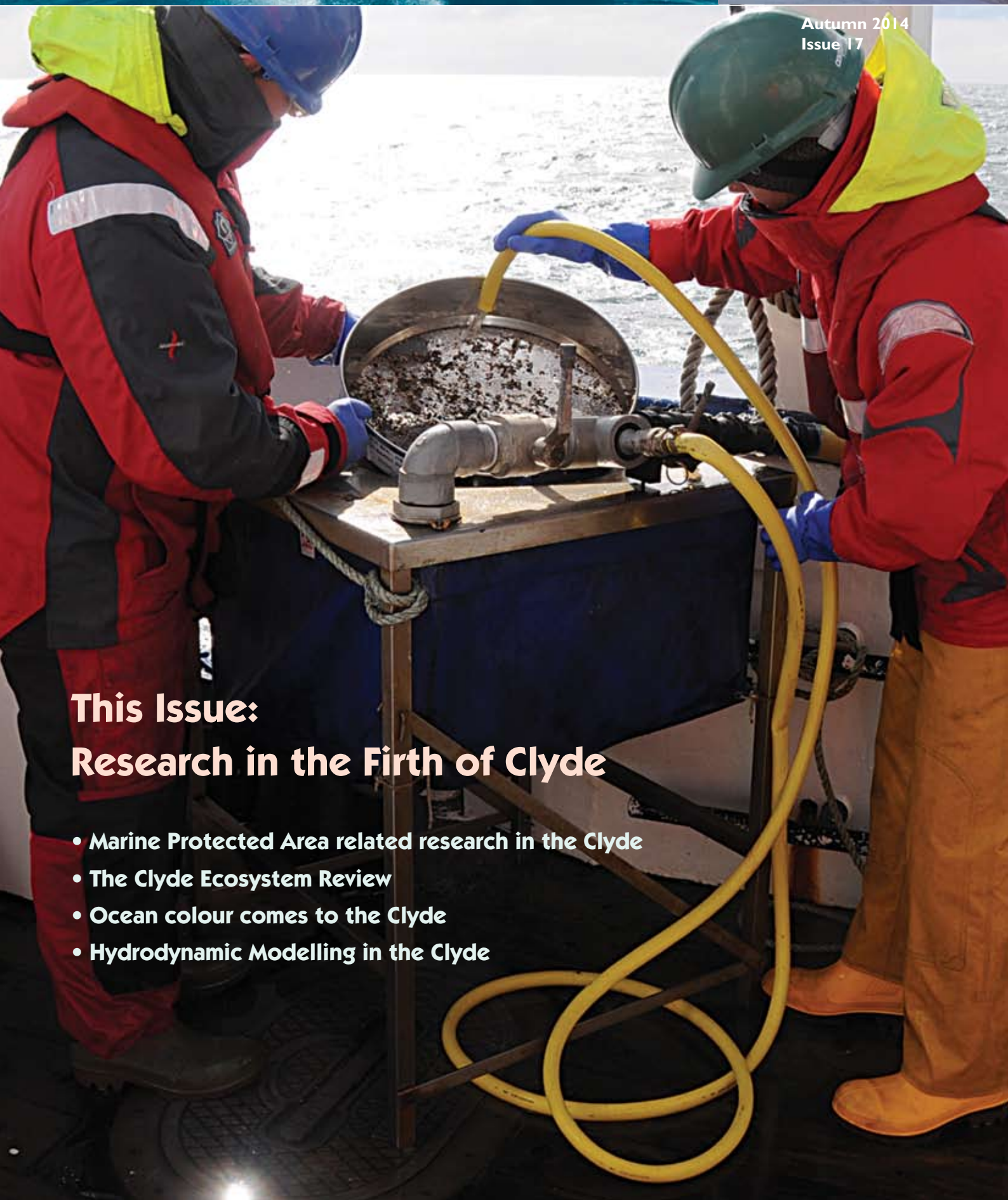
A partnership to care for the Clyde: its environment, its people and its visitors

Clyde Breakers

FIRTH OF CLYDE FORUM NEWSLETTER

Firth of Clyde FORUM

Autumn 2014
Issue 17



This Issue:
Research in the Firth of Clyde

- Marine Protected Area related research in the Clyde
- The Clyde Ecosystem Review
- Ocean colour comes to the Clyde
- Hydrodynamic Modelling in the Clyde

Contents

Forum Focus

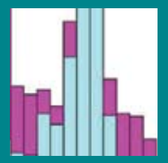
3 Sea Level Rise and Storm Surges

3 Clyde 2020

Research on the Firth of Clyde

4 Marine Protected Area related research in the Clyde

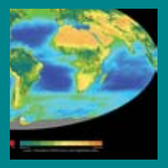
6 Science and Lamlash Bay No Take Zone



8 The Clyde Ecosystem Review

10 Early Evidence of Overfishing in the Clyde

13 Marine Biosecurity Guidelines Published



14 Gadoid Biomass in the Firth of Clyde

16 Ocean Colour comes to the Clyde

18 Hydrodynamic Modelling in the Clyde

20 FSC Millport

Front cover photograph © SNH

Printed on recycled paper

Firth of Clyde Forum News

Welcome to the Autumn 2014 edition of Clyde Breakers!

This edition of Clyde Breakers focuses on reports from a variety of sources on scientific research that has been carried out recently on the Firth of Clyde. It gives the researchers an opportunity to reach a wider audience and so we hope you have your thinking caps on!

2014 has so far proved to be a very busy year. The Forum was asked by Scottish Government to co-ordinate the Clyde 2020 Summit in April where many stakeholders were invited to start work on a process which aims to set out objectives and an action plan to recover the ecosystem in the Firth of Clyde. More on this in the Project Managers' Update on the opposite page. We have been involved in several workshops/ conferences – in May we led a session on coastal adaptation for the Glasgow and the Clyde Valley Strategic Development Planning Authority during their climate change adaptation workshop; in June we were involved in Public Dialogue workshops to consider how the general public view Ecosystem Services & Benefits and the Ecosystem Approach; in August we gave a presentation at the International Marine Conservation Congress held at the SECC. Since the beginning of the year the Forum has been providing secretariat services to the South West Inshore Fisheries Group. We have also been working with Marine Scotland to establish how best to deliver Regional Marine Planning in the Clyde and will provide further updates on this as it progresses.

We hope you have enjoyed the good weather this summer and have had an opportunity to get out and about on, in or around the Firth of Clyde!

Best wishes,

Isabel Glasgow
Firth of Clyde Forum Chair

Fiona Mills and Sarah Brown
Project Managers

Tribute to Archie McFarlane, a fisheries colleague who will be sorely missed.

The Firth of Clyde Forum Chair, its Core Group members and staff wish to pay tribute to Archie McFarlane, past Secretary of the Clyde Fishermen's Association, whose untimely death has been a great shock to us all. Archie has been a member of the Core Group for the last 5 years.

We will all remember him as a courteous and dedicated colleague, who did not shrink from expressing strong views on behalf of members of his Association but was always ready to listen to opposing views. He commanded universal respect and it was a pleasure to work with him. We will all miss him.

The huge gap created in the Clyde network by Archie's death has now been filled by Patrick Stewart, former Secretary to the Association, who has agreed to take over the work as Secretary on an interim basis.

© SNH

Sea Level Rise and Storm Surges in the Firth of Clyde

By Fiona Mills

This project has now managed to access all the data to map projected sea level rise including storm surge at 2020, 2050 and 2080 from South Ayrshire round to the inner Clyde and as far as Holy Loch near Dunoon.

The project will link with SEPA flood risk management work to enable Local Authorities to identify natural and manmade assets at risk from coastal flooding and to introduce measures to adapt to and mitigate against climate change. Case studies in the inner Clyde and Holy Loch will examine options for managed realignment whereby natural resources such as saltmarsh can provide protection against flood risk. The Firth of Clyde Forum has used this project during a workshop with Glasgow and the Clyde Valley Strategic Development Planning Authority to look at climate change adaptation at the coast. We have also used it as a case study for a series of Public Dialogues and meetings with the general public about 'Ecosystem Services'*. The final project report will be finished in autumn this year. Thanks go to our funding partners - SNH, Peel Ports Group, GCVSDPA and Loch Lomond and the Trossachs National Park.

In the spirit of this scientific edition of Clyde Breakers, here is a quick background on sea level rise projections. The Intergovernmental Panel on Climate Change (IPCC) produces global sea level rise projections based on various emissions scenarios, i.e. different levels of emissions of carbon dioxide and other greenhouse gases into the atmosphere. These global scenarios are translated into the UK Climate Projections (UKCP) which give more detailed data at the local geographical level. This project will use the UKCP09 high emissions scenario which describes a world of

- very rapid economic growth,
- increasing population to a peak of 8.7 billion in 2050,
- rapid introduction of new and efficient technologies,
- large reductions in regional differences in GDP,
- high use of fossil fuels.

*Ecosystem Services are the benefits provided by the environment that contribute to making human life both possible and worth living.

Clyde 2020

The Clyde 2020 Summit was called by Cabinet Secretary for Rural Affairs and the Environment, Mr Richard Lochhead, as part of the Scottish Government's commitment to a programme of measures that will identify, test and implement practical actions which may contribute to the renewal of the Clyde marine ecosystem.

The meeting was organised by the Firth of Clyde Forum which was tasked by Marine Scotland to do this work, bearing in mind their role as an independent organisation focused on marine planning and integrated coastal zone management in the Firth of Clyde. Nearly one hundred stakeholders with an interest in the Firth of Clyde ecosystem took part.

The meeting began with a key note address by the Cabinet Secretary and this was followed by presentations on 'The Clyde Ecosystem Review' by Dr Bill Turrell of Marine Scotland and 'The Planning Context' by Anna Donald also of Marine Scotland. The participants then split into groups for workshops on vision, practical measures and research. The workshops aimed to agree the basics of what would make up a vision for Clyde 2020 and tried to set priorities against what practical measures might be appropriate and where the focus should lie with regards to research.

To read a full version of the report on this Summit visit http://clydeforum.com/clyde-reports.

The Firth of Clyde Forum has been asked by Marine Scotland to continue to co-ordinate Clyde 2020 and we are currently organising further workshops to confirm an Action Plan before setting up a steering group to take that forward. Clyde 2020 will also link into the ecosystem work stream during the next Regional Marine Planning cycle.

Photo courtesy of Claire Pescod

Bringing the drop down video system back on board at the end of a video tow © SNH

Marine Protected Areas for the Clyde

On the 24th of July, the Scottish Government (SG) announced the designation of 30 Marine Protected Areas (MPAs) in Scottish waters (see www.scotland.gov.uk for further details). These sites have been established to protect a range of species and habitats including sandeels, fan mussels and flame shell beds. Set within a broader framework of marine planning, MPAs have an important role to play in ensuring the sustainable management of our seas, such that Scottish waters remain a valued and valuable asset now and in the future. Three MPAs have been identified in the Clyde - Clyde Sea Sill, South Arran, and Upper Loch Fyne and Loch Goil. SG's announcement is a culmination of years of work by many people across a number of organisations and groups. Here is an article from Lisa Kamphausen, Marine Policy & Advice Officer at Scottish Natural Heritage, on some of the research carried out by her and her team to inform the decision on the protection of Scotland's seas.

Marine Protected Area related research in the Clyde

By Lisa Kamphausen, Policy & Advice Officer, SNH

A beautiful spring day… with white breaking waves, temperatures just above freezing and the odd bit of sleet. Mud and seawater is splashing from the sample sorting tray, and parts of Arran are still without electricity from the latest storm. Fortunately we are safely aboard SEPA's stable 24 m research vessel MV Sir John Murray, and can continue with our survey of the seabed around Arran despite the typically Scottish weather.

Since the Marine Protected Area (MPA) project started we have been surveying the coastal seas all around Scotland to obtain the information we need to develop and manage this new suit of MPAs. Compared to terrestrial surveys, marine surveys are very time consuming. On land, you can take a look around to see which animals and plants live in a certain place, and you may see a forest stretching many miles along a glen. Underwater visibility is much more restricted, and much of the biology of Scotland's seas remains to be discovered and mapped. We survey the seabed either by diving, by using drop down video systems (an underwater video camera towed behind a boat), or by bringing a chunk of the seabed up to the surface with an automatic grab sampler. Have a look at this video to see a grab sampler in action http://youtu.be/rcJvM9XJ5KQ.

We focussed our surveys on the species and communities which were being considered as protected features of the MPAs. These are species and communities which are not yet protected sufficiently by other existing protected areas, but which are of great importance to maintain a healthy, productive and biologically diverse marine environment in Scotland. These species and communities are not only the rare or threatened ones, but also, or maybe even more importantly, those which are typical for Scotland, and for which Scotland contains some of the world's best examples. In the Clyde there are three MPAs which can protect several of these communities and species. Amongst them are seagrass beds, maerl beds, burrowed mud, black guillemots, ocean quahogs, flame shell beds, and diverse mixed sediment communities. You can find documents with detailed assessments of all of these and much further information on the SNH MPA website: www.snh.gov.uk/mpas, but here are some of the highlights from the recent surveys:

In 2012 we conducted a detailed diver survey of the flame shell bed off Otter Spit in Loch Fyne. Even though flame shells themselves are highly conspicuous with their bright orange tentacles, flame shell beds are one of the hardest habitats to recognise in the MPA network - all you see is that the seabed looks a bit spongy and fibrous. The flame shells build nests around themselves by weaving sediment and debris together with their byssus threads (similar to the way blue mussels attach to rocks), and the nests can form

Processing one of the grab samples – the fine mud is washed off and everything over 1mm is caught in the sieve to be identified later © SNH

The flame shell bed at Otter Spit © Marine Scotland

a continuous mat. Other animals and plants can attach to this, which increases the biodiversity of the area substantially. The nests are very easy to miss on video, and the flame shells themselves are well hidden so we used divers to make sure we didn't miss any of it. We found that the flame shell bed at Otter Spit extends over 50 ha, but is no longer present in part of the area where it had been recorded in the past.

Knowing about the distribution of the marine species and communities is only part of the information we need though. We also have to find out what condition these communities are in. Are they well-functioning diverse assemblages, where many different species all contribute to the overall productivity of the ecosystem? Or are the communities impoverished, with only a few species? Impoverished communities have little resilience to change: if something has a negative effect on one of the few species present, the whole system will be affected. Diverse communities on the other hand can compensate and recover much more easily, because amongst the greater variety of species there are likely to be some which are able to tolerate or even thrive under the new conditions and maintain the functioning of the ecosystem. There has never been a time when resilience to change has been more important than it is now - our changing climate will pose enormous challenges to all ecosystems, which will have to adapt to rapid and dramatic changes as global temperatures rise at unprecedented rates.

The diversity of marine communities is monitored to ensure it is maintained at a level that is as resilient and productive as possible. As an example, we saw during a video survey that the mud around Arran was riddled with burrows of the scampi Nephrops norvegicus in places, but when we looked at grab samples we only found low numbers of other species. Diverse mud communities can contain an amazing array of burrowing species of worms, clams, and crustaceans, as well as exposed and fragile sea pens and anemones.

The coarse sediments we sampled off Arran on the other hand often had very diverse associated communities. Some of these coarse sediments are made up of fragments of dead maerl. Maerl beds are carpets of pink chalky twiglets created by a red seaweed which forms hard branched skeletons. The gaps between the twiglets offer shelter to a vast number of animals and plants, which makes maerl beds highly diverse and productive. Much of the maerl around Arran has been broken up into small fragments and rubble, but we study the diversity of communities associated with these maerl gravels to inform Marine Scotland's development of appropriate management of maerl and maerl gravel areas in the MPA.

We are coming back to Arran in September to have a closer look at some of this with a diving survey, and to collect some video clips of the shallow parts of the MPA which we could not reach on SEPA's bigger Sir John Murray. All this information will be invaluable in managing the Clyde's MPAs in the spirit of maintaining the Scottish Government's vision of a 'clean, healthy, safe, productive and biologically diverse marine and coastal environment that meets the long term needs of people and nature'.

To keep up to date with what the SNH survey team gets up to around Scotland throughout the year follow our survey blog at www.scotlandsseas.wordpress.com and like "Scottish Natural Heritage" on Facebook.

Links to commissioned reports covering some of the recent research in the Clyde MPAS:

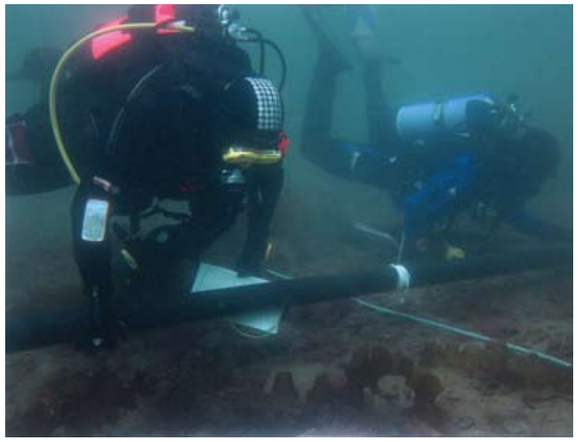
- Infaunal and PSA analyses of grab samples from the Clyde Sea - March and July 2013 http://www.snh.org.uk/pdfs/publications/commissioned_reports/745.pdf
- Validation of seabed habitat MPA search feature records relating to the South Arran possible Nature Conservation MPA http://www.snh.org.uk/pdfs/publications/commissioned_reports/620.pdf
- Biological analyses of underwater video from research cruises in the Clyde Sea (Loch Goil and the South of Arran) and in Orkney (Rousay Sound and Stronsay Firth) http://www.snh.org.uk/pdfs/publications/commissioned_reports/631.pdf
- The distribution and condition of selected MPA search features within Lochs Alsh, Duich, Creran and Fyne

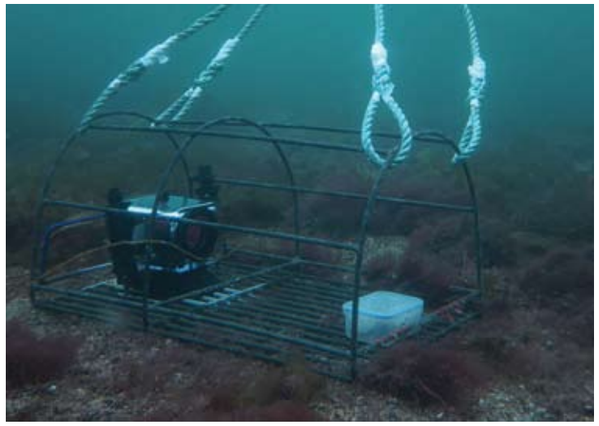
http://www.snh.org.uk/pdfs/publications/commissioned_reports/566.pdf

A juvenile Nephrops (scampi) from the mud off Arran © SNH

Science and the Lamlash Bay No Take Zone

By Andrew Binnie, Community of Arran Seabed Trust (COAST)





Images | Top left: A lobster after being measured and tagged. Top right: Two divers counting all the organisms they encounter along a 50m survey line. Bottom left: The baited underwater video camera within a protective cage. Bottom right: A photoquadrat of the seafloor within Lamlash Bay, the image shows a starfish on a bed of shells.

INTRODUCTION

In September 2008, Scotland's first No-Take Zone (NTZ) protecting a small area from all methods of fishing was established within the Firth of Clyde at Lamlash Bay, between Holy Isle and the Isle of Arran. The NTZ was established after over a decade of campaigning by the Community of Arran Seabed Trust (COAST) for better protection of their seas and now lies within the larger South Arran Marine Protected Area which was designated in July this year.

SURVEY METHODS

In 2010, the University of York in conjunction with COAST, began conducting a series of underwater surveys to investigate how the Lamlash Bay NTZ was responding to protection. What initially began as a series of basic SCUBA surveys has grown to become an extensive monitoring program drawing on a number of different survey techniques. With each survey technique designed to gather data on the different ecological components that make up Lamlash Bay. These include:

Diver surveys

A team of two divers work along a number of 50m x 3m transects in and outside the NTZ, recording the number of organisms they encounter. In addition, every scallop encountered is collected and taken back to the surface where they are measured and aged, before being returned to the sea. A small sub-sample of scallops is however retained for the dissection of their meat and reproductive organs.

Photoquadrats

Over a thousand high resolution photographs were taken of the seabed over three years in Lamlash Bay. Special software was then used to identify and count every organism within the photo and allowed researchers to investigate whether the seafloor within Lamlash Bay NTZ was recovering.

Baited underwater video cameras

Exploring how fish populations respond to the reserve is important if we are to understand how protecting an area of the sea may lead to the recovery of overexploited fish stocks. The use of a baited underwater video camera allows researchers to count and measure fish populations around Lamlash Bay without the need to dive to the seafloor.

Crustacean surveys

With the help and expertise of local fishermen, researchers have been catching lobsters and crabs in and around Lamlash Bay. Every individual caught is measured and sexed before being returned to the sea. In addition, lobster and crab are also tagged with a unique number so their growth and movements can be monitored.

RESULTS

The surveys show that following the designation of the NTZ population dynamics of crustaceans within the protected area have changed. The size and abundance of lobster has markedly increased over time, meaning the percentage of lobsters that are above legal size is greater in the NTZ than in surrounding waters and there is a greater abundance of lobsters within the zone than outside.

In fact, the frequency of berried female lobsters was 5.5 times greater within the reserve than outside. Based on these findings, it has been proposed that the 2.67 km2 marine reserve had a potential egg output equivalent to an unprotected area of 19.1 km2; supporting the idea that MPAs can contribute disproportionally to recruitment in relation to the actual area they protect. The size, age and biomass of scallops have also increased and there is evidence of increased juvenile scallop presence within the NTZ.

However the abundance of Brown Crab is greater outside the NTZ, suggesting that protection from all extractive activities within the NTZ has altered population dynamics.

Images | Animals and plants that attach to the seafloor provide structure and shelter for juvenile scallops (left) and other organisms such as pipe fish (right). Such 'nursery habitats' have been found to be two times more abundant within Lamlash Bay NTZ, suggesting the seafloor may be recovering.

Fin fish populations within and without the NTZ were not found to be significantly different possibly due to the small size of the NTZ and the mobility of fin fish species.

Photoquadrats suggest strong signs that the seafloor within Lamlash Bay NTZ is recovering. In fact, the animals and plants that attach to the seabed (such as maerl, seaweed, hydroids, bryozoans, and sponges) have all been found to be more abundant within the NTZ than outside. Such organisms are important because they provide the seafloor with structural complexity, thereby providing shelter for juvenile fish, scallops and other animals.

This article is based on an earlier report from York University PhD student Leigh Howarth. Leigh has since completed his doctorate and is preparing his full results for publication later this year.

FURTHER READING

• Heath, M. R., & Speirs, D. C. (2011). Changes in species diversity and size composition in the Firth of Clyde demersal fish community (1927-2009). Proceedings of the Royal Society B doi:10.1098/rspb.2011.1015

• Howarth, L. M., Roberts, C. M., Thurstan, R. H., & Stewart, B. D. (2013). The unintended consequences of simplifying the sea: making the case for complexity. Fish and Fisheries, DOI: 10.1111/faf.12041

• Howarth, L. M., Wood, H. L., Turner, A. P., & Beukers-Stewart, B. D. (2011). Complex habitat boosts scallop recruitment in a fully protected marine reserve. Marine Biology, 158 (8), 1767–1780

• Thurstan, R. H., & Roberts, C. M. (2010). Ecological meltdown in the Firth of Clyde, Scotland: two centuries of change in a coastal marine ecosystem. PloS one, 5 (7), e11767

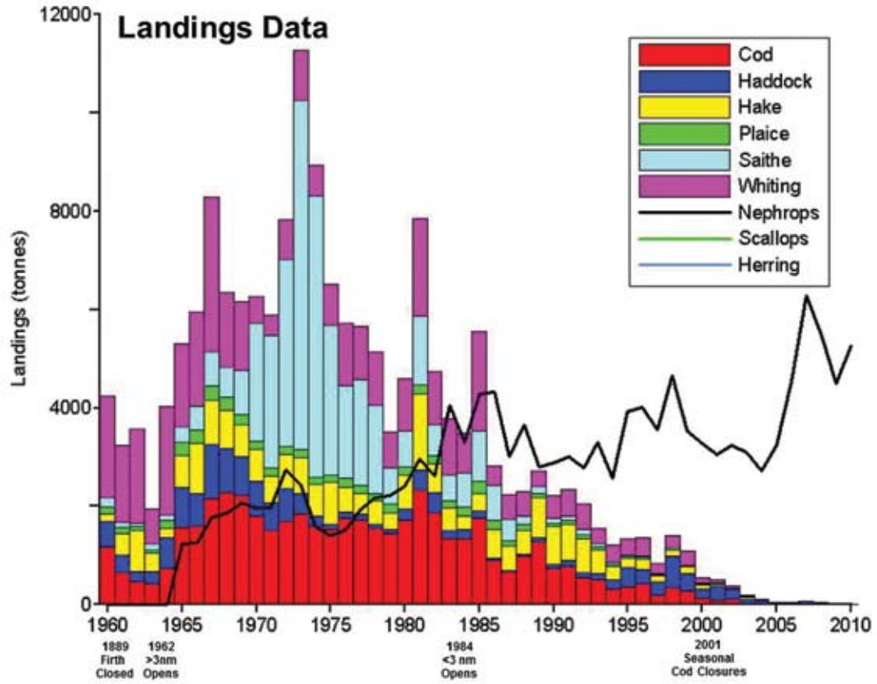
The Clyde Ecosystem Review

By Dr Bill Turrell, Marine Scotland Science Team Leader

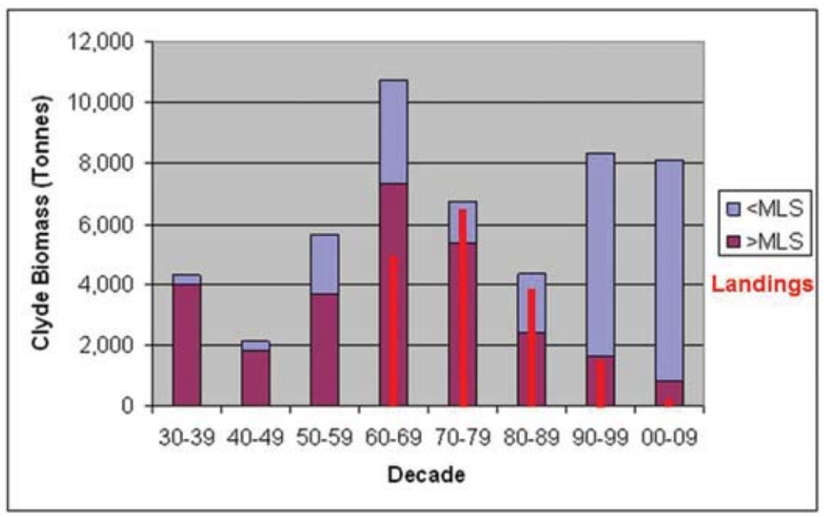
Graphs courtesy of Prof. Heath and Dr. Speirs

In 2010, Marine Scotland Science (MSS) commenced work to review the state of the Clyde Ecosystem in response to expressions of grave concern for its well-being, based on a study that relied heavily on landings data. Independently from the process underway within Marine Scotland, the University of Strathclyde also commenced work on the issue of the ecological status of the Clyde. The University study used research vessel survey data obtained from MSS.

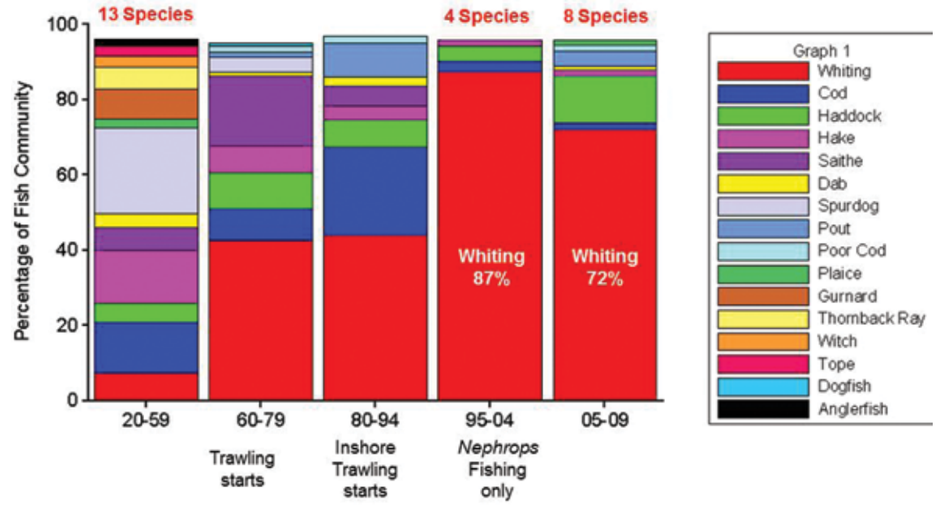
What follows is an extract from the Executive Summary of the Clyde Ecosystems Review (McIntyre, F., Fernandes, P.G. and W. R. Turrell). Dr Turrell's full presentation at the Clyde 2020 Summit, which included more detail on this topic is available from Sarah Brown, Firth of Clyde Forum Project Manager at sarah@clydeforum.com.



Survey Data – White Fish Biomass



Survey Data - Mix of Fish Species in the Clyde



As a result of a detailed and well-found analysis, in July 2011 Professor Heath, with Dr Doug Speirs, published an analysis of the present state of the Clyde Sea demersal fish community in their paper entitled "Changes in species diversity and size composition in the Firth of Clyde demersal fish community (1927-2009)" (Heath and Speirs, 2011).

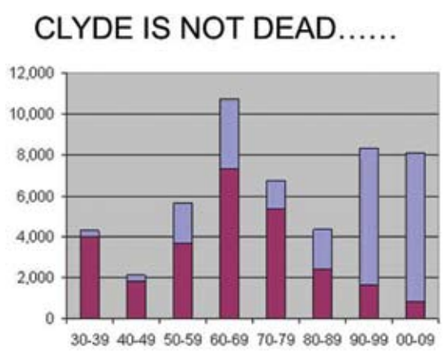
Heath and Speirs' conclusions (2011) point to a major ecological impact of fishing in the Clyde. However, the picture portrayed by Heath and Speirs is not one of an ecological desert, but of a severely altered ecosystem. Their principal conclusions were:

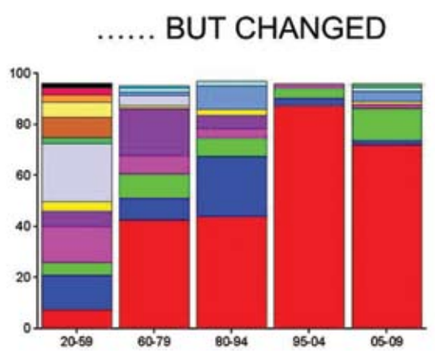
- Rather than commercial species being entirely removed from the Clyde, the biomass of the six main commercial species in the late 2000s was approximately double that prior to the onset of trawling in the 1960s.
- However, the size structures of these species were dramatically different, being markedly deficient in large commercially marketable individuals after the period of peak harvesting rates in the 1980s.
- Also the incidence of species with a maximum attainable length greater than 40 cm declined precipitously and did not recover during the period of low harvesting rates after the late 1990s possibly owing to internal predator–prey interactions.

This means that the Clyde Sea still functions as an ecosystem. Primary production still occurs, powered by the sun and supplied by water-borne nutrients, which sustains secondary zooplankton production, which in turn feeds an active food web. However, the Clyde ecosystem has been changed. The biomass of fish in the Clyde is the same, or for some species, more than when intensive fishing started. Additionally, a large and healthy population of shellfish (Nephrops) living on the seabed of the Clyde is present, but the community of fish is now made up mostly of small fish, and mostly small whiting.

The Clyde ecosystem is one that has been used by humans for centuries, and hence it is changed. But humans can also now influence the direction the ecosystem takes by managing human activities in the future.

The full report can be downloaded from http://www.scotland.gov.uk/Publications/2012/06/7562.





'Fishing Boats at Port Righ, Carradale'. John Campbell Mitchell (1898)

Early evidence of overfishing in the Clyde: a cautionary tale

By Peter Jones, University of Strathclyde

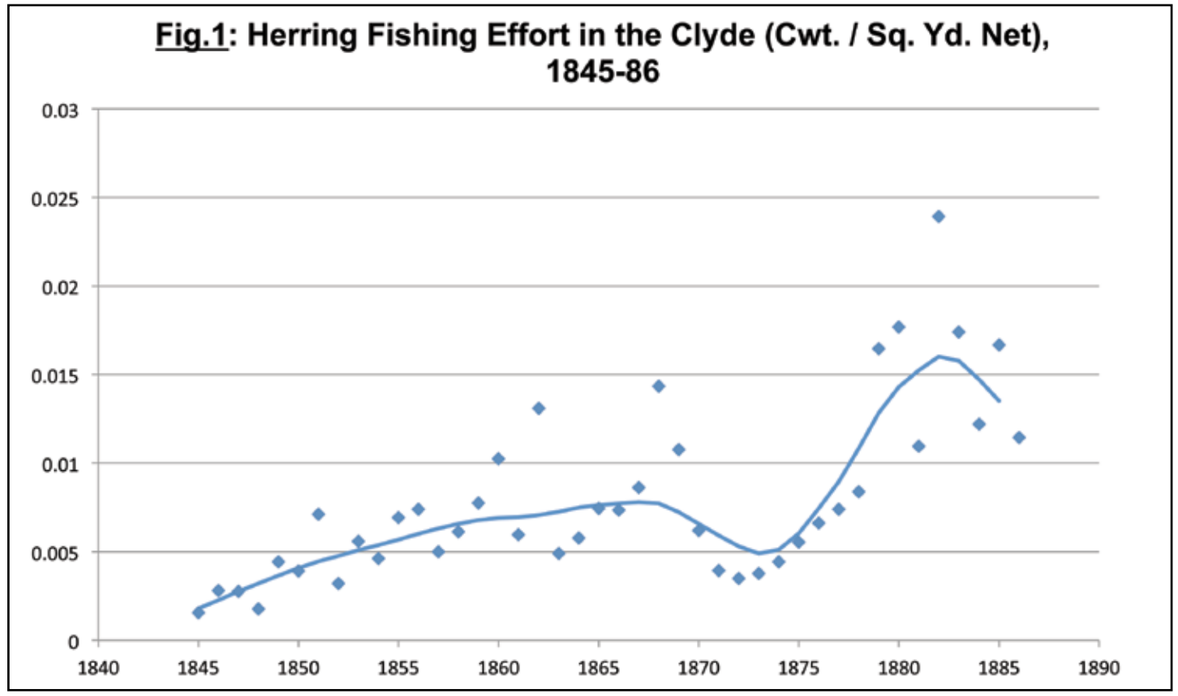
A lot has been written about the state of the Clyde's fish stocks, recently. In 2010, a team of marine scientists from York University caused a stir by claiming that the Clyde was at the point of 'ecological meltdown'.[1] Although not everyone agreed with their findings, most researchers now believe that over 100 years of commercial fishing has taken a severe toll on Scotland's largest inland sea, and that drastic action is necessary to safeguard the marine environment and the future of commercial fishing in the Clyde. Many, if not most, of those who believe such action is necessary point the finger of blame at bottom trawling and the rise of motor power.

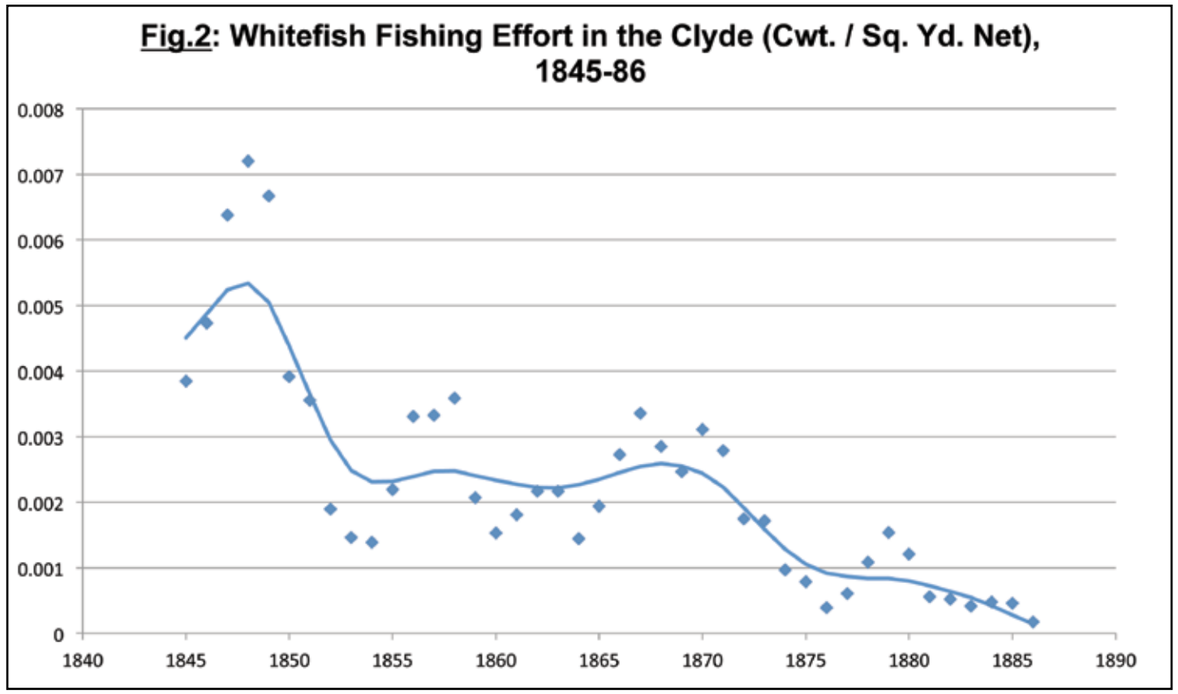
Although trawling has always attracted a degree of controversy, we are only now beginning to realise just how devastating it can be, not only for fish stocks, but also for the fragile benthic marine environment, the sea bed itself. Sea bed ecology is particularly susceptible to change: it can take years, decades, and even centuries for it to regenerate after disturbance, so the effects of dragging a trawl beam or otter boards across it can long outlive the period of trawling itself. All things considered, marine conservationists perhaps have good reason for focusing on trawling when pointing to the history of overfishing and destructive fishing methods.

Yet for the Clyde, the focus on the development of steam trawling may have masked an even longer-term trend in overfishing and declining fish stocks. Evidence is now emerging that overfishing was at first a product, not of drastic changes in productivity with the adoption of beam trawling and steam power at the end of the nineteenth century, but of the much gentler, but no less destructive, increase in the traditional fishing gear of small boats, drift nets and hand-lines fifty years earlier.

The evidence for this comes from the statistics of the Fishery Board (or, more properly, the Commission for the British Fisheries) which are held in the archives of the National Records of Scotland in Edinburgh. The Board recorded most landings of herring in Scotland from 1809 onwards, and those of commercially fished 'whitefish' (mostly cod, ling and hake, but also haddock and pollock) from 1821. Not only that; it also recorded, in one form or another, the total square yardage of drift nets used to catch herring and the total yardage of hand-line used to catch whitefish from 1845 onwards.

By putting these two sets of statistics together, it is possible, not only to track the overall amount of fish caught across most of the nineteenth century, but also to give an indication of the productivity of fishing in the Clyde from 1845 onwards – something which, to date, has only been done for the twentieth century. The standard method for calculating fishing productivity is to estimate what is called the 'catch per unit effort' (or CPUE) of fishermen by dividing the amount of fish they catch by the amount of 'effort' they put into catching them (in this case, measured by square or nets and yardage of hand-lines used).





The early results of this exercise are very interesting indeed. In terms of the herring fishery, it appears that CPUE fluctuated considerably, did not generally decline across the second half of the nineteenth century, and in fact the general trend was upwards (Figure 1). This is unsurprising: herring are a migratory species, and fishermen have long been aware of natural, sometimes profound, fluctuations in their availability. The most famous case of this migratory capriciousness is probably that of the historic Bohuslän fishery in Sweden. There, historians have discovered that the herring would visit the Kattegat sea (similar, in many ways,

CONTINUED ON PAGE 12

FROM PAGE 11

to the Clyde) in tremendous numbers for between twenty and eighty years from the fourteenth to the eighteenth centuries, but then would disappear as quickly as they arrived for up to a hundred years at a time.

In other words, the most likely explanation for the success of the Clyde herring fishermen in the mid- to late-nineteenth century is sheer luck, as the herring seem to have migrated north from the open sea, through Kilbrannan Sound and into Loch Fyne in ever increasing numbers! For whitefish, though, the story is very different. After an initial rise between 1845 and 1848, productivity for hand-liners in the Clyde followed a consistent and quite dramatic downward trend (Figure 2). Once again, the explanation for this can be found, at least in part, in the nature of the fish themselves. As Mike Heath and Douglas Speirs suggested in a recent article on Clyde fish stocks in the twentieth century, demersal white fish in the Clyde (that is, those fish that live close to, or are partially reliant on, the sea bed) seem to be 'spatially distinct' from other demersal fish communities in the open sea. In other words, there is reason to believe that there is much less 'outside recruitment' of many species of Clyde whitefish than there is among similar communities in the open sea, and as a result they are far more 'susceptible to local impacts of fishing'. [2]

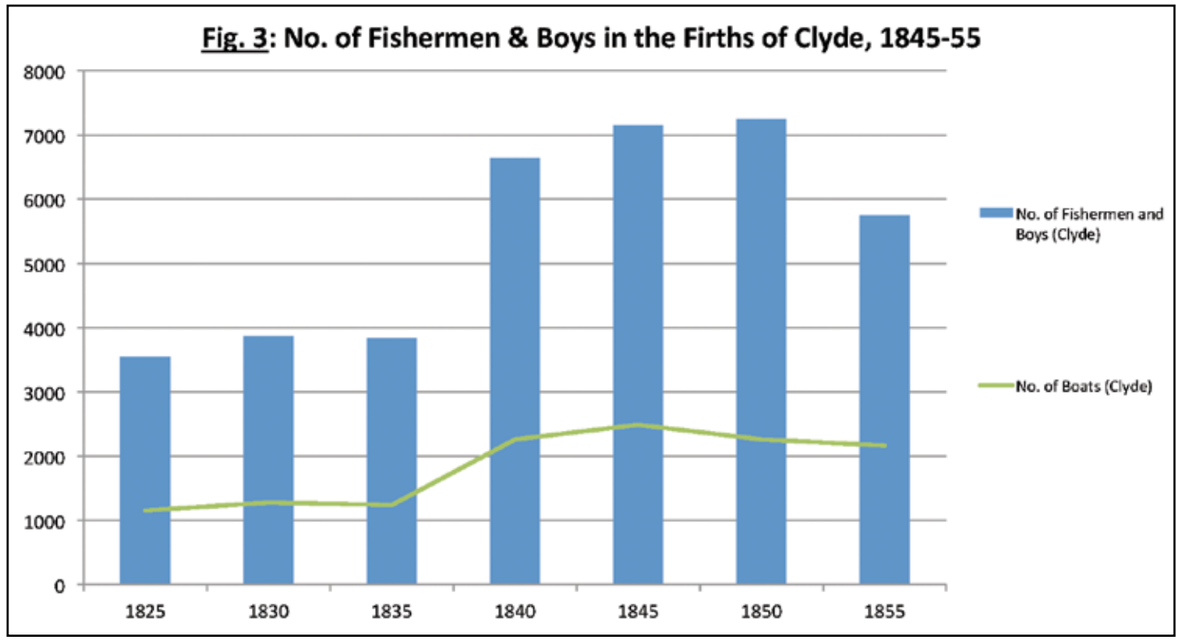
It is no coincidence that the period which saw the beginnings of the decline in productivity (CPUE) in whitefish catches occurred shortly after a great increase in the number of boats, boys and men fishing in the Clyde (Figure 3). Many of these would have fished for herring using drift nets in the Spring or Autumn, and would then have reverted to hand lines for whitefish in the Winter. Certainly, by the 1860s fishermen themselves were noting both the increase in the number of herring they were catching, and the dramatic decrease in the availability of whitefish. David Galbraith, of Campbeltown, spoke for many when giving evidence to the Parliamentary Commission on Sea Fisheries in 1866: of the herring fishery, he said, 'I think it is rather gaining. There are both better fish and more of them too'; but of the cod and ling fishery, he was adamant that 'they are not near-hand so plentiful. I have seen them getting 20 and 30 score, and now it is very rarely they can get eight score'.

So what are we to make of this cautionary tale from the archives? On the one hand, it suggests that we need to look much further back than we have so far in order to get a true picture of how and when our fisheries began to decline. It may seem obvious to blame motor power, trawlers and the era of 'industrial fishing', but the truth is likely to be more complex (and, perhaps, more unsettling) than that. The history of the Clyde fisheries in the nineteenth century demonstrates that relatively small shifts in the balance of power between fishermen and marine resources can have quite drastic effects, especially in fragile and sensitive ecosystems like the Clyde. If we are to rectify past wrongs and protect our sheltered inshore waters for the future, the message is that we need be much more sensitive in all our interactions with them; and, in this, we cannot afford to ignore the lessons of history.

Peter Jones is a doctoral candidate in environmental history at the University of Strathclyde. peter.jones@strathclyde.co.uk.

[1] R.H. Thurstan and C.M. Roberts, 'Ecological Meltdown in the Firth of Clyde, Scotland: Two Centuries of Change in a Coastal Marine Ecosystem' PLoS One, 5:7 (2010), e11767. doi:10.1371/journal.pone.0011767, 10.

[2] M.R. Heath and D.C. Speirs, 'Changes in Species Diversity and Size Composition in the Firth of Clyde Demersal Fish Community (1927-2009)', Proceedings of the Royal Society B, 279 (2012), doi:10.1098/rspb.2011.1015, 548.



Marine Biosecurity Guidelines Published

By Sarah Brown, Firth of Clyde Forum

Following on from the creation of a biosecurity plan for the Clyde the Forum has taken the work a step further by publishing, in partnership with SNH, guidance on how to structure a biosecurity plan for a marine site or specific marine event.

The guidance has been heralded as ground-breaking and has been adopted by Natural Resources Wales, SEPA and SNH as guidance for use in case work. CEFAS and DEFRA have also circulated it to relevant staff for use in their work in England and Wales. Already RYA Scotland has used it to create a biosecurity plan for the Commonwealth Games Flotilla which recently brought 250 boats to the inner Clyde.

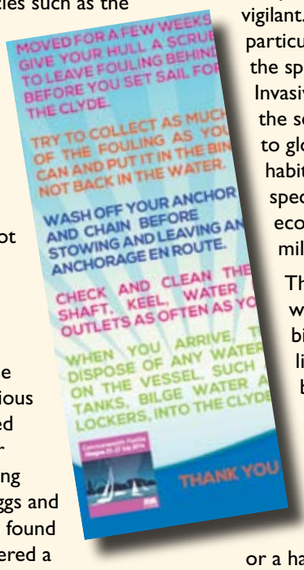
The guidance gives site operators easy to follow procedures for creating a biosecurity plan which will help to reduce the threat of moving and introducing new species to their site. More than 90 marine invasive non-native species have been identified in British and Irish waters, 17 of which are now established in Scotland.

As it is now an offence to introduce INNS to Scottish waters through commercial or recreational marine activities, even if the introduction was unintentional, using the biosecurity planning guidance can help organisations avoid prosecution and the financial cost if something does go wrong. Creating a biosecurity plan also highlights a business's green credentials in responding responsibly to a serious environmental threat.

The Firth of Clyde Forum has produced a handy, pocket-sized INNS identification guide and an online reporting system, linked through from our home page, www.clydeforum.com, which complements SNH's marine tracker mobile phone app.

The invasive plants and animals can destroy local species and habitats, affecting the food chain and biodiversity, leading to massive financial costs for fisheries and other leisure and commercial marine operations. These globetrotters get to Scottish waters by hitching a ride on the hulls of boats or in ballast water. Some can survive for several days out of the water on damp hulls, bilges and water-sports gear.

Species such as invasive carpet sea squirts like *Didemnum vexillum*, a fast-growing animal which smothers underwater structures, plants and animals, are already present in Scotland. This sea squirt was first reported in the UK in 2008, and has been found in several sites in the Clyde. Other brackish water species such as the Mitten Crab which can destroy bankside habitats with their destructive burrowing and the Zebra Mussel, which multiplies at an astonishing rate, can quickly clog water intakes and block canal gates thankfully have not got established in the Clyde as far as we know.



Freshwater species, such as the "Killer Shrimp" can be a massive problem: these small creatures have voracious appetites and have munched their way through the river systems of Europe devouring native invertebrates, fish eggs and fry. They have not yet been found in Scotland, but are considered a high risk.

The guidance gives detailed steps an organisation should take to prevent and control the movement of any invasive species.

Sarah Brown, Project Manager of the Firth of Clyde Forum, said:

"It's a continual struggle to keep these invasive species from spreading in Scottish waters. Our seas are important in so many ways for both the environment and the economy and we wanted to make it as easy as possible for businesses and individuals to know what to do in response to the new legislation. It is great to see the guidance already in use by RYA Scotland."

James Stuart, CEO of RYAS said, "Creating a biosecurity plan was actually much simpler than we thought it might be. The risk based approach was familiar and easily showed where the practical control points were. We established what the effective measures would be including pre event communications, hull fouling assessment points and a risk assessment based on the salinity of the destination pontoons so even if something did slip through unnoticed we felt confident that none of the salt water loving species could survive long enough to get established in the new areas."

Stan Whitaker, SNH's invasive non-native species expert, added:

"The new guidance on biosecurity planning is arguably the best of its kind in Europe, but we still need to be vigilant. Once established, it's particularly hard to control the spread of marine species. Invasive non-native species are the second most serious threat to global biodiversity after habitat loss, with non-native species costing the Scottish economy around £246 million each year."

The guidance, along with a review of marine biosecurity best practice literature, were produced by SAMS Research Services Ltd (SRSL).

Dr Adrian Macleod of SRSL said:

"Whether you're a boater, a marina or a harbour authority, the responsibility for your impact on the marine environment lies with you. The biosecurity planning guidance makes it straightforward for those using Scottish waters to assess and reduce the risk of spreading invasive non-native species."

Gadoid Biomass in the Firth of Clyde

By Neil Burns

A new project sets out to investigate the links between whiting in the Firth of Clyde and other areas around the Scottish coast. In the face of historically high fishing pressure in the Clyde whiting have responded differently to other related species (cod and haddock), persisting in greater numbers albeit at relatively small size. Whether whiting in the Firth of Clyde are part of a larger West Coast group, or are a separate population is fundamental to understanding the trends seen in this species. In turn this information is critical to explain the current state of the Clyde's fish communities and to guide future management.

The Firth of Clyde has a well-documented history of fishing for various species including, among others, herring, turbot and gadoid (cod family) species like cod and haddock. At present, however, the main fishery focuses on Norway lobster (*Nephrops norvegicus*), also referred to as langoustine and prawns. The trend for targeting different species over time is one seen throughout the world's fisheries as stocks of traditionally targeted species decline until the fishery becomes no longer profitable. This phenomenon is known as "serial overfishing". In the Clyde the opening up of the Firth to trawling in 1962 and the further relaxing of a three nautical mile trawling limit to the coast in 1984 allowed fishers to more easily exploit numerous demersal species (those living on or near the seabed). From the mid 1980s a reduction in landings of gadoids (such as cod, haddock and whiting) has overlapped with a switch to a *Nephrops* dominated fishery[1], [2]. Along with the reduction in landings of gadoids the presence of traditionally non-targeted species in the Clyde has also reduced. These include anglerfish and a number of shark and ray species. To give some context to this, before 1960 there were 13 species making up most of the demersal fish in the Firth of Clyde. Now, however, only 8 species contribute to the same group having climbed from a low of 4 species in the late 1990s and early 2000s.

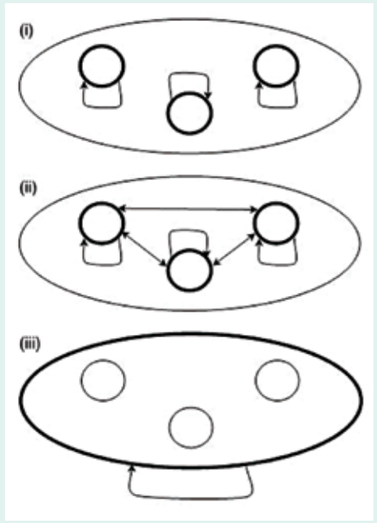


Figure 1. Structuring in fish populations redrawn from Kritzer and Sale (2004). Small circles depict individual populations within the wider population. Arrows indicate larval travel and recruitment. Thick lines indicate the level at which population fluctuations can be observed. (i) Network of closed populations. (ii) Metapopulation. (iii) Patchy population. The nature and strength of the links between areas and populations is their "connectivity"

It would be expected that the reduction seen in landings of gadoids described above would coincide with a reduction in actual numbers of fish present. The story in the Firth of Clyde is more complex than this, however. While landings of commercial species have fallen, little change in actual biomass of demersal fish has been recorded in scientific surveys. Rather than simply fewer cod, haddock and whiting being present, a change in the species which make up the demersal fish community has been observed. This change also shows a pattern, with a reduction (or complete absence) in the number of large species such as elasmobranchs (sharks and rays) and large cod. Furthermore, the average size of each species now tends to be smaller than that seen in the past[3]. With targeted trawling for demersal species having all but stopped from 2005 and a seasonally protected cod spawning area in place since 2001, these stocks may have been expected to recover. However, the demersal fish community is now dominated by one small species of gadoid - the whiting (*Merlangius merlangus*). One possible explanation may be that whiting are better suited to surviving and breeding given the current conditions. For example, in comparison to whiting, cod take longer to achieve the larger size they require for spawning[4]. Current conditions may prevent the larger gadoid species like cod from surviving long enough within the Clyde for this to happen, meaning vastly reduced numbers of offspring contributing to the following generation. It is not clear whether the changes that have taken place in the Clyde are symptomatic of an isolated ecosystem or are part of a wider scale change in fish communities. Many fish species migrate to different locations to spawn or utilise different habitats at different life stages (nursery grounds in estuaries for example). The level of exchange among areas affects the health of populations and so it is important to consider if fish in one area are a resident population or just a component of a much larger unit (see figure 1). Therefore, an understanding of the way gadoid populations are structured around the Scottish coast is required to explain any differences observed between species, and within members of the same species.

Coastal Scottish gadoid populations show a variety of different levels of connectivity between juvenile and adult stages. Figure 2 shows the findings of recent research examining the contribution of juveniles from nursery areas to known spawning grounds. Spawning adult cod can be seen to come mostly from local juvenile nursery areas whereas haddock and whiting show much less reliance on just one juvenile area and tend to recruit from much further afield. Haddock, however would appear to show a similar pattern to cod for the Clyde.

Tracking the movements of fish throughout their lives in the wild is fraught with difficulty. Small larvae and juveniles are difficult to mark or tag by conventional means; vast numbers of them die before becoming adults requiring many to be tagged and adults can often be particularly mobile. A technique that has previously proved successful uses the chemical composition of bony structures to infer the location of a fish at the time of bone formation. Specifically, it is possible to use otoliths (ear bones) because they accrete layers over the life of the fish allowing specific time points to be identified, much like the rings of a tree (figure 3). The elements incorporated into the bone are representative of the waters in which the fish was living. Although not exactly the same as the water chemistry, it is possible to match the chemical signature of groups of fish that have inhabited the same area. In this way it will be possible to identify if whiting in the Clyde are part of a larger population or, like cod, live as a closed population in the Firth. This knowledge is key to understanding the reasons for the change observed in the Firth of Clyde gadoid populations and the drivers maintaining the current regime. Effective management at appropriate scales is only possible if the correct geographic scales of the populations living here are understood. This knowledge is essential in supporting the regeneration of the Firth of Clyde as part of the Clyde2020 programme.

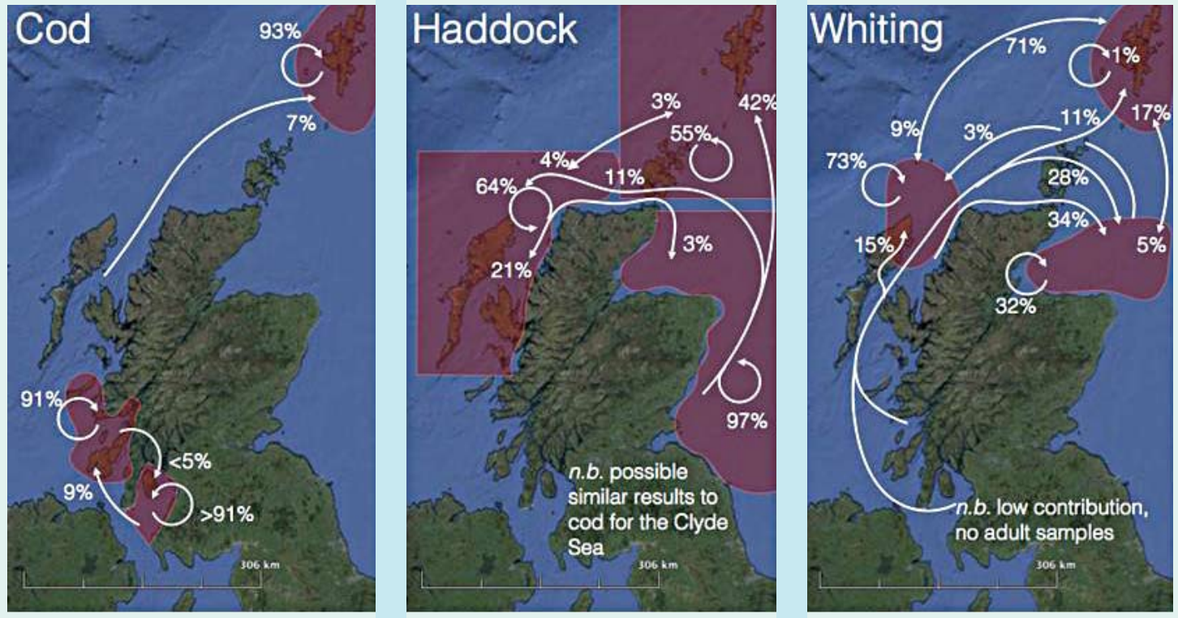


Figure 2. Population connectivity in three gadoid species around the Scottish coast. Arrows show the path taken by fish from the nursery areas where they spend their first months/years of life as juveniles to the locations where, as mature adults they spawn. Percentages show the proportional contribution from different nursery areas to the spawning groups. Adapted from; ([5]) Wright et al., 2006, ([6]) Wright et al,. 2010 and ([7]) Tobin et al., *2010.*

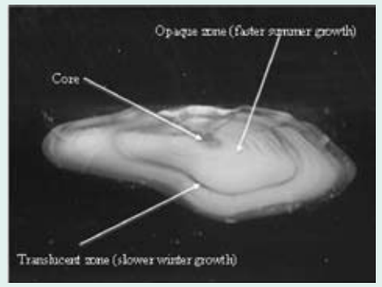


Figure 3. Whiting otolith section showing annual growth increments (annulus) consisting of an opaque and translucent zone.

References

1 - Heath, M. R. & Speirs, D. C. (2012). Changes in species diversity and size composition in the Firth of Clyde demersal fish community (1927-2009). *Proceedings of the Royal Society B-Biological Sciences*, 279: 543-552.

2 - Hislop, J. R. G. (1984). A comparison of the reproductive tactics and strategies of cod, haddock, whiting and Norway pout in the North Sea. In: POTTS, G.W. & WOOTON, R. J. (eds.) *Fish reproduction: strategies and tactics*. London: Academic Press.

3 - Hislop, J. R. G. (1986). The demersal fishery in the Clyde Sea area. *Proceedings of the Royal Society of Edinburgh Section B-Biological Sciences*, 90B: 423-437.

4 - Thurstan, R. H. & Roberts, C. M. (2010). Ecological meltdown in the firth of clyde, scotland: two centuries of change in a coastal marine ecosystem. *Plos One*, 5: e11767.

5 - Tobin, D., Wright, P. J., Gibb, F. M. & Gibb, I. M. (2010). The importance of life stage to population connectivity in whiting (Merlangius merlangus) from the northern European shelf. *Marine Biology*, 157: 1063-1073.

6 - Wright, P. J., Neat, F. C., Gibb, F. M., Gibb, I. M. & Thordarson, H. (2006). Evidence for metapopulation structuring in cod from the west of Scotland and North Sea. *Journal of Fish Biology,* 69: 181-199.

7 - Wright, P. J., Tobin, D., Gibb, F. M. & Gibb, I. M. (2010). Assessing nursery contribution to recruitment: relevance of closed areas to haddock Melanogrammus aeglefinus. *Marine Ecology Progress Series,* 400: 221-232.

Article and figures courtesy of Neil Burns, PhD student at the University of Glasgow and Marine Scotland Science. (Supervisors: Dr David Bailey and Dr Peter Wright).

Ocean colour comes to the Clyde

By David McKee, University of Strathclyde

Figure 1: Palm trees in Rothesay courtesy of the Gulf Stream. No polar bears in sight.

The sea has always been a place of mystery for human beings. For the vast majority of people, our direct experience of the sea extends to no more than paddling on the very edge. Even for those who spend significant time on or even in the sea, we barely scratch the surface of what is there. The cliché is that we know more about the moon and stars than we do about the oceans on our doorstep.

Understanding how the sea works is, of course, tremendously important for the large numbers of people that earn their living in marine industries or who live in close proximity to the coast. Indeed it is estimated that approximately 40% of the world's population lives within 100km of a coast. The marine sector contributes ~£3.5B to the Scottish economy (excluding oil and gas) and is associated with ~40,000 jobs including fisheries, tourism and leisure, aquaculture and many other areas. Scotland truly is a maritime nation.

The ocean is also a critical component of the Earth's global climate system. Ocean currents transport huge quantities of heat from warm regions near the equator to cold polar waters. The effect of this is particularly important for the west coast of Scotland which enjoys much milder winters than places such as northern Canada and Moscow that are on similar latitudes. Thanks to the Gulf Stream in the Atlantic, we have palm trees in Rothesay, not polar bears.

The oceans also play another critical role in Earth's climate system. Surface waters of the ocean are home to phytoplankton, microscopic plants that capture carbon dioxide and convert it into plant material, releasing oxygen back into the environment through the process of photosynthesis. Many people will be aware of the importance of tropical rainforests in regulating oxygen and carbon levels in the atmosphere. Fewer are aware that an equivalent amount of photosynthesis occurs in the ocean as on land.

The realisation that the ocean plays such fundamental roles in the health of the planet and local communities has led to renewed focus on taking steps to maintain and enhance its ecological state. The European Union has introduced several directives that seek to protect coastal and inshore waters from over-exploitation and damage and to ensure that we provide future generations with a legacy of a marine system that can support new generations of jobs and recreational opportunities.

Legislation requires that nations take steps to protect their marine resources and, crucially, to demonstrate that they have achieved compliance with the relevant directives. For Scotland, this is a mammoth task. Scotland has 18,000km of coastline and is responsible for an area of sea that is almost six times greater than its land area. The questions is: how can we possibly monitor such a vast area? We need to look up for at least part of the answer.

Since 1st August 1997, when a satellite called SeaStar was launched into space carrying a spectral camera called SeaWiFS (Sea-Viewing Wide Field-of-View Sensor), space agencies such as NASA and ESA have maintained a series of satellite sensors that provide daily global images of the entire world ocean. So how do these spectral cameras work?

White light from the sun passes through the Earth's atmosphere and hits the surface of the ocean. Some of the light enters the ocean and is absorbed by algae or mud and some of it is reflected back up towards space again. Satellites at the top of the atmosphere measure how much light is reflected back and changes in the colour of the light (wavelength). We can use this measure of ocean colour to determine a number of important properties of the seawater, including the concentration of phytoplankton (chlorophyll concentration), the concentration of sediment, and the clarity of the water (diffuse attenuation coefficient, turbidity and euphotic depth). A big part of the research activity in the MORSE (Marine Optics and Remote Sensing) group at the University of Strathclyde is developing new and improved ways to generate these products and to provide direct validation of data quality.

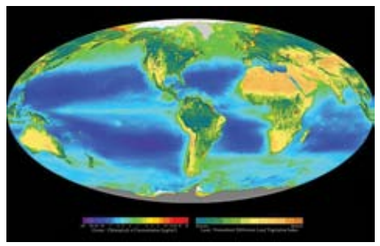


Figure 2: A global view of marine and terrestrial plant life provided by SeaWiFS. Image provided by NASA Goddard Space Flight Centre.

SeaWiFS, and successors such as MODIS and MERIS, are mounted on satellites that are in polar orbits designed to give daily passes over virtually every part of the globe at times when the sun is close to noon and there is plenty of light to record images (sun-synchronous orbit). As a result it is possible to produce global maps of ocean chlorophyll concentration (Figure 2), but this comes with some limitations. First of all, the camera cannot see through clouds, so images such as Figure 2 are built up over periods of weeks or even months to fill in the gaps caused by cloud cover. Residents of the west coast of Scotland will quickly realise that this problem is particularly acute here. We recently analysed NASA data to find that the west coast of Scotland suffers from more than 50% cloud cover on 95% of days!

A second big limitation is spatial resolution. Each pixel in a standard satellite image is approximately 1km x 1km. This makes perfect sense for global imaging; smaller pixels would mean even more data and would quickly become unmanageable. However, this does limit how useful the data is close to shore and in inshore areas such as the Firth of Clyde where we have islands, sea-lochs and the estuary itself. In order to get data from narrow fjords and rivers, we need sensors with better spatial resolution. A new generation of satellite sensors will provide exactly that.

We were recently able to start accessing data from a new satellite sensor, LandSat-8, which carries a spectral camera that gives 30m resolution at the sea surface. This dramatically increases the resolution we are able to achieve in areas like the Clyde Sea. Figure 3 shows a 'true colour' image recorded by LandSat-8. This 'true colour' image is actually generated by mixing data from several different waveband (colour) images. Even at this scale you can see incredible detail in the Clyde Sea area. Of course this lucky image was obtained on an unusually clear day and this sensor only revisits once every 8 days – there are no free lunches in this business.

Zooming into the southern part of the scene and selecting a single (red) waveband (Figure 4), we can start to identify a range of features that would never normally be visible in a lower resolution image. Here we can see the southern end of the Kintyre peninsula, most of Arran and the surrounding seas. The image is affected by some clouds in the bottom right hand corner (red patches) with evidence of cloud shadows (nearby dark blue patches). One of the challenges of interpreting this data will be distinguishing changes in water quality from surface reflection effects. We can see these effects in the ripple patterns at the bottom left of the image, which is probably reflection from internal waves. We can also see a fast ship near the bottom centre, possibly the fast ferry sailing from Troon, which leaves a long wake (dark line) and rapidly spreading bow waves (bright lines).

Moving to the Clyde Estuary itself (Figure 5), we can see a large area of high sediment concentration in the outer Firth (red colours), and relatively low sediment at the mouth of Loch Long and interestingly towards where the Clyde enters the scene from Glasgow. There are is some evidence of where dredging has previously taken place to maintain the shipping channel and the keen-eyed might be able to spot some small ships near the Tail of the Bank, possibly including Dunoon ferries.

These new high resolution images open up a whole range of new potential applications for ocean colour remote sensing. These include supporting development and monitoring of marine renewable energy projects, aquaculture operations, marine protected zones and many, many others. The key to success will be to develop new, reliable data products that are properly validated and that can be used with confidence by the wider community. This is a major focus of our research.

Figure 3: A true colour image of the Clyde Sea area provided by LandSat-8. Image provided by NASA and USGS.

Looking to the future, there are great opportunities to build on the technology that is currently available. There is a growing community of active researchers in the Scottish industrial and research sectors that are developing new platforms and sensors to expand on current capabilities. We are currently working with colleagues from SAMS and UWS to develop spectral cameras to be mounted on small remotely piloted aircraft that would offer even higher spatial resolution. We believe that this could become an extremely useful technology for monitoring specific sites such as fish farms, marine protected areas and power plants. Looking further into the future, there is a growing community of Scottish researchers who are working towards developing microsatellites, Cubesats, that are a tiny fraction of the size (and cost) of traditional satellite systems, and could provide images with the same or better resolution of LandSat-8 but with the repeat visit frequency of SeaWiFS . We have the technological capability right here in Scotland. The key is to generate support with potential end users to encourage funding to get the idea, literally, off the ground.

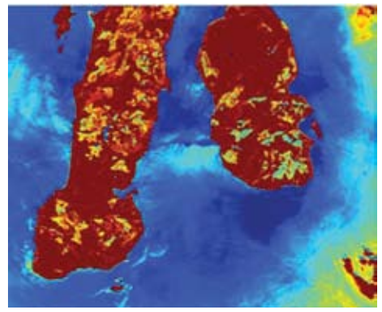
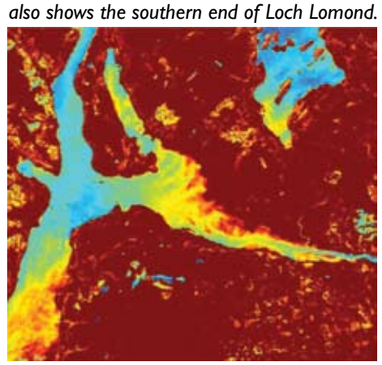


Figure 4: A high resolution image of the southern Clyde Sea using LandSat-8 (band 4).

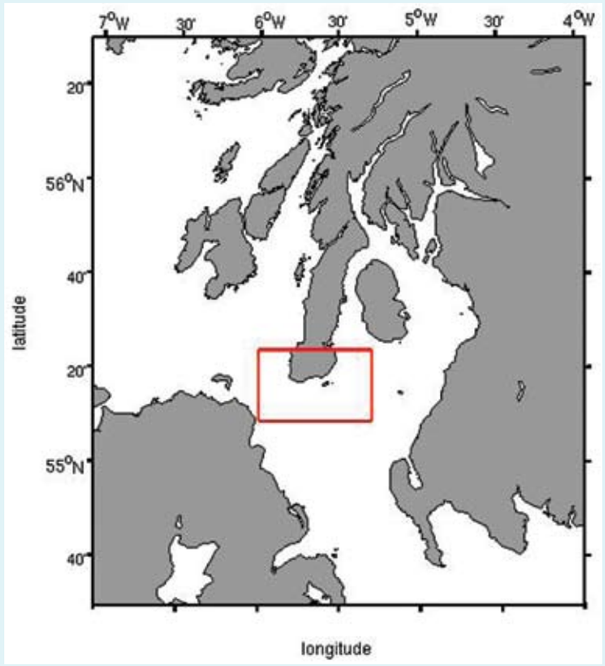
Figure 5: A high resolution image of the Clyde estuary using LandSat-8 (band 4). The image also shows the southern end of Loch Lomond.



Hydrodynamic Modelling in the Clyde

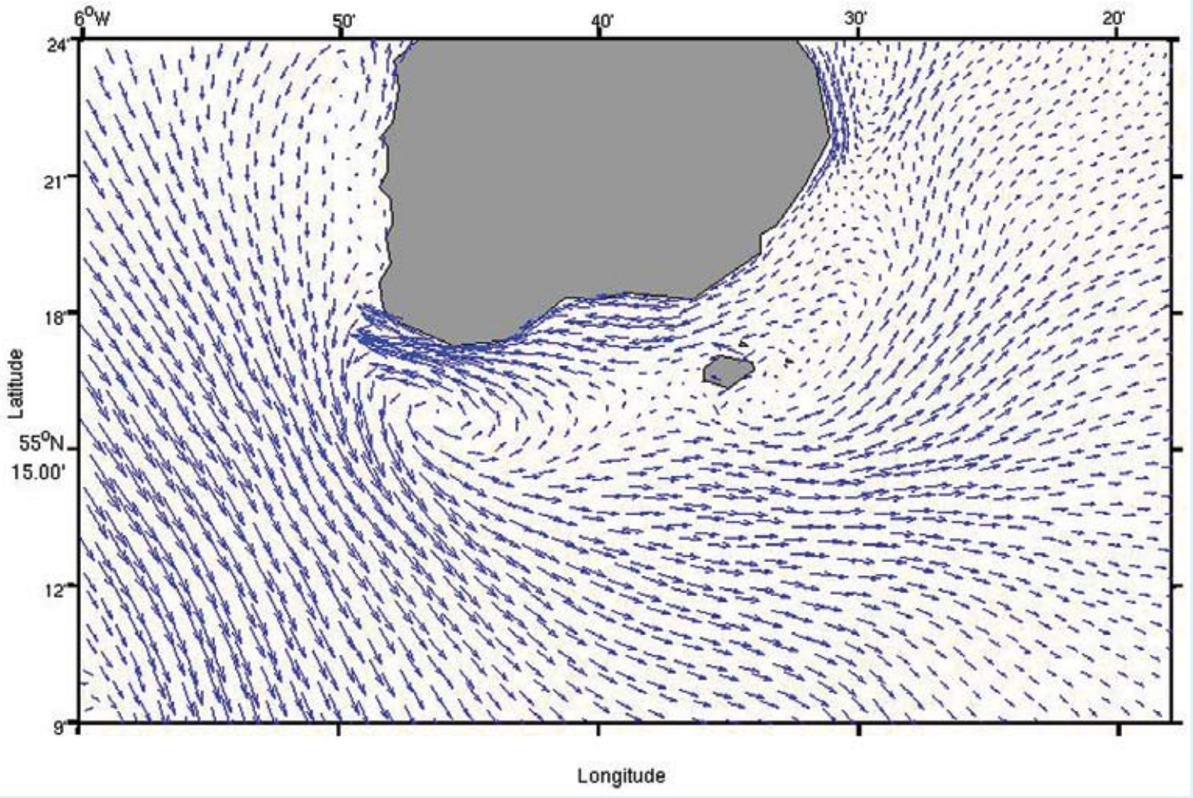
By Alessandro Sabatino, University of Strathclyde

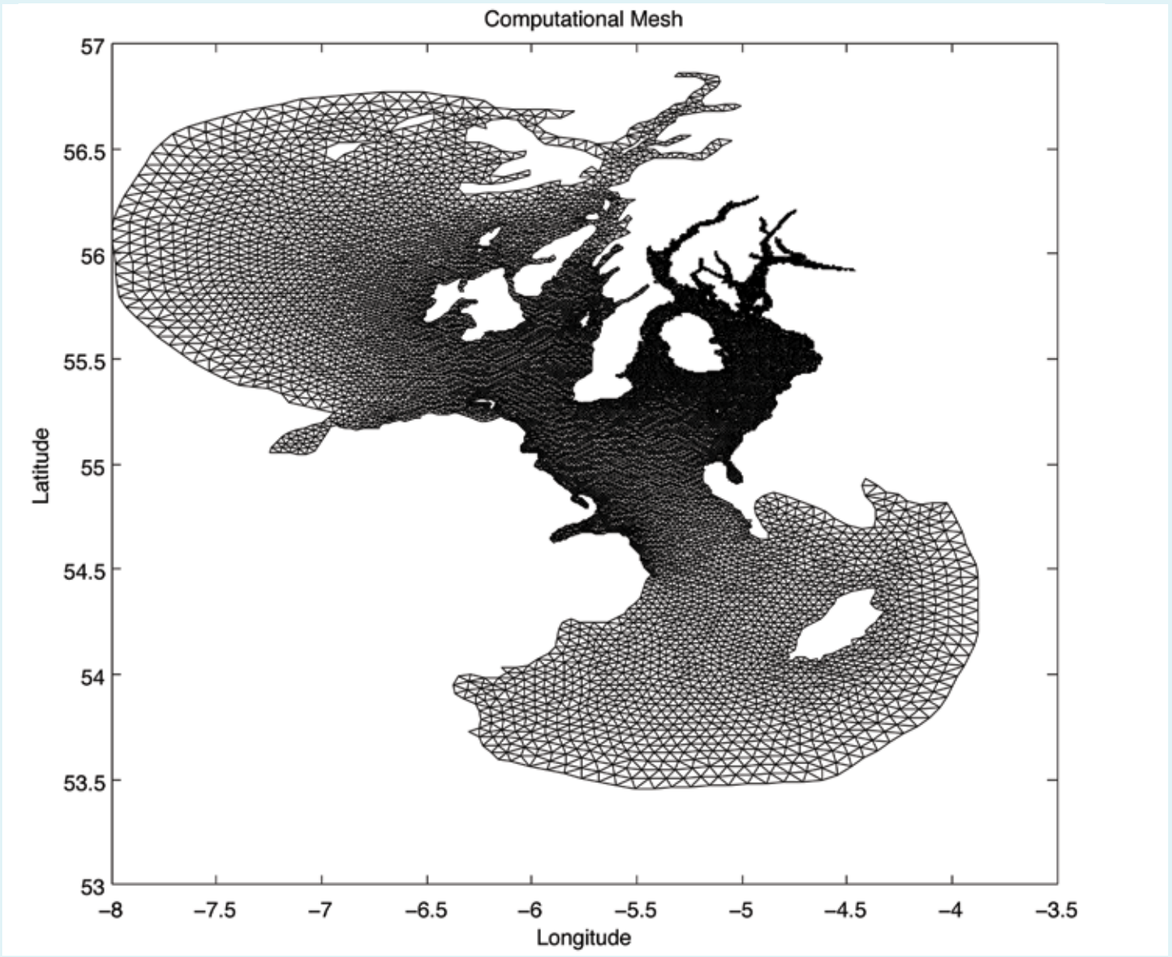
The twice-daily tides are a dominant feature of coastal and marine activities in the Clyde. The cycle of drying and inundation of the sand and mud flats in the estuary above Greenock are obvious to even a casual observer, but for those travelling by ferry, making a living by fishing, or engaging in recreational boating , the currents and rise-and-fall generated by the tides are an every-day part of life.



Measuring currents and sea-level changes at a given location is relatively easy using moored instruments – or even just with a pole and a tape-measure on the beach! Generating tide-tables of expected future sea-level heights above a chart datum is also well understood – some of the earliest applications of modern computer systems were for tidal predictions based on gravitational forces generated by the orbits of the sun and moon. However, producing detailed maps of the tidal currents and heights at different states of the tide is altogether a different matter. Most currently available tidal atlases consist of maps with sparsely distributed arrows indicating the speed and direction of currents estimated from measurements made at sea.

In order to improve on crude tidal atlases we need to use mathematical models to predict the flow patterns of water through the complicated topography of a region as the tidal wave passes-by. The basic equation describing this phenomenon





is called Navier-Stokes equation. Unfortunately, despite more than 200 years of effort by mathematicians and a large prize being available for the first person to solve it analytically, nobody has managed to produce a solution. However, it can be solved computationally using high performance computers. A project by PhD student Alessandro Sabatino at the University of Strathclyde has implemented a computer model to solve the equations for the Firth of Clyde, using software developed at the University of Massachusetts. The model is extremely detailed in the inner parts of the Clyde Sea, down to <100m resolution, and become coarser in the outer areas extending to Islay and Jura in the north, and south into the Irish Sea. The model requires a 'parallel computing' system to run, in which the task is shared out between the processors of a network of inter-connected computers.

A detailed analysis shows that tides are in fact not just a single wave passing through a region, but composed of many separate waves – referred to as harmonics, which are akin to the components of any audio signal. The main harmonic of the tides is generated by the gravitational pull of the moon. The gravitational pull of the sun produces a secondary harmonic, and the interaction of these leads to the spring-neap cycle in which tidal ranges become larger and smaller over an approximately 2 week cycle. The computer model produced detailed spatial maps of the sea surface levels and currents generated by the 7 main harmonics of the tides. The model performs these calculations at steps of just a few seconds over periods of months, but the results are saved at intervals of 15 minutes.

Using the model outputs, the researchers produced a number of useful products. The first of these is a map of the tidal range on a given date – that is the difference in height between low and high water. Locations with the same range are connected by contour lines much like the contour lines on an Ordnance Survey map. Similarly it was possible to produce detailed contour maps of the time of high and low water. Detailed maps of current speed and direction at different states of the tide reveal the locations of eddies around headlands and in bays which experienced navigators of the areas may be already aware of but these results map their extent and quantify the currents.

The research at Strathclyde is continuing, to investigate the effects of river inflows on the current patterns, the propagation of storm surges in sea level up the Clyde into the inner regions, and possibly the patterns of waves in the Clyde generated by winds. Sea level surges and wave overtopping are the main causes of coastal flooding experienced in some parts of the Clyde region. The research is co-sponsored by the University, Marine Scotland Science and the Scottish Environmental Protection Agency.

FSC Millport (source Rachel Summers)

FSC Millport By Daniel Moncrieff, Head of FSC Scotland

At the beginning of 2013 the future of Millport Marine Station was seriously threatened, when significant funding was withdrawn for the site, and the University of London decided they could no longer continue to run it. The Field Studies Council (FSC) then took over the site at the beginning of this year. The FSC is in an independent charity which runs 15 residential field centres in the UK and 3 further day centres, and its aim is to increase environmental understanding through first hand experiences of the outdoors.

Millport has a significant reputation, built up over the last 115 years, as a venue for marine research and undergraduate marine courses. The FSC aims to continue to provide a venue for these courses, as well as developing other taught terrestrial and freshwater fieldwork investigations as well as microbiology studies for university students. At the same time we are developing residential courses for schools and a 2015 programme of adult courses ranging from general interest marine biology, marine mammal and bird courses to specialist courses identifying non-native seaweeds and polychaetes. The aim of all of these courses is to develop understanding of the habitats around the Isle of Cumbrae and hopefully help to train the next generation of researchers to monitor and suggest ways of better managing the Clyde and wider environment.

To ensure we continue to attract people to Millport, the FSC have already redeveloped one floor of the oldest part of the Centre, creating new recreational spaces, with three lounges and tea and coffee facilities as well as a new large work room for visiting groups who use the site. An ambitious redevelopment plan has been possible because of the generous support of a whole host of organisations including North Ayrshire Council and Highlands and Islands Enterprise. Phase 2 of the development plan will be finished by next Easter and will include 30 twin en-suite rooms, a further 2 rooms which will be fully accessible for wheelchair users and we are also be investing in a new 150 seat lecture theatre and extra classroom.

At FSC Millport we are also keen to continue the sites rich tradition of supporting research, and facilities on site such as our Scanning Electron Microscope (SEM); research vessel, the R.V Actinia, large seawater tanks, research aquarium and microbiology facilities are all available for visiting researchers to utilise. This autumn we are also organising a research seminar which includes speakers who have undertaken research at Millport over this year. This is planned for November 1st and more details are available at www.field-studies-council.org/millport

The FSC is also keen to continue and develop long term data sets which can be used by visiting students and researchers. Millport has long been an important hub location for the collection of such data, including the longest continuous set of sea water temperatures in Scotland, metrological readings collected on site, a location for a tidal gauge, recorded periodic scientific trawls and regular rocky shore surveys. We plan to make more of this data available on line, to continue this data collection and expand the data collected to include moth trapping and recording and collection of bird data. The aim of this work is to further support the work of students and researchers studying in the area.

If you would like more information about any of the projects outlined above, our email address is enquiries.sco@field-studies-council.org

Tell Us What You Think...

Clyde Breakers is your newsletter; tell us what you think of this issue and what you would like to see in the future. If you would like to receive an electronic version of Clyde Breakers rather than a printed copy, please send your email address to us. Many thanks to those of you who contributed to this edition.

If you would like to become involved in the Forum and its work, contact us at the address below.

Project Manager
Firth of Clyde Forum
Caspian House
2 Mariner Court
Clydebank Business Park
Clydebank, G81 2NR

Tel: 0141 951 0820
Email: clyde@clydeforum.org
Website: www.clydeforum.com

The Firth of Clyde Forum has a broad membership base with representatives from industry, local authorities, community groups and charities. The opinions expressed by members within this issue are not necessarily the opinions of the Forum or its Core Group.

The Firth of Clyde Forum would like to thank the following organisations for their continued core funding and support:

Scottish Natural Heritage
Dualchas Nàdair na h-Alba
All of nature for all of Scotland
Nàdar air fad airson Alba air fad

marine scotland

GLASGOW and the CLYDE VALLEY strategic development planning authority

PEEL PORTS GROUP