

Marine Fisheries Science Yearbook

2007/2008



defra
Department for Environment
Food and Rural Affairs

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Introduction



Defra funds science projects to increase our understanding of marine fisheries. We need scientific information to develop soundly based policies for managing fisheries in our waters and to help us to negotiate effectively in the European Union (EU).

This is our second yearbook. It reports on a range of marine fisheries science projects to illustrate the work we funded from April 2007 to March 2008. We publish yearbooks to increase understanding of what fisheries scientists do and to help people interested in fisheries to give us ideas for future scientific work, which will build on existing work or fill gaps. A list of marine fisheries science projects we have funded recently, including all 2007/08 projects, is at the end of the yearbook. You can read our Marine Fisheries Science Yearbook 2006/2007 at: www.defra.gov.uk/marine/science/yearbook.htm

We fund four types of marine fisheries scientific work:

- **Fish stock monitoring and assessments** provide annual information about the state of fish stocks, which feeds into international scientific advice (pages 6-7).
- **Sustainable marine fisheries research** includes long-term research into issues such as the status and structure of fish stocks around our coast and the impact of climate change on them (pages 8-19).
- **The Fisheries Science Partnership**, which started in 2003, charters commercial fishing vessels to do surveys of particular fish stocks or other investigations using scientific techniques. These are carried out on the normal commercial fishing grounds and using the normal gear of the chartered vessels (pages 20-29).
- **The Fisheries Challenge Fund** supports short-term scientific projects, as well as economic and social projects, suggested by organisations with an interest in fisheries (pages 30-35).

Fish stock monitoring and assessments



Stock monitoring work involves market sampling, fishing surveys and discard sampling. It is organised by national laboratories, such as the Centre for Environment, Fisheries and Aquaculture Science (Cefas). Monitoring provides the basic information used by international working groups within the International Council for the Exploration of the Seas (ICES) and the EU's Scientific Technical and Economic Committee for Fisheries (STECF) to assess the status of stocks. Their advice feeds directly into policy decisions on the management of fisheries in UK and international waters. Commercial finfish and shellfish stocks are assessed by international scientific working groups organised by ICES, which meet each year.

We explained in our first yearbook – the Marine Fisheries Science Yearbook 2006/2007 – why we need to sample catches, why we need to conduct research surveys and why we sample discards each year. We also explained stock assessments. We have included this information in Appendix 1 of this yearbook. Below, we report on the data collected in 2007.

What market sampling data were collected in 2007?

A total of 237,440 length measurements and 26,244 samples for age determination were collected from finfish landings and 75,722 length measurements from shellfish. All the main fleets and gear types which contribute significantly to English and Welsh landings were sampled during the year.

What data were collected in 2007 from fishing surveys?

A total of 128 ship-days were devoted to six research vessel monitoring surveys in the North Sea, the Channel, Celtic Sea, Irish Sea and Bristol Channel. A further 37 days' fishing were undertaken on chartered commercial vessels surveying for bass in the Solent and Thames, herring in the Thames, flatfish in the western Channel, and juvenile flatfish along the North Sea coast from the Humber to the Thames.

Figure 1: Cefas scientists sorting survey catch



Sustainable marine fisheries research



Defra is committed to the protection and sustainable use of our marine resources and ensuring that management decisions are based as far as possible on sound scientific information. We therefore need a range of information on the fish stocks around our coast. For example, we need to know about populations of fish, how climate change affects important commercial fish and shellfish stocks and how to reduce bycatch in fishing gear.

Defra funds the following sustainable marine fisheries research:

- **Impact of fishing on the marine ecosystem** – To understand how fishing affects the productivity of the fish and shellfish resource and other vulnerable species and habitats in the ecosystem.
- **Effects of the environment on fish stocks** – To understand how changes in environmental conditions affect fisheries' productivity.
- **Fisheries management tools** – To provide the tools for better fisheries management including improved understanding of the status of fish and shellfish stocks.

This work is carried out by Cefas, universities and research centres, often working together. The research supports international work carried out through ICES and the STECF, as well as linking with EU-funded research programmes.

Impact of fishing on the marine ecosystem

Reducing discards by modifying fishing gears

About 50% of all fish caught in English and Welsh fisheries are currently discarded. Most of this discarding (about 85%) is because fish are too small to be landed or non-commercial species. Other reasons include the fisherman not having a quota for that species. But discards are widely regarded as unethical, a waste of natural resources and disruptive to marine ecosystems.



Figure 2: A mixed catch of fish with many discards

Cefas scientists have found that much discarding is due to the use of poorly selective fishing gears. They have therefore worked with fishermen to develop modifications to fishing gear which reduce the catch of unwanted fish. There is no single answer to this 'discard problem' and each fishery requires its own solutions. For example, in the *Nephrops* (Scampi prawn) fisheries off Tyneside, fishermen and scientists tested many gear modifications, eventually choosing the best one, which reduced discard levels by 40%. This design incorporated multiple square-mesh escape panels in the upper body of the trawl, which allowed unwanted juvenile fish (mostly whiting, cod and haddock) to escape from the trawl.

Cefas scientists have also teamed up with fishermen and Seafish to investigate a new trawl design (The Eliminator) used in Rhode Island (USA). In tests in the North Sea, the new net reduced discards by over 80%. Very importantly, the trawl also allowed over 90% of cod to escape from the catch. This design incorporates very large meshes (2.4 m) in the front parts and belly of the trawl and allows the cod and other unwanted fish to escape through these meshes unharmed. Large haddock and whiting behave differently from other fish and do not tend to pass through these large meshes. Fishermen can now have the opportunity to target fish, such as haddock and whiting (Figure 3), much more selectively using the Eliminator trawl, while at the same time keeping discards low and protecting vulnerable stocks, such as cod.

Reducing discards has clear economic and environmental benefits; it lessens the overall environmental impact of the fishery on the supporting marine ecosystem; and helps to conserve stocks. It also addresses broader public concerns about the waste associated with discarding.

Figure 3: An almost pure catch of whiting and haddock caught with the Eliminator trawl



Reducing marine mammal bycatch

Marine mammals come into frequent contact with fishing boats and fishing gear, which can occasionally be fatal for them. In the year 2005-2006 bycatch monitoring for Defra of over 2600 fishing operations reported that 180 dolphins and 20 porpoises were caught. Dolphins are iconic animals with huge public appeal and their accidental capture in fishing gear causes public concern. No-one in the fishing industry wants to see dolphins or other marine mammals killed in fishing gear – not only is it distressing, but it can also damage fishing gear.



Figure 4: Dolphin

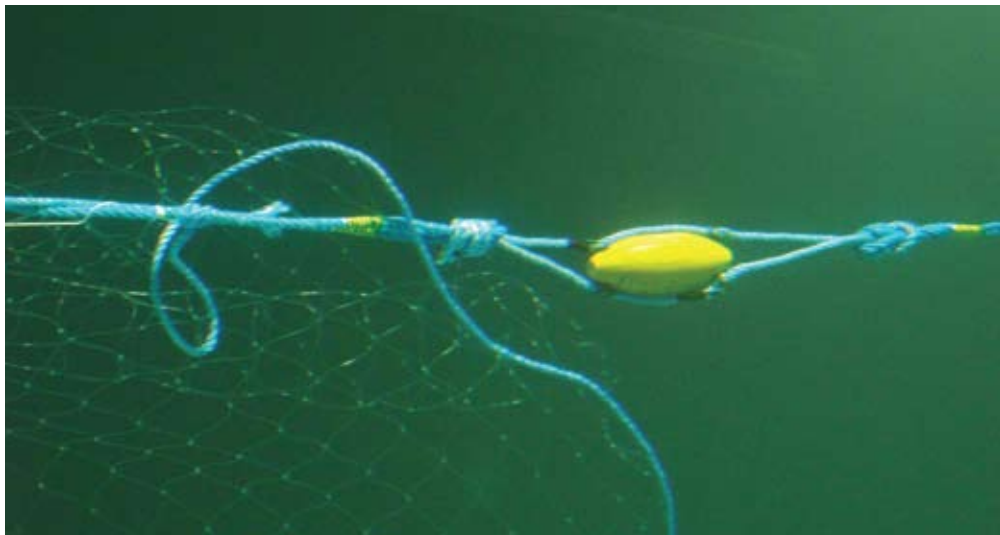
The Sea Mammal Research Unit's (SMRU) research builds on several years of monitoring fisheries around the UK to understand how, where and why marine mammals become caught in fishing gear. With help from the fishing industry, SMRU has placed independent observers on over 1600 fishing trips and monitored over 11,000 fishing operations. The information gained has allowed SMRU to develop and test ideas about why these animals get caught and to test measures to reduce the number of bycatch fatalities.

The most successful tools for reducing dolphin and porpoise bycatch that SMRU has tested so far are acoustic deterrent devices, also known as pingers (Figure 5). These small battery-powered devices give off warning sounds that deter dolphins and porpoises from approaching fishing gear too closely. Different devices work better with different species and fisheries. Further work is needed to improve designs for use on commercial fishing boats.

SMRU has also investigated how a number of other measures might help reduce bycatch rates. Exclusion devices have been tested in pelagic trawls. These allow dolphins that end up near the back of the trawl – and would otherwise be caught as bycatch – to be guided out of an escape route, while fish are kept in the net (Figure 6). Early designs of exclusion devices are not yet totally effective. Other experiments show that porpoises visit static nets

frequently yet only rarely get caught, suggesting that they are usually able to avoid nets. Some studies show that some net types are more dangerous to porpoises than others. SMRU is continuing to try to understand these and other issues to find out how and why entanglements occur in any type of fishing gear.

Figure 5: Pinger



The results of this work and further studies will help the fishing industry to reduce the risk of accidentally entangling dolphins and porpoises. They also help explain to the public how and why bycatch happens and what it means for the conservation of dolphin and porpoise populations.

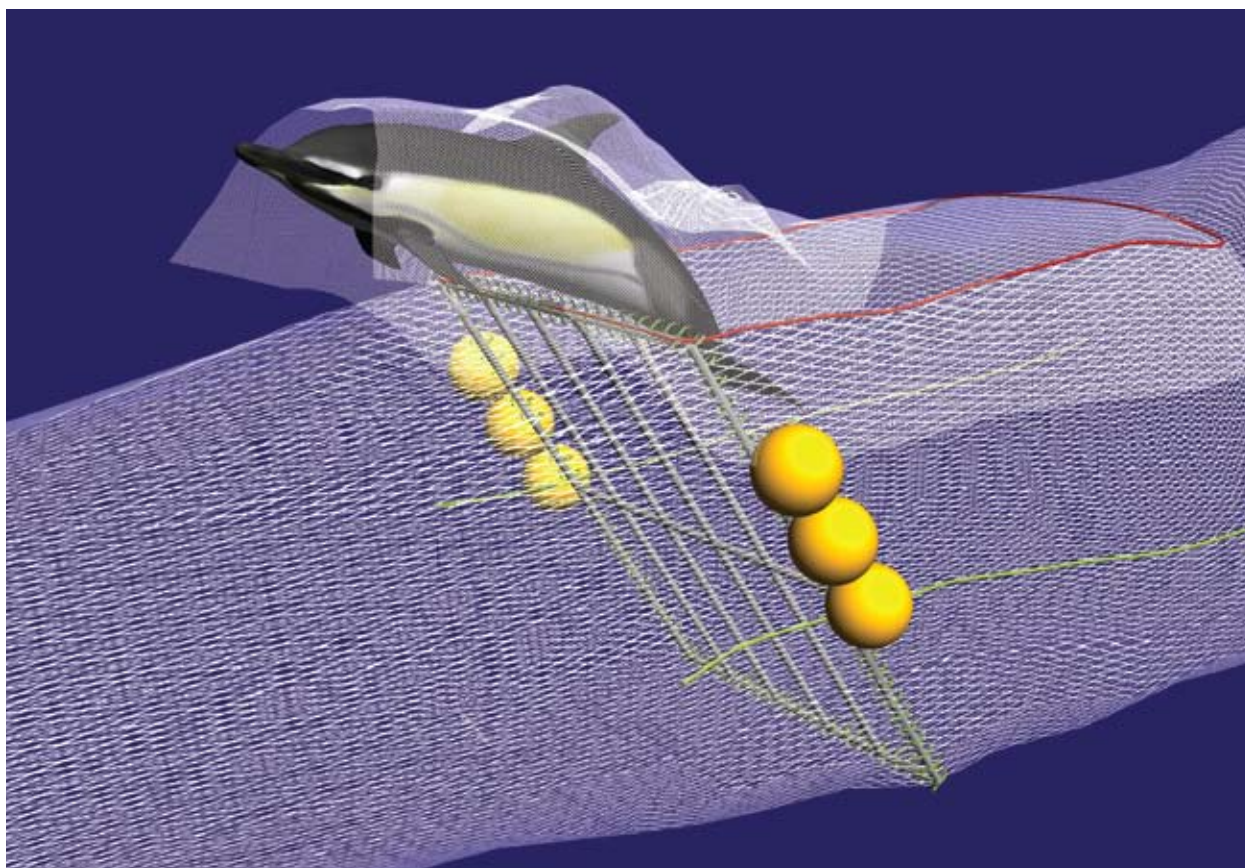


Figure 6: Exclusion device on a trawl

Effects of the environment on fish stocks

Effects of climate change on the growth of larval cod

Although fishing is the major influence on the size of commercial fish stocks, there is increasing evidence that environmental factors have also contributed to their decline and are, for example, affecting the production of young cod.

Cefas scientists have been studying the mechanisms by which changes in sea temperature may affect cod stocks through their prey. Information on the distribution of plankton on which larval cod feed (obtained from the Continuous Plankton Recorder – see pages 16-18 in the Marine Fisheries Science Yearbook 2006/2007) and environmental conditions recorded in the north-east Atlantic in recent years were used to develop a computer-based model for the growth of cod during the first 40 days following hatching. The results suggest that although there has been a general decline in the numbers and weight of zooplankton in the north-east Atlantic, this has been most significant for the warmer months of the year (June to October). As a result this does not seem to have led to reduced growth of larval cod hatched at the peak of spawning. Furthermore, slight reductions in the availability of prey may be compensated for by the larvae processing prey faster as the rate of digestion is increased with a warming in temperature.

The results suggest that observed changes in zooplankton may have less impact on cod larvae when they start feeding than was previously thought. Cod stock recovery, at least in the near future, is unlikely to be hindered by the effects of climate change on early larval growth.

Figure 7: Cod larva eating an artemia (a type of crustacean)



Impacts of climate change on the growth of adult cod

Cod stocks in the North Sea have declined to historically low levels of abundance in recent years and there is increasing concern about the way in which climate change may affect the ability of these stocks to recover. In other species, climate change has affected the timing of events, such as migration in birds and early flowering in plants.

Cefas scientists have investigated whether there has been a shift in the timing of growth of cod, using otoliths (earstones) collected routinely for ageing fish over a period of more than 20 years. Otoliths, found beside the brain in fish, are small calcareous structures in which carbonate material is deposited every day. In cod, two growth zones are deposited each year, an opaque growth in the spring and a more translucent growth in early summer (Figure 8). By assessing the time at which the growth zones were laid down, it was possible to assess the impact of rises in sea temperature on growth. The results show a clear shift of the start of translucent growth in warm periods, which occurred on average up to 20 days earlier than in cold periods.

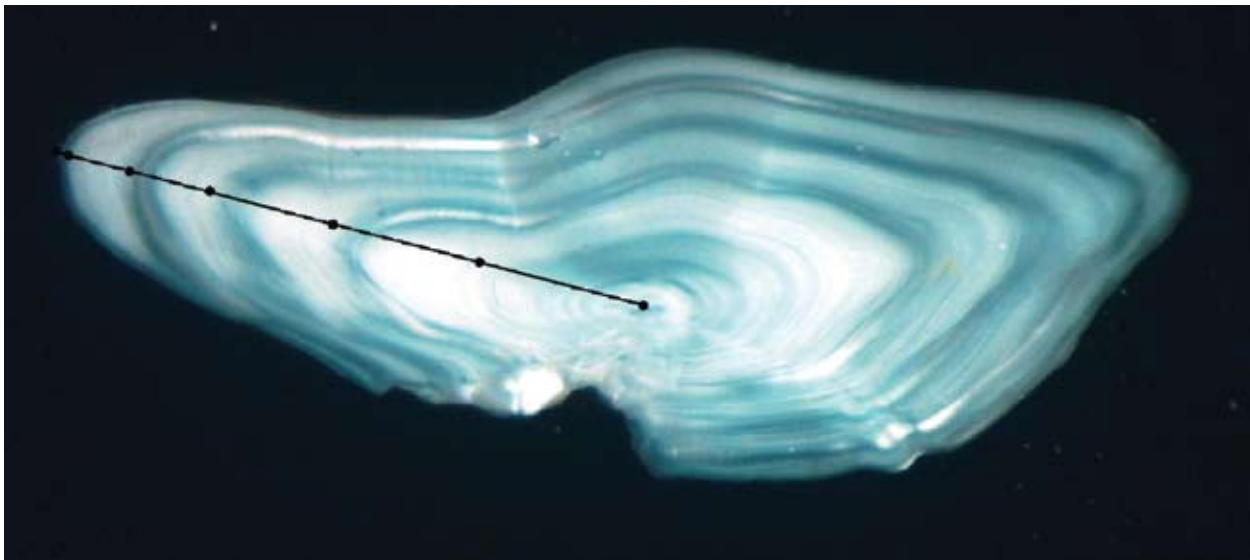


Figure 8: Cod otolith showing the different annual growth zones. The edge of the translucent zones is marked with a dot

The early development of the translucent zone indicates that cod are suffering physical stress from rising sea temperatures and this could affect their ability to feed and grow effectively during peak temperatures in the summer. The work has also shown the value of otoliths as bio-recorders that store information on the life history of individual fish. Detailed chemical analysis of otoliths offers the opportunity to investigate a range of problems from movements between different sea areas through to individual temperature histories and even changes in metabolism. Insights into the impact of climate change on fisheries allows better planning for management changes, taking environmental factors into account.

Fisheries management tools

Movements of North Sea plaice stocks

Methods to assess fish stocks and decisions about their management are usually based on the assumption that the stocks are separate units. Such units should ideally be distinguished from one another on the basis of knowledge about the biology of the fish, including their seasonal migrations or their movements as they grow and develop.

Cefas scientists have tagged hundreds of plaice, many with electronic data storage tags (DSTs), from which they can work out the detailed movements of individual fish over long periods. They have also examined the otoliths of tagged plaice and used chemical signatures to trace where the fish were born and to reconstruct their lifetime movements. This has allowed the scientists to develop a computer-based movement model for plaice populations in the North Sea which may be used to assess management strategies for the fisheries. The model describes the movement of theoretical populations of plaice, distinguishing between male and female juveniles and adults.



£50 Reward*

CEFAS scientists are releasing plaice tagged with distinctive **ELECTRONIC TAGS** to study migratory behaviour.

It is essential that as many as possible are recovered

*£25 reward for the electronic tag & £25 for return of the whole fish (plus market value). In addition, you will receive a specially designed gift, and your name will be entered into an annual cash draw for £1000

We thank you for your help and co-operation

Please return the tags and the whole fish, together with details of time and place of capture to:
The Centre for Environment, Fisheries & Aquaculture Science (CEFAS),
Lowestoft Laboratory,
Paolfield Road, Lowestoft,
Suffolk NR33 0HT UK
Tel: +44 (0) 1502 4526
www.cefas.co.uk/fishtagreturn

CEFAS
The Centre for Environment,
Fisheries & Aquaculture Science

Figure 9: Reward notice for tags



Figure 10: Plaice tagging

By applying data from the UK and Dutch beam trawl fleets, the scientists tested a range of management choices, such as the benefits of annual or seasonal closures of a spawning area. The population growth observed under each of the computer-simulated management choices can help to predict how management might be more effectively implemented to achieve sustainable fishing. The model outputs were also used to identify areas where lack of available data limits our ability to make reliable predictions, for example of recruitment to the adult stock. Analysis of traces of two chemicals in the plaice otoliths (strontium and calcium) revealed differences in the ratio between them dependent on area of birth of the fish and on how far they have migrated. This may help to distinguish distinct sub-stocks within the North Sea plaice stock. By including movement patterns and increasing biological realism, this approach should greatly improve the accuracy of the model predictions used in making management decisions and the targeting of future research.

English Channel and North Sea cod stocks

Some important UK fisheries catch cod in the southern North Sea and English Channel. Tagging studies, including those with electronic tags reported in the Marine Fisheries Science Yearbook 2006/2007 as 'Cod stock structure in the North Sea and English Channel', have shown that some juvenile and adult cod from the eastern English Channel move into the southern North Sea where they may be caught in fisheries. But there is no evidence of movement the other way. This has important implications for how the stock is assessed and managed because the fish from the eastern Channel appear to be increasing the size of the southern North Sea breeding population.

Figure 11: Tagging cod



Cefas, working with the University of Wales Bangor, did a genetic analysis to confirm whether the cod stock in the eastern English Channel belong to the same stock as that in the southern North Sea as the earlier tagging studies suggested. The scientists did not find any differences in the genetic fingerprint of cod from the different regions, which suggests that cod living in the English Channel and southern North Sea mix together when they breed.

Figure 12: Tagged cod waiting to be released



The results support the existing fisheries assessment that assumes there is a single stock unit in the southern North Sea and eastern English Channel. European Commission quota management, however, treats the eastern Channel cod stock as part of the wider Channel management area. This research provides evidence for a change in the management area.

Testing fisheries management strategies

The management of fisheries has to address potentially conflicting biological, ecological, economic and social objectives. As a result, despite constant efforts to regulate fisheries, fishing capacity often remains above that necessary to ensure sustainable levels of exploitation. Although the need to develop alternative management strategies is widely recognised, it is almost impossible to develop them through large-scale experiments on fish stocks.



Figure 13: Fishing boats drawn up at Hastings

Cefas scientists, working with international colleagues, have developed a computer-based model that can be used to assess management and recovery plans before they are implemented. The model's framework allows consideration of uncertainty in our knowledge about stock dynamics (the pattern of growth or change and interactions between individuals in a stock) and the responses of fishing fleets to alternative management plans. It therefore helps to provide precautionary advice required by international agreements. Scientists did several case studies, including using this framework model to assess the impact of climate change on North Sea cod and to work out where fishermen are likely to move their fishing effort if they are displaced from a fishery area. They also investigated new assessment methods that do not depend on the collection of data from fisheries.

The framework has already been used to develop management plans for hake, mackerel and North Sea flatfish stocks. In future Cefas scientists plan to work with the Regional Advisory Councils to provide a tool that can be used by stakeholders to pose "what if?" questions. These might include asking: "If managers want to ban a particular gear to help protect a particular species, what would the impacts be on other species and the income of the fishermen?" or, "How can managers implement measures to protect species such as harbour porpoise but still maintain the livelihoods of the fishermen?" This will allow stakeholders to propose alternative management actions and discuss management choices.

Effects of sandeel fisheries on predator species

Sandeels are an important part of the diet of sea birds, marine mammals and fish but in past years were also caught by a large industrial fishery in the North Sea. This has fuelled concerns that the fishery may have adverse impacts on these other species, some of which currently have reduced populations.



Figure 14: Sandeels



Figure 15: Puffin – a predator on sandeels

Cefas has investigated the direct and indirect impacts of sandeel fishing on predator species through both research at sea and computer-based modelling. Remote observations using acoustics revealed many more sandeel schools in highly fished than in lightly fished areas, and the clustering pattern of these fish was influenced by the availability of suitable habitat and food. The results suggest that the area with the higher number of sandeels may act as an important local nursery area for the population of sandeels from a wider area. Whiting, lesser weever and grey gurnard were the most important predators of sandeels, taking about 90% of the fish that were eaten. However, because predatory fish readily supplement a shortfall in one prey species with another different prey species, it appears that predatory fish species may be less crucially dependent on an abundant supply of local sandeels than, for example, are seabird colonies. Nevertheless, fish predators whose diet was rich in sandeels generally appeared to be in a better physical condition, which would probably improve their growth and breeding success.

These results underline the importance of a healthy sandeel population for the commercially important predatory fish species of the Dogger Bank. Computer-based modelling investigations indicated that area closures, rather than European Common Fisheries Policy Total Allowable Catch (TAC) or seasonal management measures, would have the greatest benefits for sandeels, their predators and the fisheries.

The Fisheries Science Partnership



The Fisheries Science Partnership (FSP) encourages fishermen and Cefas scientists to work together. It also involves fishermen in planning scientific studies. It has been running since 2003 to:

- provide information from commercial fishing operations on key stocks, to supplement the data used in ICES assessments;
- address issues raised by fishermen on scientific assessments or on stocks not currently assessed; and
- investigate new scientific methods and more environmentally friendly or selective fishing methods.

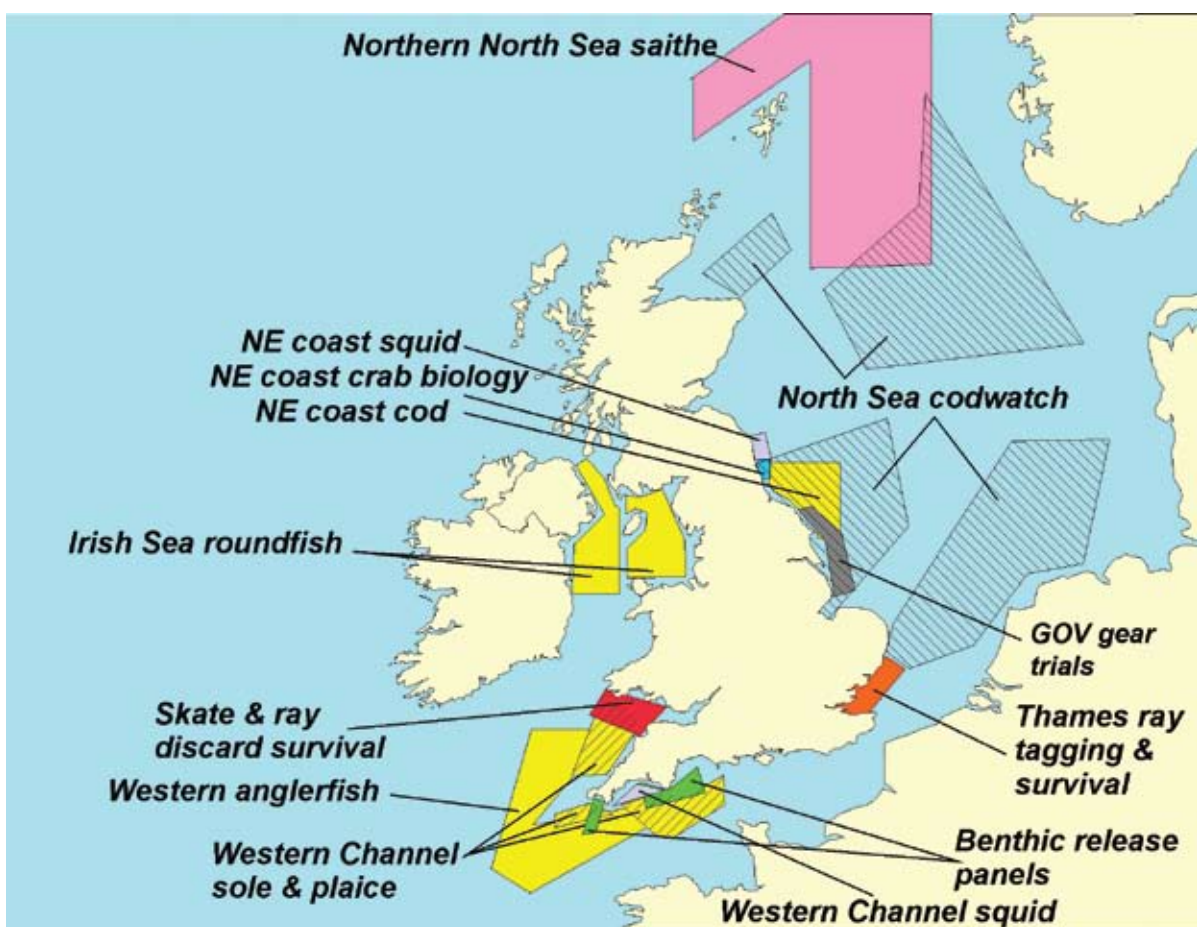


Figure 16: Location of 2007/08 FSP projects. The four time-series projects are shown in yellow. The two squid projects were 2006/07 projects that continued into 2007/08. A map of FSP projects up to 2006/07 is in the Marine Fisheries Science Yearbook 2006/2007.

Western Channel sole and plaice

Scientists base their assessments of Western Channel sole and plaice on commercial catch and effort data and survey measures of abundance. The project aimed to develop a time-series of information for a commercial fishery to add to, and allow evaluation of, ICES's management advice on stock status and distribution trends.

The beam trawlers *Lady T Emiel* and *Carhelmar* were chartered to carry out the fifth in a time-series of surveys of Western Channel sole and plaice. Similar surveys in the same area, using the same chain-mat fishing gear and survey design, have been carried out each autumn since 2003. The surveys were designed to find out the distribution patterns of sole, plaice and other commercial bycatch species; trends in the abundance and age composition of the two target species; and the amount of bycatch of species such as cod.

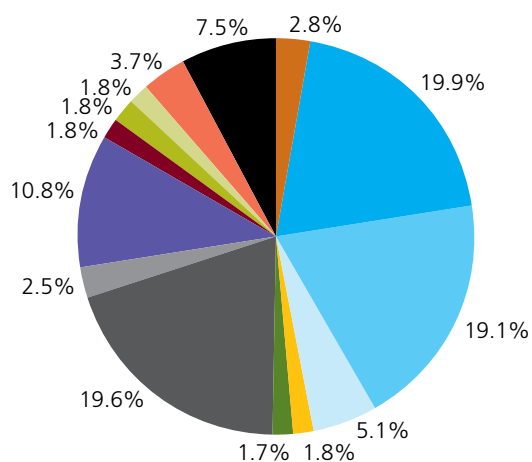
Sole and plaice together made up 11% by number of the two beam trawlers' catches. Gurnard were abundant, particularly in the east, but only 33 cod were caught in 151 tows, less than 0.1% of the total catch. The percentage composition of sole and plaice in the catch was similar to that found during all surveys since 2003, and the catch compositions of the two surveys' tows were also similar (Figure 17).

The age compositions ranged broadly, especially of sole, of which fish older than 20 years were caught. Despite sampling just a small portion of the available area of the stock, the relative age compositions of both species in the surveys have remained broadly similar to those found in fishery landings since 2003, and also tend to mirror ICES forecasts for current years.

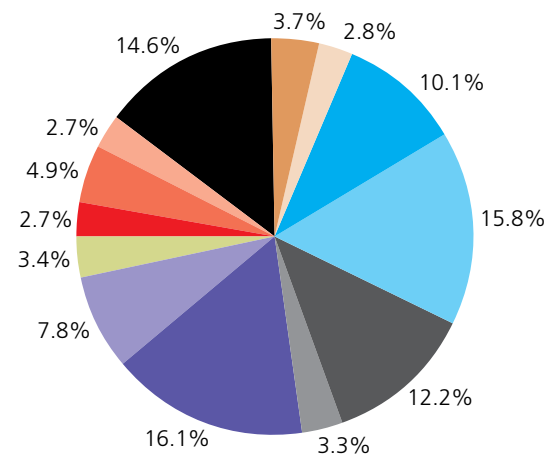
Even if the trends in several series are the same, having another time-series of abundance estimates by age from a commercial fishery helps with stock assessments and therefore the preparation of management advice. For the UK fishing industry, developing its own time-series of estimates generates confidence in the data used for stock assessments for fisheries management.

Figure 17: Percentage catch composition by number shown for the 12 most abundant species caught by (a) *Lady T Emiel* (eastern survey) and (b) *Carhelmar* (western survey) in 2007

(a): Eastern survey



(b): Western survey



North Sea codwatch

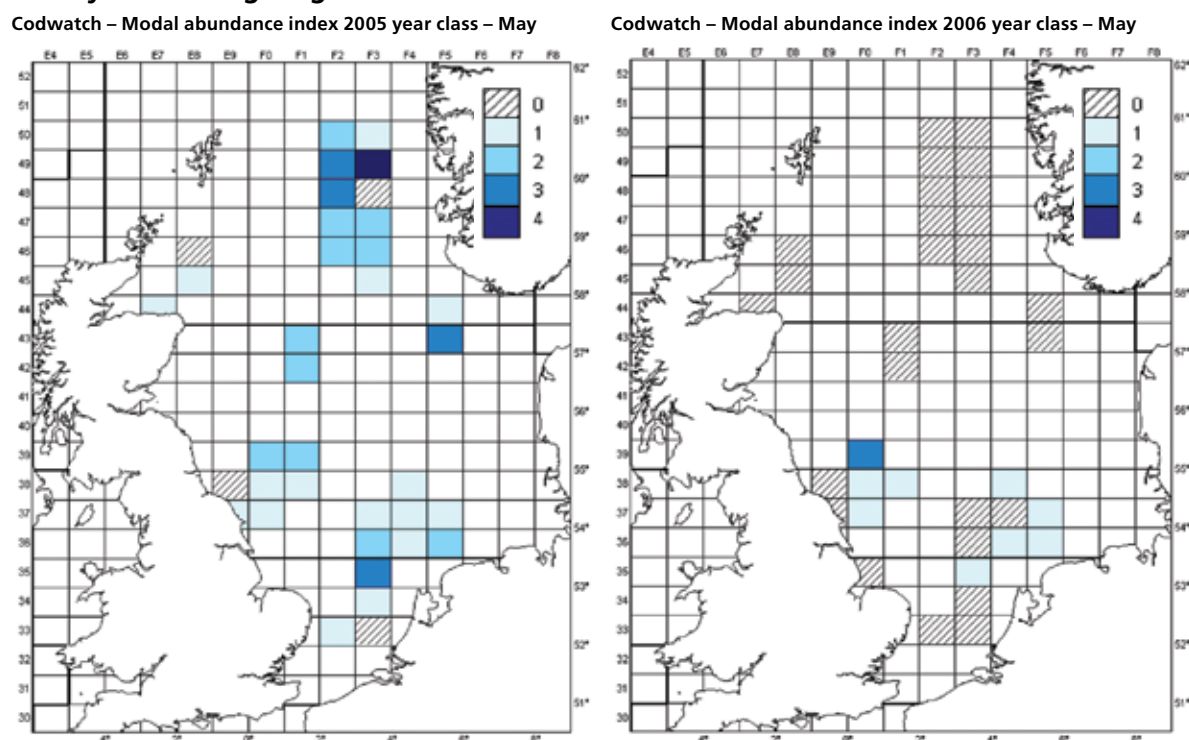
The 2005 year class of North Sea cod is generally thought to be stronger than the poor year classes of 2000 to 2004. However, the results from stock assessments indicate that this year class is still below the longer-term historical average. Some fishermen believe, however, that it could be much stronger than the long-term historical average.

To try to resolve some of the differing views, fishermen self-monitored the status of the 2005 and 2006 year classes of cod in catches made by up to 12 fishing vessels associated with the Eastern England Fish Producers Organisation Ltd (EEFPO), using a variety of fishing gear. They also collected data on the general distribution of cod. The data and additional information, including fishing location, fishing effort, details of fishing gear and target species were collated by the EEFPO before analysis by Cefas scientists and EEFPO representatives. The results provide information on the abundance and geographical and seasonal distribution of cod (Figure 18).

The results from April to July 2007 suggest that the abundance of the 2005 year class may be similar to the results of recent assessments, showing this year class to be one of the most abundant in the past 10 years, although not as strong as many of the large year classes of earlier years. Fishing industry partners do not agree with this conclusion and have commented that the results may reflect other factors, including attempts by fishermen to move fishing effort to areas where there are fewer cod to make quotas last longer and to minimise discarding. More information will be available after May 2008 when the initial codwatch project ends.

The codwatch project provides a useful means of structuring the views of fishermen on a scientific basis and provides them with a way of contributing information to stock assessments. Codwatch is also a useful source of information on discards in a fishery, where the level of discarding is causing concern, particularly when vessels have restrictive quotas.

Figure 18: Geographical distribution of the 2005 and 2006 year classes of cod in May 2007 using all gears

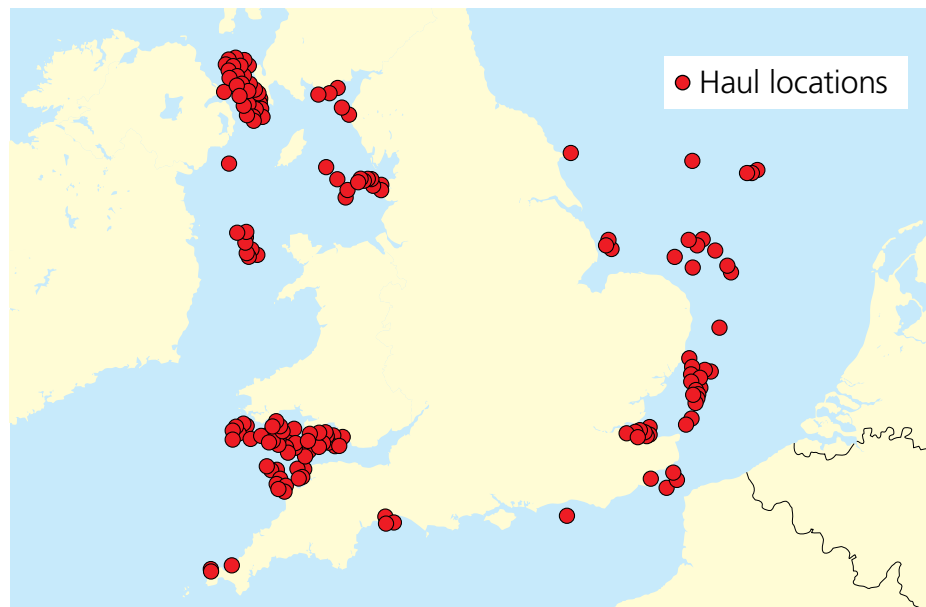


Key: 0 = zero, 1 = small numbers, 2 = moderate numbers, 3 = high numbers, 4 = very high numbers.

Skate and ray discard survival

Several stocks of skates and rays (generally marketed as skate; and skate is used here in its generic sense) are found in the north-east Atlantic. Some species, such as the common and white skate, are depleted and other species, particularly thornback ray, blonde ray, and small-eyed ray (also known locally as painted or sandy ray) – are of concern to fisheries managers. These species are vulnerable to fishing because they grow slowly, do not mature until they are several years old and produce few young. Many rays are landed in mixed demersal fisheries, but there are also some targeted fisheries of which the Bristol Channel trawl fishery is one of the UK's most important – with 20% of the English and Welsh total annual landings of skates (by weight), valued at about £1 million (Figure 19). In the English Channel, Western approaches, Celtic and Irish seas (ICES Subarea VII), an average of 3,237 tonnes of skates are caught each year, but about 823 tonnes (20%) of these are discarded.

Figure 19: Haul locations around England and Wales where fishermen catch skates.
Source: Cefas catch and discard database



In a study in the Bristol Channel, suggested by the National Federation of Fishermen's Organisations (NFFO), Cefas scientists estimated short-term survival rates of discarded thornback rays (Figure 20). They used specially designed holding tanks to keep the rays on board before tagging during three short trips on the commercial otter trawler *Our Olivia Belle*. They found that for every three thornback rays returned to sea, it seems that two survive for at least three days. They also tagged and released 900 thornback, small-eyed, blonde and spotted rays (Figure 21) to estimate the long-term discard survival rates of the most commercially important ray species. When the skates are caught again, the scientists will be able to estimate longer-term rates of survival. Already, we know that some discarded skates are surviving for at least 45 days.



Figure 20: Thornback ray being measured

Scientists also investigated the effect of codend weight on skate discard survival and found that as total catch weight and the length of time of the tow increase, the survival rate for discarded skates decreases (probably because there are more injuries in heavier codend catches). They also found that large thornback rays do not have better rates of survival than smaller individuals.

Figure 21: Dart tag used for tagging skates in the Bristol Channel



Clearly, fewer skates survive being discarded after long tows, which generally produce larger catches, so reducing the length of time of the tow or reducing catch weights could benefit survival rates of skates. A possible measure would be to use benthic release panels and/or square-mesh codends, which reduce the catch of unwanted organisms in beam trawls. Also, introducing a maximum landing length for skates would allow the largest breeding fish to remain in the population. However, for this to be an effective conservation measure, large skates would need to survive after being released.

Thames ray tagging and survival

In 2007 the North Sea total allowable catch under the Common Fisheries Policy for mixed skates was cut by 20% with a bycatch limit of 25% (although this was removed for under 15 metre vessels in 2008). This had a particular impact on the English inshore fleet operating in the southern North Sea, where thornback ray (the main skate species – Figure 22) is locally common in all size classes. With bass, cod and sole, skate are the main commercial species. Scientists needed to find out the survival rates of skates discarded from various fisheries to check the effectiveness of possible management measures for skates, for example bycatch quotas or size restrictions.

Figure 22: Thornback ray



Seven surveys between summer 2007 and early 2008 were carried out in the Greater Thames Estuary by five commercial fishing boats (*Harvester*, *Janeen*, *Jessica M*, *Jolene* and *T-Rex*); using three gear types: trawls, longlines and gillnets. The main aim was to tag thornback rays and to monitor their rates of recapture to find out about their likelihood of survival after release. Cefas scientists examined the species, sex and size composition of skates caught, visually assessed the health of the fish, and undertook a tag-and-release programme (Figure 23).



Figure 23: Thornback ray tagged with Petersen disc

Gillnet surveys operating in summer 2007 tagged and released 434 thornback rays, of which about 3% were recaptured by March 2008. The three trawl surveys operating out of Southend and West Mersea successfully tagged and released 2,481 thornback rays (plus 97 other elasmobranchs, mainly spotted ray and smoothhounds), and the recapture rates from these surveys ranged up to about 8%. Only 47 thornback rays were released from longline surveys in the summer, with about 10% of these recaptured. During winter 2008, a further 700 line-caught rays were tagged and released off West Mersea and Orford, and more than 400 rays taken in gillnets off Orford tagged. Recapture rates of fish tagged in winter will be analysed later, when the fish have had a longer time at liberty.

Skates caught inshore generally appeared healthy, although a small proportion of them were dead in gillnets, especially if the soak time was long, for example because poor weather prevented hauling nets. Also a small proportion of line-caught fish had badly damaged mouths.

The surveys generally caught few other commercial species (e.g. sole in trawls, cod and bass on lines). Given the few species of commercial fish in the area, and the daily nature of the fisheries, bycatch quotas may not be the best way to manage the fisheries, although such measures may be appropriate for offshore trawlers that can more easily change fishing grounds during a trip. Given the good health of commercially caught fish, and that they are indeed being recaptured after some time at liberty, size restrictions may have a role in the future management of the stock.

North-east coast crab biology

In September 2006, Defra circulated a discussion paper to promote debate among fisheries interests about possible methods of avoiding overexploitation in the UK crab fisheries. One option was to increase the minimum landing size (MLS) by 10 mm or more, to allow more crabs to spawn. However, some fishermen suggested that population size and structure are limited by the availability of suitable habitat or refuge and that there would not be any benefits from increasing MLS.

Figure 24: *Wendy Patricia* – a multipurpose catamaran, primarily equipped for potting



Fishermen and Cefas scientists investigated the population structure of edible crabs in relation to the characteristics of the seabed in the mixed crab and lobster static gear fishery off the north-east coast, from the River Tyne to Druridge Bay. Working from the *Wendy Patricia* (Figure 24) they carried out a potting survey and an acoustic survey of ground types. They used sidescan sonar and underwater video to map ground types next to the fishing positions. The potting survey provided information on the distribution of catches of brown crabs (Figure 25), velvet crabs and lobsters, as well as size compositions of the catch.



Figure 25: Brown crab

Catches of brown crabs were generally better further offshore on ground that included areas of sand. Catches inshore, where the seabed was generally hard or rocky reefs, were dominated by lobsters and velvet crabs. Although small catches of lobsters were also taken offshore next to wrecks, velvet crabs were only caught inshore in the areas of hard seabed. Analysis of catch rates using computer-based modelling showed that the seabed characteristics obtained using sidescan sonar images, combined with the skipper's knowledge of the seabed during fishing, can explain the variations in crab catches during the survey.

By providing information on the habitat needs of commercial crustaceans and some information on the geographical limits of these habitats, the project has provided new information for stock managers. This can be used when management decisions need to be made, for example on the likely impact of an increase in minimum landing size for brown crab on fishery yields and stock dynamics in the area. Fisheries managers can now make allowances for natural limitations on the crab population imposed by habitat availability.

GOV gear trials

The UK fishing industry has argued that the international bottom trawl survey (IBTS) carried out in English waters on the *Cefas Endeavour* using the GOV gear is not representative of the numbers of fish, especially cod, in the North Sea. They are particularly concerned about the set up of the ground gear and fear that a large proportion of fish escape underneath the gear and between the fishing line and the ground gear.

Catch rate comparisons were made between two commercial fishing boats – the *Our Lass II* fishing soft-ground areas (supported by the FSP) and the *Jubilee Quest* fishing hard-ground areas (funded by the fishing industry and FSP), and those achieved by the *Cefas Endeavour* using the soft-ground GOV gear (Figure 26). Standardised 2-mile tows were carried out to test if the survey was likely to catch the same proportion of the stock as the commercial vessels. The rate of escape of the main commercial species from the standard GOV trawl was assessed by fitting additional nets behind the ground gear to capture escaping fish. The aim was to determine not only the escape rate, but also which factors, if any, influenced escape.

Although analysis is still continuing, standard GOV catch rates for cod were roughly 70% of those on commercial vessels, with about 25% escaping under the net. Patterns of abundance across areas were consistent with those found by commercial vessels on soft ground. Catches on commercial hard-ground areas, though, yielded much higher catch rates and possibly contained a different proportion of the population. When the fish were at low density, an average of 40% of the cod would escape underneath the standard GOV gear. This rate of escape decreased substantially to only some 15% at greater cod abundance, indicating that cod abundance on the grounds is not simply and directly linked to catches – which was an assumption of the assessment. The effects of this finding on the assessment process will be examined in the months ahead.

GOV catch rates for plaice were much lower than commercial rates (21%) on soft-ground areas, even when the proportion escaping under the net (33%) was included. The reasons for this are not yet clear, but it could indicate losses from the experimental gear, or more efficient herding by the commercial gear.

Figure 26: Shooting a GOV trawl from the *Cefas Endeavour*



Lower catch rates themselves should not adversely affect the ICES estimates of stock abundance, as they are recognised and compensated for in the stock assessments. This is because the research vessel surveys provide only an index of relative abundance of the numbers of fish of particular ages. The indices are used to 'tune' or calibrate the stock assessments. A commercial vessel could work alongside the research vessel catching twice the number of fish at each age. If both sets of indices, research and commercial, were used to tune the same stock assessments, the results from the research and commercial vessels would be very similar. However, one consequence of catching more fish is that there will be a greater number of older fish in the catch. The more fish there are in the index the better will be the precision of the assessments.

The Fisheries Challenge Fund



The Fisheries Challenge Fund was introduced in 2005 in response to the *Net Benefits* report by the Prime Minister's Strategy Unit. It funds short-term scientific projects, as well as economic and social projects, suggested by organisations with an interest in fisheries.

Involving fishermen in improving lobster stocks

Lobsters can be reared successfully in large numbers in hatcheries, and survival rates of hatchery-reared lobsters in the wild have been estimated to be very high. Stock enhancement programmes can be used therefore to supplement conventional fisheries management measures such as restricted entry licensing schemes, minimum landing sizes, and V notching.



Figure 27: The decay of the galvanic mechanism timed to release juvenile lobsters within 48 hours (with 1p coin for scale)



Figure 28: The test release container sits in a storage cage aboard a fishing vessel awaiting deployment

The National Lobster Hatchery in Padstow, Cornwall carried out a review of the advantages and disadvantages of the various techniques used in four regions of the UK to release the juvenile lobsters, in terms of both scientific and social benefits. They concluded that release by fishermen, deploying creels from their boats to the seabed, was found to be the overall best technique although there were problems with the release system. The project developed a more effective system for transporting, securing and timing the release of hatchery-reared juvenile lobsters. Different materials were tested to find the most robust container with a reliable time-release mechanism for local fishermen to use (Figures 27 and 28). Further development could lead to a highly successful method of marine timed-release, allowing releases from fishing boats to become the usual method for lobster hatcheries (Figure 29).



Figure 29: A lobster creel housing the time-release container being deployed from a fishing boat in the Helford Estuary, south-west Cornwall

Open sea shellfish farming

There is a strong, undersupplied market for fresh, live, high quality mussels in Europe and increasingly in the UK. Production has peaked or is declining in many traditional European production areas. In the UK mussel production comes largely from the managed dredged fisheries of North Wales and Northern Ireland or from hanging culture farms in Scottish lochs. These all have limited capacity for increased production for reasons including competition for space and poor water quality. Open sea farms have often been proposed as a way of meeting the growing demand in an environmentally sustainable way. Successful trials and commercial production units have been established elsewhere in the world and the technology is reasonably well developed, but there have not been any UK offshore trials of significant scale.

This project, carried out by Offshore Shellfish Ltd., examined the feasibility of farming mussels in the open sea in Lyme Bay, South Devon, which initial research suggested has many of the favourable conditions needed for a successful farm. It assessed the legal and regulatory framework, technical, economic and environmental factors, and the interactions with existing users of the area that would influence the size, location, design, management and profitability of open sea mussel farming in Lyme Bay. It focused on sub-surface, suspended culture, rope grown mussel farming techniques that are in use or being developed elsewhere in the world but not yet adapted or proven for UK growing conditions.



Figure 30: Native mussels

The project drew on practical and commercial knowledge gained through experience of operating existing inshore mussel farms in the UK and observation of offshore farms elsewhere in the world.

The project suggested that mussel farming could be feasible in Lyme Bay and the report provides practical guidance on the requirements of an open sea farm. This will allow the fishing industry, regulators and planners to make informed decisions about future developments in UK waters and to encourage more productive and sustainable use of coastal waters in appropriate locations.

Tuna fishing

The Cornish Fish Producers Organisation, working with Irish and French partners, proposed assessing whether trolling for albacore (long fin) tuna (*Thunnus alalunga*) could be shown to be a viable alternative to stocks targeted by Cornish fishermen. Trolling, which is catching tuna on baited hooks trailed by a boat, if viable could reduce fishing effort on the pressured stocks. It also has a very low environmental impact and high quality catch.

The project aimed to collect the range of information needed to assess the viability of a tuna fishery, including catch data and identification of preferred locations and seasons for tuna. It also sought to acquire the technical knowledge of rigging the vessel, rigging and working the gear, best methods for processing and handling the catch; and preferred lures for target species.

Defra funded phase 1, a feasibility study, to provide technical training for operating trolling gear and allow accurate costing of the subsequent phases. The owners of the vessels involved (*Nova Spero* and *Charisma*) funded phase 2 rigging of the vessels for tuna trolling in Spanish yards with privately secured funds. Phase 3, funded by Defra, involved the first season's fishing in the Bay of Biscay to obtain an evaluation of the fishery including catch rates, fish movements, and temperature conditions, as well as assessing economic viability.

Figure 31: Line-caught tuna on board the *Nova Spero*



Technically the fishing operation was successful, although catch rates were variable. The quality of the fish and fish handling were excellent, but improved marketing was needed. The project indicated that there were opportunities, if the fishery was well managed, for developing a sustainable and economically-viable fishery.

Annual Fisheries Reports

We have limited up-to-date, easily-accessible information on different fishing fleets and their changing activities. This problem could be reduced by the organised input of information, data and knowledge from fishermen. Initiatives designed to capture the experience and viewpoint of fishermen include the fishermen's questionnaire, organised by the North Sea Regional Advisory Council and the Fisheries Science Partnership. Despite these initiatives, there is still a problem because much information from fishermen is anecdotal and not methodically recorded.

The National Federation of Fishermen's Organisations (NFFO) proposed organising the collation and provision of fishing industry data through preparing Annual Fisheries Reports. The project aims to involve fishermen in drawing up regional reports which will provide local industry information on changes in fishing fleets and their activities; changes in stock abundance; economic trends; and evidence of the impact of management measures.

Project work involves preparing a template for reports; testing the report preparation arrangements with fishermen in three areas; and putting in place arrangements to help fishermen's organisations to produce their own reports in future years. The Cornwall Fisheries Resource Centre is carrying out the work with Cefas, the Marine and Fisheries Agency (MFA), producer organisations and fishermen's associations.



Figure 32: Local fishing fleet – Scarborough

As well as improving the quality of the dialogue between fishermen, scientists and fisheries managers, the reports will provide up to date information on how current management measures are working in practice. This will help Regional Advisory Councils and fisheries managers to understand the latest changes in fishing activity and make the case for management measures that reflect these changes.

List of current and recent marine fisheries science projects



Sustainable marine fisheries research projects

This list identifies projects started in 2007/08 and also includes projects started or completed in 2006/07, plus a few projects from previous years reported in our first yearbook to illustrate the breadth of work undertaken.

Impact of fishing on the marine ecosystem

Fishing impact on benthic communities – phase 2

(MF0729) Completion date: 31/03/2007

Reported in the Marine Fisheries Science Yearbook 2006/2007 as 'Impacts of bottom trawling'

To provide advice on the validity of listings of marine fish and invertebrates as vulnerable, endangered or critically endangered by fishing. To test the effectiveness of existing fishing surveys to provide information on these existing species.

Development and testing of ecological indicators and models to monitor and predict the ecosystem effects of fishing

(MF0731) Completion date: 31/03/2007

Reported in the Marine Fisheries Science Yearbook 2006/2007 as 'Developing indicators for fisheries management'

To provide a basis for selecting indicators of the ecological effects of fishing, for advice on the usefulness of indicators proposed by other groups, and to establish an ecosystem-based approach to fisheries management.

Monitoring, impact and mitigation of marine mammal bycatch

(MF0736) Completion date: 31/03/2008

Reported as 'Reducing marine mammal bycatch'

To develop a greater understanding of the extent of bycatch and its impact on marine mammal populations in order to provide better information for management strategies. To develop and test mitigating measures to reduce or eliminate marine mammal bycatch.

Gear technology, discard reduction, and environmentally friendly fishing studies

(MF0738) Completion date: 31/03/2008

Reported as 'Reducing discards by modifying fishing gears'

The first and second years of the project were reported in the Marine Fisheries Science Yearbook 2006/2007 as 'Reducing bycatch in fishing gear'

To evaluate the effectiveness of mandatory technical measures in the brown shrimp fishery. To analyse further the discard database, providing tools which will enable identification of discarding 'hotspots' (concentrations in space or time or associated with particular types of gear). To maintain updated knowledge on global developments in the field of environmentally-friendly fishing methods.

Ecosystem approach to fisheries**(MF1001) Started: 2007/8 Completion date: 31/03/2012**

To develop, test and report on indicators that allow managers and stakeholders to assess the status of the ecosystem and the impacts of fishing, and to develop decision tables that allow managers and stakeholders to see the effects of different management options and to choose from among them. The project will pilot the ecosystem approach to fishing in the south-west of England.

Effects of the environment on fish stocks**Validation and testing of biologically-based movement models for North Sea plaice and implementation in management and assessment****(MF0152) Completion date: 30/06/2007*****Reported as 'Movements of North Sea plaice stocks'***

To develop spatially-structured stock assessment models for plaice in the North Sea that take account of seasonal changes in its geographical distribution, its availability to fishing gear, and fishing effort in order to provide better advice on management options for fish stocks and fisheries.

Linking the behaviour, spatial dynamics and the environment of cod and ray populations to evaluate fisheries scenarios**(MF0154) Completion date: 31/03/2009*****The first three years of the project were reported in the Marine Fisheries Science Yearbook 2006/2007 as 'Cod stock structure in the North Sea and English Channel'***

To incorporate environmental and biological datasets into a computer-based model of fish migration in order to develop a more comprehensive understanding of the response of cod and ray stocks to changes in the environment and fisheries.

Electronic telemetry tags: development of behaviour sensors for fish**(MF0155) Completion date: 31/03/2009*****The first three years of the project were reported in the Marine Fisheries Science Yearbook 2006/2007 as 'Tools for studying fish in the wild'***

To provide information about the feeding behaviour of marine fish in relation to the environment and to use this to improve multi-species and ecosystem computer-based models. To identify the location of spawning that is necessary for understanding stock identity and dynamics.

Spatial and temporal genetic structuring of edible crab populations**(MF0230) Completion date: 31/03/2008*****The first 18 months of the project were reported in the Marine Fisheries Science Yearbook 2006/2007 as 'Brown crab populations'***

To provide important genetic information on crab stock structure in the English Channel in order to improve crab stock assessment and management advice.

**The Continuous Plankton Recorder survey: fisheries investigations
(MF0430) Completion date: 31/03/2007**

Reported in the Marine Fisheries Science Yearbook 2006/2007 as 'Plankton fluctuations and their effect on fish stocks; the role of the Continuous Plankton Recorder Survey'

To provide plankton data over about a 70-year time period in the north Atlantic to monitor responses to hydroclimatic change and pollution. To explore with computer-based modelling techniques and other numerical tools relationships between Continuous Plankton Recorder (CPR) data and fisheries statistics.

**Impacts of environmental change on the recruitment of commercial fish stocks
(MF0431) Completion date: 30/06/2007**

Reported as 'Effects of climate change on the growth of larval cod'

To examine effects of sea temperature change on egg and larval growth and survival, maturation and fertility of adult fish, and changes in abundance and distribution of prey in order to discover their impact on the recruitment success of cod and plaice around the UK.

**Detecting predation of fish eggs and larvae
(MF0432) Completion date: 30/06/2009**

To investigate post-settlement mortality (deaths of fish recently developed from larvae) due to predation by commercial fish species, such as cod and plaice. Changes in the abundance and distribution of predators, possibly linked to processes of climate change, have the potential to inflict increased mortality on the early life history stages of commercial fish species and thus can damage stock viability or limit stock recovery.

**Changes in growth in cod as an indicator of climate change
(MF0433) Completion date: 30/06/2007**

Reported as 'Impacts of climate change on the growth of adult cod'

To obtain time trends in the start of growth in cod in the spring and autumn each year using historical collections of otoliths from the southern North Sea and Norwegian coastal waters. To allow predictions of the impact of climate change on growth of cod populations in the North Sea.

**ICES/GLOBEC project office
(MF0434) Completion date: 31/12/2009**

To support the ICES/GLOBEC (Global Ocean Ecosystem Dynamics) project office which exists to help with implementing the cod and climate change programme strategic plan, and other co-operative international studies on the effects of climate change on the marine ecosystem.

Evaluating shelf-wide spatial and temporal changes in fish larval distribution over the last half century in relation to environmental factors and adult distributions

(MF1101) Started: 2007/08 Completion date: 31/03/2011

To analyse Sir Alistair Hardy Foundation for Ocean Science (SAHFOS) Continuous Plankton Recorder (CPR) fish larval samples from UK Shelf Seas from 1948 to the present day and explore changes in larval abundance, distribution, timing and size in relation to environment, plankton and adult fish. To assess how different species of fish have responded to past environmental changes at the critically-important larval stage.

Macro-ecology of marine fish in UK waters

(MF1102) Started: 2007/08 Completion date: 31/03/2012

To improve our understanding of population biology and ecology for key species of commercial fish (e.g. cod, plaice, sole), fish valued by recreational anglers (e.g. bass) and fish of conservation interest (e.g. skates and rays). To study relationships between fish population sub-units in spawning areas, on nursery grounds and on feeding grounds, how these vary year-on-year, and the contribution of the environment to such variation.

Spatial dynamics of edible crabs in the English Channel in relation to management

(MF1103) Started: 2007/08 Completion date: 31/03/2011

To provide improved knowledge of the movements of edible crabs (*Cancer pagurus*) in the English Channel at local and regional scales, as the basis for giving better quality advice on management of crab stocks.

Spatial and temporal patterns in scallop recruitment and their implications for management

(MF1104) Started: 2007/08 Completion date: 31/03/2012

To find out the key biological and hydrographical processes governing the recruitment of scallops in the English Channel, and the possible effects of climate change on these processes. To develop a computer-based forecasting model for scallop populations which includes information on where scallops are at different stages in their lifecycle based on new insights into scallop recruitment gained during the research.

The Continuous Plankton Recorder Survey: fisheries investigations (CPR VI)

(MF1105) Started: 2007/08 Completion date: 31/03/2012

To monitor and analyse the changes in plankton production and biodiversity associated with hydroclimatic changes in the north Atlantic over about 70 years. To further investigate links between plankton data and long-term changes in fish stocks over the North West European shelf and in the north-east Atlantic in order to develop new approaches to fisheries management and conservation strategies. This is a continuation of Project MF0430.

Fisheries management

Movements of rays in ICES Sub-area IV in relation to special protected areas (MF0148) Completion date: 30/09/2004

Reported in the Marine Fisheries Science Yearbook 2006/2007 as 'Management of thornback rays in the southern North Sea'

To describe the movement of individual rays in the Thames Estuary by using electronic tags and to relate ray movement and distribution to patterns across time and place of fishing effort. To use the combined data to assess the effect of closing particular areas to fishing.

Field trial of genetic probes for the identification of gadoid eggs (MF0151) Completion date: 31/03/2004

Reported in the Marine Fisheries Science Yearbook 2006/2007 as 'Impacts of climate change on fish recruitment'

To field test a semi-automated, genetically-based egg identification method developed under former project MF0146 'Genetic identification of fish eggs by species specific DNA markers for use in stock biomass assessment'.

Genetic structure of cod (*Gadus morhua*) populations in the southern North Sea and English Channel

(MF0159) Completion date: 31/08/2007

Reported as 'English Channel and North Sea cod stocks'

To conduct a programme of genetic sampling of cod in the eastern English Channel and southern North Sea to find out whether the stocks are separate during the spawning season and the feeding season. This allowed identification of the extent of biologically-significant mixing between stocks as well as mixing between stocks managed as separate fisheries.

Pilot study for fishery-independent monitoring of cod recovery in the Irish Sea by means of egg production surveys

(MF0160) Completion date: 31/03/2011

The first year of the project was reported in the Marine Fisheries Science Yearbook 2006/2007 as 'Impacts of climate change on fish recruitment'

To assess the application of genetic egg identification methods within a full annual survey of gadoid (eg cod, haddock and whiting group of fish) spawning. To provide high-resolution data on the distribution of spawning by cod and other species in 2006.

Development of integrated systems for shellfish data collection, assessment and management

(MF0229) Completion date: 31/03/2007

Reported in the Marine Fisheries Science Yearbook 2006/2007 as 'Management approaches for shellfish stocks'

To develop frameworks for the provision of advice on shellfish stocks, integrating the processes of data collection, assessment and management.

Fisheries interactions**(MF0322) Completion date: 31/03/2007*****Reported as 'Testing fisheries management strategies'***

To improve the understanding of the impact of current and alternative management strategies on mixed fisheries, and to provide a robust range of strategies for possible management objectives, consistent with the precautionary approach.

Multi-species fisheries management: a comprehensive impact assessment of the sandeel fishery along the English east coast**(MF0323) Completion date: 31/03/2007*****Reported as 'Effects of sandeel fisheries on predator species'***

To produce a spatially explicit multi-species model in which the dynamics of sandeels and their predators can be explored in relation to a range of local management options.

A risk analysis framework for fisheries management**(MF1201) Started: 2007/08 Completion date: 31/03/2012**

To review international best practice and knowledge and implement appropriate tools in a common framework. To apply this to selected case studies working with others including Defra and EU project teams, ICES and Regional Management Organisations (RMOs), and Regional Advisory Councils (RACs).

Improved understanding and management of shellfish fisheries**(MF1204) Started: 2007/08 Completion date: 31/03/2012**

To model the possible responses of shellfish stocks and shellfish fishing fleets to different management options. To do this by computer-based life-history modelling and analysis of satellite monitoring data, as well as catch and effort returns from the shellfish licensing scheme. To evaluate relationships between inshore and offshore shellfish populations and their response to exploitation, and assess the impact on the breeding potential of crustacean stocks of exploitation patterns which differ between sexes.

Management of marine finfish fisheries and monitoring under the EU data collection regulation

Cefas Fish stock monitoring contract – ongoing

Part of this work was reported in the Marine Fisheries Science Yearbook 2006/2007 as 'Changes in the distribution of cod'

To provide the best scientific advice on the status of finfish stocks of interest to the UK, through monitoring and assessment of the most important commercial stocks.

Details of sustainable marine fisheries research projects are at www.defra.gov.uk/science/default.htm

Fisheries Science Partnership projects

There are two types of Fisheries Science Partnership projects. Time-series projects involve fishing surveys which are repeated in the same area with the same fishing gear and the same towing practices for several consecutive years. Shorter-term projects are commissioned each year. Those commissioned in 2005/06, 2006/07 and 2007/08 are listed below.

Time-series projects

Western Channel sole and plaice

Started in 2003/04. Fifth survey completed in 2007/08

To produce a time-series of surveys in the western English Channel to provide information on distribution patterns of sole, plaice and other commercial bycatch species, trends in numbers and age composition of sole and plaice, and information on the bycatch of species such as cod.

Western anglerfish

Started in 2003/04. Fifth survey completed in 2007/08

Reported in the Marine Fisheries Science Yearbook 2006/2007

To produce a time-series of surveys to provide data on the distribution, catch rates and length distribution of anglerfish and other species caught at the same time using commercial gear off south-west England.

Irish Sea roundfish

Started in 2003/04. Fifth survey completed in 2007/08

Reported in the Marine Fisheries Science Yearbook 2006/2007

To carry out fishing surveys aimed at evaluating the abundance of various year classes of cod, haddock and whiting in the western and eastern Irish Sea.

North-east coast cod

Started in 2003/04. Fifth survey completed in 2007/08

Reported in the Marine Fisheries Science Yearbook 2006/2007

To construct a time-series of surveys of north-east coast cod to provide annual comparative information on distribution, relative abundance and size/age composition of cod, and to obtain additional information on distribution, relative abundance and size/age composition of whiting and haddock off the north-east coast of the UK.

2005/06 projects

North Sea lemon sole

Completed: 2005/06

To examine the catch composition of the June/July flatfish fishery off the north-east coast of England sampling in detail lemon sole, plaice and cod.

Western Edge ghost nets and lines**Completed: 2005/06**

To conduct a retrieval survey for, and to attempt to determine the impact of, lost and abandoned 'ghost' nets and lines in deep water, including at and around Rosemary Bank, west of Scotland.

East Greenland cod**Completed: 2005/06**

To carry out a trawl survey of cod in selected areas to the east of Greenland.

Selectivity of hake gill nets in the south-west fishery**Completed: 2005/06*****Reported as 'Hake selectivity' in the Marine Fisheries Science Yearbook 2006/2007***

To examine the catch composition and selectivity of a range of static gears for hake in south-west UK fisheries.

Western cod**Completed: 2005/06**

A one-off survey of western cod, to determine whether it was feasible to build a time-series of catches.

2006/07 projects**North Sea lemon sole and plaice****Completed: 2006/07**

To assess the composition of catches across the North Sea lemon sole and plaice fishing grounds in summer, and in particular to examine the linkage with cod in relation to the cod recovery plan and associated effort control.

Gillnet retrieval survey**Completed: 2006/07**

To determine the extent and impact of ghost nets at and around the Porcupine Bank, south-west of Ireland.

North Sea whiting**Completed: 2006/07*****Reported in the Marine Fisheries Science Yearbook 2006/2007***

To analyse the stomach contents of North Sea whiting to find out about their diet, and to see if there have been any changes to their diet since the last large-scale stomach survey in 1991. The project looked at whether whiting prey extensively on cod, which, if they do, may have adverse effects on cod recovery.

Yorkshire coast crustaceans**Completed: 2006/07*****Reported in the Marine Fisheries Science Yearbook 2006/2007***

To analyse variations in the catch rates of velvet swimming crab (*Necora puber*) and other commercially important crustaceans in the Bridlington Bay area, using commercial traps.

Eastern Channel cod**Completed: 2006/07 (with tag recoveries up to March 2008)**

To identify and map spawning aggregations of cod in the eastern English Channel and to tag mature, spawning fish in these groups by traditional, non-electronic means.

North-east coast squid fishery**Completed: 2007/08**

To map the distribution of squid caught by trawl, and the catches and bycatches taken during a night-time experimental jig fishery, over two seasons.

Western English Channel squid fishery**Completed: 2007/08**

To map the distribution of squid catches and to record catches and bycatches in the English Channel using lures, jigs, gurdies and dedicated lighting.

2007/08 projects**Thames ray tagging and survival****Completed: 2007/08**

To examine, mainly through traditional tagging methods, the survival rates of released rays of a range of sizes by vessels under 10 metres in the otter trawl sector, the netting sector and liners.

Skate and ray discard survival**Completed: 2007/08**

To investigate discard survival rates in trawl fisheries to find out the survival rate for skates and rays that would be discarded with the introduction of a maximum landing length. Also to develop species identification on-board and contribute to improved data collection.

Benthic release panels**Completed: 2007/08**

To investigate the effects of introducing benthic release panels with square-mesh codends in the Cornish beam trawl fleet.

North-east coast crab biology**Completed: 2007/08**

To assess the impact of increased minimum landing sizes for edible crab by investigating the growth rate/biology of resident edible crab populations, mapping the extent of suitable crab habitat in the region and determining whether the habitat restricts crab growth.

GOV gear trials**Completed: 2007/08**

To examine the nature of catches of the major commercial whitefish species on the *Cefas Endeavour* using the GOV trawl, and those of commercial whitefish trawlers fishing alongside the *Cefas Endeavour* to compare catch rates and size compositions of fish caught in commercial and research operations.

Northern North Sea saithe: distribution of saithe and cod**To be completed: 2008/09**

To observe and record the incidence and abundance of saithe and cod in commercial catches in order to develop management measures aimed at minimising bycatches of cod in the saithe fishery.

North Sea codwatch**To be completed: 2008/09**

To involve fishermen in reporting the incidence, distribution and abundance of the 2005 and 2006 year classes of North Sea cod in commercial catches, in a form that allows the data to be analysed and evaluated graphically in time and space

Details and reports for all completed FSP projects are at www.cefas.co.uk/FSP

Fisheries Challenge Fund projects

Projects started in 2005/06, 2006/07 and 2007/08 are listed below.

2005/06 projects

Investigation of potential fisheries for razorfish and other bivalves in the eastern Irish Sea

To identify any potential future fishery for bivalves in the eastern Irish Sea. The project involved a review of available information and vessel-based surveys of the fishery areas.

Desk study of possible long-term management approaches to North Sea fisheries which reflect stakeholder objectives

Regional Advisory Councils have used the information from this desk study to help develop long-term management plans for key commercial stocks in the North Sea.

Feasibility study of mapping key fishing areas in the North Sea

Consultation exercise to help the North Sea Regional Advisory Council to collect information that helped fishermen to take a strategic approach to spatial planning.

Margin of tolerance: the accuracy of on board catch estimates

To investigate the feasibility of complying with an 8% margin of tolerance rule. The weight of fish estimated by observers was compared with that estimated by the skipper of the vessel to assess whether the margin of tolerance allowed between the logbook entry and landing declaration was realistic.

Trans-national albacore tuna trolling pilot project phase 1

To investigate the feasibility of traditional trolling for albacore tuna for Cornish vessels. The research aimed to identify a viable alternative and sustainable fishery that will result in a reduction of fishing effort on pressured fish stocks.

2006/07 projects

UK observer trips in the westerly gillnet fishery for anglerfish

To investigate whether the ban on deep sea gill nets should apply to all deep sea gill netting. The project involved observer trips in the anglerfish fishery in ICES Subarea VI.

Model showing the vessel-level financial and economic impacts of restrictions on the whitefish fleet fishing in the north-east of England

To create a model to analyse the behaviour of fishermen with limited quota and days at sea.

Exploration of harvesting strategies for achieving long-term sustainability for the North Sea mixed demersal roundfish fisheries

Reported in the Marine Fisheries Science Yearbook 2006/2007

To adapt a model to investigate harvesting strategies for cod, haddock and whiting. The project assisted the North Sea Regional Advisory Council to develop long-term management objectives for these stocks.

Feasibility study into inshore potting for fish

To Investigate alternative designs for pots to increase the proportion of finfish caught. Designs may aid diversification of fisheries and reduce costs compared with netting for finfish.

Cornish fishing activity mapping project

To prepare a baseline study of fishing activity in Cornwall to help the Cornish Fish Producers Organisation with strategic spatial planning.

Definition of fisheries groupings for the development of long-term management plans for the demersal fisheries in ICES Subarea VII

Reported in the Marine Fisheries Science Yearbook 2006/2007

To develop matrices of stocks and fishing activity to identify key fishing links in ICES Subarea VII, to help the North Western Waters Regional Advisory Council to prepare long-term management objectives in Subarea VII.

Socio-economic study of North Sea fisheries and fishing communities

To help identify key factors that determine resilience and vulnerability of communities to changes in fishing legislation. A framework of socio-economic information was created to help the North Sea Regional Advisory Council to assess the social and economic effects of the European Commission proposals on North Sea fishing communities.

Diffuse source pollution trial, Fal, Cornwall

Reported in the Marine Fisheries Science Yearbook 2006/2007

To use a new DNA technique to trace the sources of pollution in the River Fal, Cornwall to help mussel and oyster fishermen to address pollution issues.

Feasibility study into the development of open water shellfish farming; a case study of Lyme Bay, South Devon

Reported as 'Open sea shellfish farming'

To determine the legal and regulatory framework, the technical and economic feasibility, and the environmental and socio-economic effects of developing large-scale shellfish farming operations in open sea coastal waters, using Lyme Bay as a case study.

Use of lobster/crab pots as a resource by other shellfish: scoping study for methodology and viability

To involve fishermen in investigating the effect of laying bait on juvenile lobsters and crabs. The results could help to determine management strategies such as pot density.

West of Scotland long-term management plans: definition of fishing activity by area, species and nationality

To help the North Western Waters Regional Advisory Council to develop long-term management proposals for its area on a fishery and area basis. The project provided descriptions for fisheries in ICES Subarea VI.

Developing stakeholder participation in lobster stock enhancement projects *Reported as 'Involving fishermen in improving lobster stocks'*

To enable the National Lobster Hatchery to develop a system to let fishermen release juvenile lobsters as a part of their normal fishing activities.

Trans-national albacore tuna trolling pilot project phase 3 *Reported as 'Tuna fishing'*

To test the viability of tuna trolling as a sustainable alternative fishery for Cornish vessels, using a low-impact fishing method of poles and lures which is highly selective with no bycatch of non-target species.

2007/08 projects

Pilot Fisheries Strategic Environmental Assessment project Completion date: 30/06/08

To deliver a generic framework for undertaking a fisheries specific Strategic Environmental Assessment (SEA) in the UK; and to use the generic model to pilot a fisheries specific SEA within the North Eastern Sea Fisheries Committee District. The project will provide a point of reference and guidance for other organisations wishing to undertake a fisheries related SEA in the future.

The economic, environmental and social aspects of the inshore fishing fleet of the Greater Thames Estuary with special reference to quota species Completion date: 30/06/08

To provide an objective analysis of the economic, environmental and social aspects of the inshore fleet operating in the greater Thames estuary (between Yarmouth and Ramsgate), including an assessment of the benefits and viability of the inshore sector operating in this region.

Fishermap – mapping the activity and knowledge of fishermen around the coasts and offshore areas of Devon, Dorset and Somerset Completion date: 31/12/08

To map the activities and knowledge of fishermen across Devon, Dorset and Somerset. This large-scale pilot project is being carried out as part of *Finding Sanctuary*, a project that will plan and identify a network of Marine Protected Areas (MPAs) around the coasts and seas of south-west England.

Spatial variability in velvet crab populations – a possible candidate for real-time fisheries management

Completion date: 31/12/08

To assess the variability of the moult cycle in velvet crabs to inform the management of the fishery in Shetland. This will lead to the application of appropriate management measures to maintain both environmental and economic sustainability of Shetland's fragile fishing communities.

NFFO Annual Fisheries Reports

Completion date: 31/03/09

Reported as 'Annual Fisheries Reports'

The National Federation of Fishermen's Organisations (NFFO), working with Cefas, producer organisations and fishermen's associations is setting up arrangements for the preparation of regional annual reports on fishing fleets and their activities.

Using restricted-catch areas to benefit recreational sea bass angling

Completion date: 31/03/10

To evaluate whether closing coastal areas to extractive fishing with nets and lines (and catch and release, with strict bag limits for anglers, if necessary) would enhance survival and enable more sea bass within local populations to grow bigger.

Details of Fisheries Challenge Fund projects are at:
www.defra.gov.uk/marine/science/challenge.htm

Appendix 1: Fish stock monitoring and assessments – more information



Fish stock monitoring and assessments – more information

Stock monitoring

Market sampling

Why do we need to sample catches?

Each year, Cefas organises a large programme to sample fish caught in commercial fisheries around England and Wales as part of the UK's commitment to monitor fish stocks under the European Data Collection Regulation. The main purpose of this programme is to estimate the age composition of the catches. This information is an important part of the stock assessment calculations performed by the ICES Stock Assessment Working Groups. The sampling involves measuring the length of a large number of fish and also taking the small ear stones, or 'otoliths', from about one in ten of the fish measured. By examining the otoliths under a microscope it is possible to determine the fish's age.

Fishing surveys

Why do we conduct research surveys?

In recent years, as some commercial catches have declined, ICES has had to rely more heavily on research vessel surveys for estimating the abundance of commercially exploited stocks. Cefas contributes towards this process through a number of annual surveys carried out on its own research vessel, *Cefas Endeavour*, and on chartered fishing vessels. The main purpose of the surveys is to maintain long-term data series on distribution and abundance of commercial species. They also provide useful data on species that do not have a commercial value. Research vessel surveys allow additional biological information, such as stomach contents, to be collected on fish which cannot be obtained from commercial surveys or market sampling.

Discard sampling

Why do we sample discards?

We need to gain as complete a picture as possible of the fish killed by commercial fisheries, so we sample the fish discarded by fishermen. Fish may be discarded because they are too small to be landed or because the fisherman does not have a quota for that species. The current discard sampling programme is designed to obtain information on the numbers and size of fish discarded, but the programme also provides more detailed data on catch rates to improve the current assessments of fishery performance. This programme is also part of the European Data Collection Regulation, and there is therefore a statutory requirement for regular sampling of all segments of the fishing fleet.

What sampling is done?

Industry Liaison Officers (ILOs) from Cefas carry out the current discard sampling programme in England and Wales, sailing with a selection of fishing vessels and measuring the discarded and retained portions of the catch. The ILOs travel as guests of the industry and the aim is to observe normal fishing activities. They aim to sample 600 fishing days per year, and this is spread between all the major fleet types within UK waters. As part of this programme, Cefas also carries out observer trips on vessels fishing for deep water species to the west of the British Isles.

Stock assessments***What are stock assessments?***

Commercial finfish and shellfish stocks are assessed by international scientific working groups organised by ICES, which meet each year. Assessments involve estimating the size and composition of the stock and providing options for the future management of the fisheries. The main data used to assess the status of the stock are the estimated numbers of fish of each age group caught by the commercial fleets. These data are obtained from the sampling programmes and provided by each country represented on each working group. Additional data, such as more detailed, catch-per-unit-effort information obtained from research vessel catches, may be used to improve the understanding of the results of the assessment.

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