How important is shellfish life history to assessment and management of shellfish stocks?

Marine Theme Objective: Science for integrated Marine Management

What's the problem?

Shellfish fisheries are an increasingly important component of UK marine fisheries, and there is an increasing need for sound evidence-based advice on the management of shellfish stocks, as recognized in *Net Benefits* and in *Securing the Benefits*. The English Shellfish Industry Development Strategy coordinated by Seafish on behalf of the industry highlighted key gaps in shellfish data and science. Most conventional stock assessment techniques have been developed for traditional fin fisheries, and do not necessarily incorporate the wide range of life histories exhibited by shellfish species, such as sedentary behaviour in molluscs and growth by moult in crustaceans, or the different fishing gears used to harvest shellfish. The project will develop assessment and management approaches which take into account the different life history aspects of shellfish biology, including spatial modelling approaches for species that are relatively sedentary in their adult phase. The emphasis throughout is on how both shellfish stocks and fleets respond to exploitation and changes in management strategies.

What are the aims of the project?

The primary objective of this project is to undertake modelling studies to provide a better understanding of the way in which shellfish stocks and fleets respond to exploitation, and hence to improve the evidence base on which advice on the sustainable management of shellfish stocks is given. The project has five specific scientific objectives:

1. To model the potential responses of shellfish stocks to different management options through incorporation of life-history modelling.
2. To evaluate the potential responses of shellfish fishing fleets to different management options through analysis of satellite monitoring data and catch and effort returns from the shellfish licensing scheme, and to present this information in a GIS framework.
3. To evaluate relationships between inshore and offshore shellfish populations and their response to exploitation using metapopulation and hydrographic modelling.
4. To extend spatial modelling frameworks currently being developed (under M0229) and apply generic lessons to specific case studies on Nephrops and crabs.
5. To evaluate the impact on reproductive potential of crustacean stocks of exploitation patterns which differ between sexes.

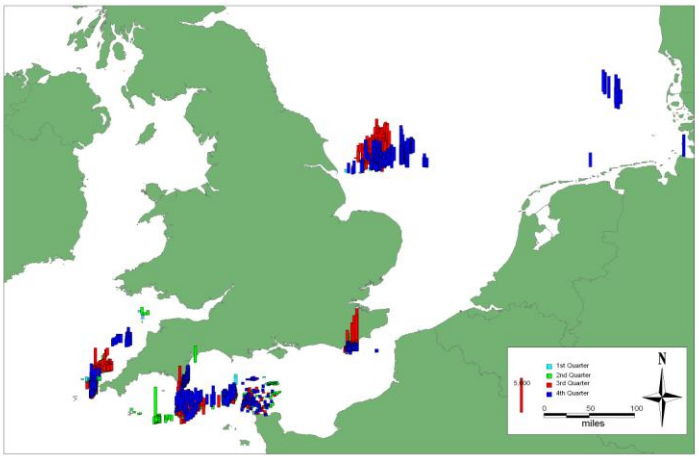

Figure 1: VMS data from crab potting vessels linked with landings from FAD showing the seasonal and geographical pattern of fishing effort and landings. File: VMS2005_PottersLinkedDailyAVG. (Source: Cefas Crown Copyright).

Which policy areas will the research inform?

The project will provide sound evidence-based advice to Defra on the sustainable management of shellfish stocks in England, including the status of shellfish stocks in relation to Good Environmental Status under the Marine Strategy Framework Directive, as well as other international drivers such as the World Summit on Sustainable Development (WSSD). The output will also help the new Inshore Fisheries and Conservation Authorities meet their management responsibilities under the UK Marine Act.

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What are the results from the project and how will they be used?

More realistic biological information has been incorporated into our assessment models for lobster and crab stocks by developing a seasonally structured yield and egg per recruit model with probabilistic growth, which explicitly includes moult probability and moult increment. The models will be developed further to include information on the size-age relationship, variable catchability and vulnerability.

Detailed information on the distribution of fishing effort and success of shellfish fleets is being collated to allow an evaluation of the potential responses of fishing fleets to different management options. For example, for >15m potting vessels fishing for edible crab, data have been taken from the Defra Vessel Management System and cleaned up to remove steaming and other non-fishing time, and then combined with landings data from the Fishing Activity Database (Figure 1). Similar data are being compiled for vessels targeting other shellfish fisheries.

Metapopulation modelling approaches have been developed to investigate various scenarios about the links between the inshore and offshore components of crustacean fisheries. A framework has been developed which follows the development of interlinked sub-population units as they are subject to various fishery regimes. Initial analyses show that moderate linkages can have significant impacts upon stock levels and the timing of the linkages can have profound effects upon the stock structure. In order to parameterise larval interchange rates between metapopulations, particle tracking models are run under various hydrographic scenarios. Initial runs based on crab larvae distributions observed show how the source of recruitment to inshore crab fisheries may be the hotspots of larvae production observed offshore (Figure 2).

A spatial modelling framework for shellfish stock management has been developed using a combination of matrix based population processes and individual based modelling for the fishing vessels. Each vessel keeps a daily logbook of activity, recording the location, numbers and sizes of animals caught thus providing data to the management module. This modelling framework has been constructed for use in answering management questions about the Nephrops and scallop fisheries.

"Sperm competition" may be evident in fisheries which are based on mature males, with a consequent significant reduction in males available to fertilise the excess of females remaining in the population. We have developed models that investigate the potential for sperm competition in Nephrops. A long term projection model suggested that even at very high levels of fishing effort, fishing appears unlikely to cause a shortage of males to fertilise females, although there are still uncertainties in model parameters. The model will be developed further to cover other crustacean fisheries where there is a difference between exploitation rates on males and females.

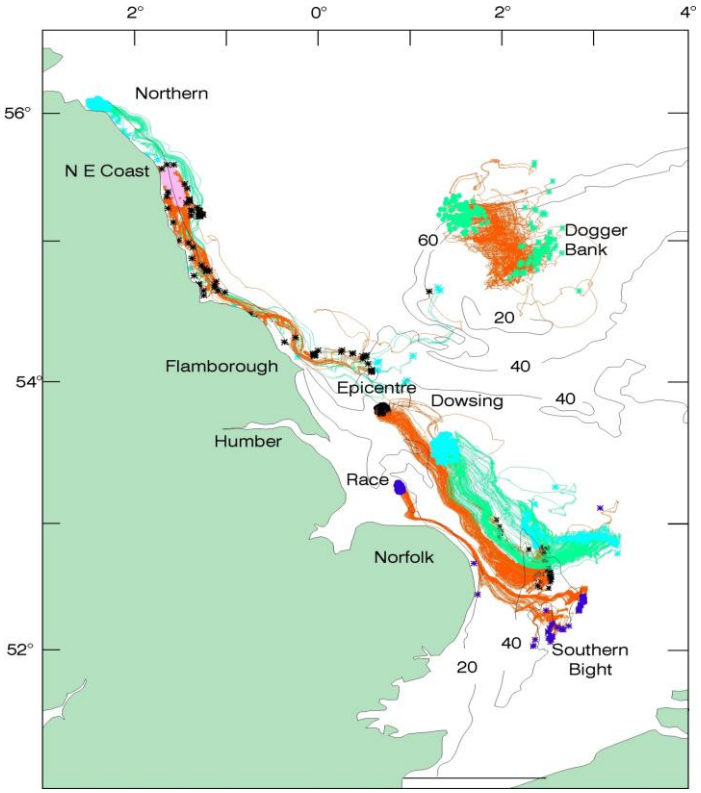

Figure 2: Predicted dispersal of crab larvae from observed spawning grounds using a two-dimensional Lagrangian dispersal model. File: Crab larvae. (Source: Cefas Crown Copyright).

Where can I find further information about this and related research?

Cefas are responsible for delivering this project. For more information on the project, please contact Julian Addison (julian.addison@cefas.co.uk).

Alternatively, please contact Defra's Marine and Fisheries Science Unit: marinescience@defra.gsi.gov.uk.

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