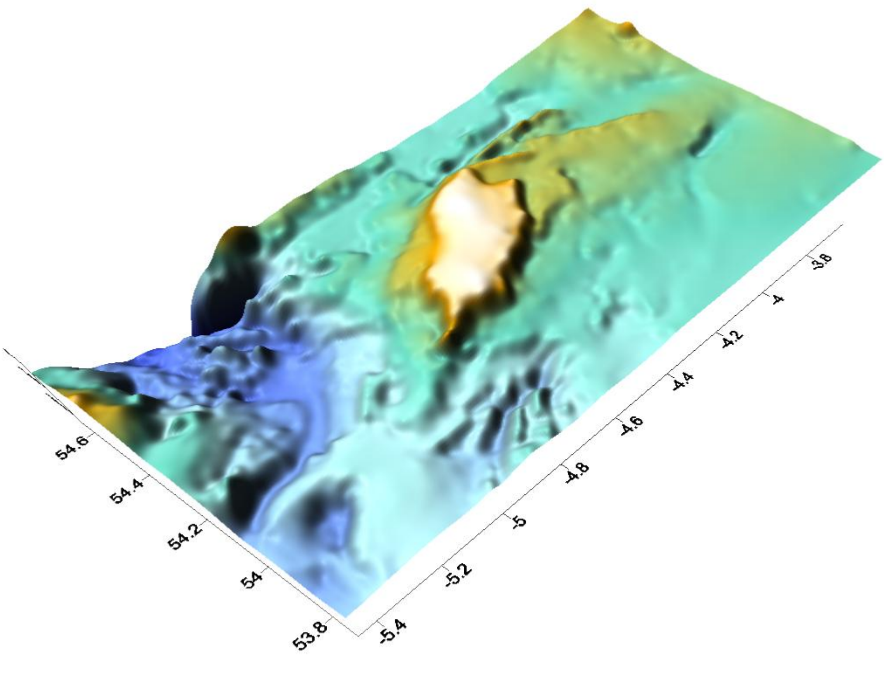
Isle of Man sustainable fisheries strategy



Michel J. Kaiser, Lee Murray, Hilmar Hinz, Anne McLay*

School of Ocean Sciences, College of Natural Sciences, Bangor University

*Fisheries Research Services, Aberdeen

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Background

The School of Ocean Sciences, Bangor University has been contracted to provide fisheries advice and underpinning science for the Isle of Man Government in relation to fisheries under its jurisdiction. The aim of this contract is to ensure a sustainable, innovative and profitable fishery moving forward into the future. In order to achieve sustainable use, a combination of long-term strategic and short-term responsive research is required to understand better the population dynamics and drivers of the key fisheries, to minimise the impacts of the fisheries on the wider ecosystem and to understand the goals, motivations and socio-economic drivers that act upon the fishers engaged in the fishery.

This document provides an overview of the research undertaken to date, and a strategy for improving our knowledge of Manx fisheries that will better inform our advice to the Isle of Man Government. Integral to this goal is the need to improve our understanding of wider environmental and socio-economic issues that are relevant to Manx waters and the fishery. The five main fisheries considered in this document are those that prosecute king scallop (*Pecten maximus*), queen scallop (*Aequipecten opercularis*), brown crab (*Cancer pagurus*), lobster (*Homarus gammarus*) and whelk (*Buccinum undatum*). In addition to research specific to these individual fisheries, there are some important over-arching research questions that should be addressed in the context of developing a sustainable fishery, these are outlined below.

Over-arching research questions

Fishers' knowledge questionnaire: Sustainable fisheries management involves stakeholder engagement and integration of fishers' knowledge into the management process. We are currently administering a stakeholder questionnaire that seeks knowledge about the following issues:

- Changes in patterns of distribution and abundance through time of the main commercial species.
- Key species-habitat associations.
- Key forcing agents (e.g. weather, economics etc) that affect decisions regarding when and where to fish.
- Fishers' goals and motivations - what type of fishery do they want.
- Attitudes towards the management and regulation process in the Isle of Man (with a follow-up questionnaire towards the end of the contract).

Oceanographic surveys: Undertake comprehensive oceanographic surveys of the waters around the Isle of Man to validate particle tracking models (that provide insights into connectivity among sub-populations) and to examine patchiness in plankton blooms (the food supply for larval and adult scallops) and identify important oceanographic features. Surveys will include measurements of temperature, salinity, chlorophyll *a* and turbidity. Remote sensing could also augment this data and would give greater temporal coverage than could be achieved using a research vessel sampling programme.

In the longer-term, more modelling may be required to improve the validity of our particle tracking models with respect to advising on the placement of MPAs or the identification of brown crab spawning grounds.

Seabed biodiversity mapping: In order to understand the potential impacts of fishing and other activities (renewable energy developments, aggregate extraction etc.) on the seabed, it is necessary to map the extent of the different types of seabed communities in Manx waters. In August 2008 we undertook extensive towed video and still camera surveys of the seabed. These studies are particularly relevant given the affinity of the target species with key habitat features that may influence recruitment (e.g. presence of hydroid turfs, gravel beds). By determining species-habitat associations, the effect of any habitat loss on fished species can be incorporated into management strategies. By extension, additional negative feedback through fishing activity (e.g. loss of critical habitat through direct physical disturbance of the seabed), beyond the removal of the target species, will be accounted for in stock assessments.

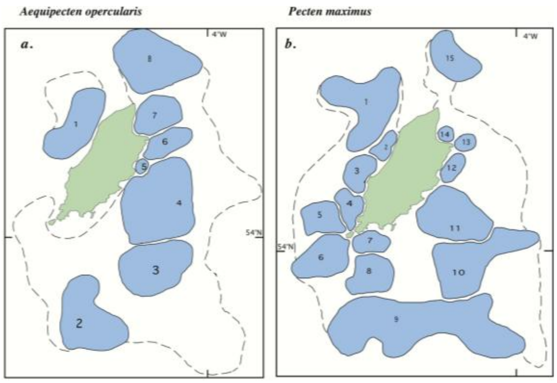
Fisheries interactions: Although it may be convenient to monitor fisheries and assess stocks on an individual species basis, as is the common practice (see Hixon *et al*., 2007) measurements of the interactions between commercially fished species and habitat loss should also be incorporated into stock assessments where possible (FAO, 2005). An Ecosystem Approach to Fisheries (EAF) recognises the interactions between fisheries resources, the value of marine ecosystems, and the inadequacies of current fisheries management approaches (FAO, 2003). Multi-species stock assessment models have been developed (Shepherd, 1988) but suitable data are required for such models . As an adjunct to the more traditional single species stock assessments, laboratory and field experiments will be conducted to study predator-prey interactions and determine their effects on the lobster, crab and scallop fisheries. The output of these studies will allow the interactions between these fisheries species to be determined and accounted for in stock assessments.

Public science partnership: Engaging the general public and schools in science projects relevant to achieve the objectives of sustainability is an important process in developing 'ownership' of marine resources. Such projects might involve deployment of settlement plates in the closed areas or use of tracers (oranges) to validate particle tracking models.

Fisheries specific issues

King and queen scallop

Existing research



Queen scallop and king scallop fishing grounds around the Isle of Man. Major fishing grounds are bounded by solid lines; the dotted outline indicates areas where scallops occur and are occasionally fished. All boundaries are approximate and many fishing grounds are contiguous. Panel a shows the queen fishing grounds: (1) The Targets; (2) H/I Sector [10-20' South Port St Mary]; (3) Southeast Douglas; (4) East Douglas; (5) Laxey Bay; (6) Maughold Head; (7) Ramsey Bay; (8) Point of Ayre. Panel b shows the king scallop grounds: (1) The Targets; (2) Kirkmichael Bank; (3) Peel Head; (4) Bradda Head; (5) Offshore Bradda/West Calf; (6) The Chickens; (7) Port St. Mary Inshore; (8) Port St Mary Main; (9) H/I Sector [10-20' South Port St Mary]; (10) Southeast Douglas; (11) East Douglas; (12) Laxey Bay; (13) Maughold Head; (14) Ramsey Bay; (15) Point of Ayre.

The population biology of the king scallop fishery has been extensively studied in the context of Manx fisheries (Brand *et al*., 1980; Allison, 1993; Beukers-Stewart *et al*., 2003; Brand, 2006). The Port Erin Marine Laboratory undertook scallop dredge surveys in June and October for each of the years between 1991 and 2006 (see Beukers-Stewart *et al*., 2003 for 1991-2001 survey results) using the same standard sampling gear (4 scallop dredges fished off one beam with 4 queen dredges fished off the other beam). These sampling dates occur just after the end of the fishing season (June) and prior to the start of the fishing season (November). These fishery independent data enable the population structure and number of pre-recruits (2 - 3 yr old king scallop) to be estimated. There exist published growth rates for each fishing bed. In addition, catch per Unit Effort (CPUE) data for each fishing bed were recorded by one third of the fleet until 2005 in log-books, a scheme which was expanded to the entire fleet from 2006 onwards.

To date, there has been no attempt to undertake stock assessments of either the king or queen scallop stocks, although potentially useful data exist. Currently, logbook data is not entered in a form that would enable us to generate CPUE data and the fishery independent data is complete only from 1991 – 2001, and 2007; and from 2002 – 2006 for 2 yr old *P. maximus* only. Data from the Vessel Monitoring System (VMS) has also been recorded for all scallop dredging vessels fishing within the 3 nm zone since 21st March 2007. Prior to 2007, only vessels >18m were required to install VMS from 1st Jan 2004, and from 1st Jan 2005 all vessels >15 m. Fishing activity can be inferred from vessel speed thus acquisition of this data will elucidate spatial and temporal distribution of fishing effort.

Previous fisheries research has focused predominantly on *P. maximus*. However, regular biannual surveys of *A. opercularis* were conducted at four sites around the island, namely Chickens, 15 miles South of Port St. Mary, East Douglas and Laxey (Brand, 2005). Allison (1993) also provides comprehensive data on *A. opercularis* and *P. maximus* stocks prior to 1992. There has been no obvious decline in landings, and the market is currently limiting the quantity of both king and queen scallops landed, not stock size. Asessments based on available data, for both these fisheries are being carried out and will be completed by December 2008.

Analysis of the biannual scallop stock survey results and temperature data have revealed that increasing seawater temperature may lead to is associated with increased king scallop yields in the Isle of Man and elsewhere (Shephard *et al*., submitted). In the United States it has been found that low temperatures lead to a delay in the spawning of *Argopecten irradians*, leading to a smaller winter size and potentially reduced survival (Tammi *et al*., 1997). Moreover, growth of *P. maximus* spat is temperature limited at low temperatures (7°C), and also, above a minimum food threshold, at higher temperatures; at the highest temperature (23°C) food ration is limiting (Laing, 2000).

Particle tracking models have revealed that at least some larvae derived from scallops in Laxey Bay, Douglas Bay and Ramsey Bay are likely to settle within Isle of Man waters. Therefore, the establishment of no-fish areas in these bays could prove beneficial to the scallop fisheries by protecting a spawning stock of both *A. opercularis* and *P. maximus*. Following discussions with fishers, Laxey Bay and Douglas Bay were identified as the preferred areas for closure to fishing. [new para] Video and digital stills images have been obtained from extensive underwater surveys of Douglas Bay, Laxey Bay and the Port Erin fishing exclusion zone. From these visual surveys *A. opercularis* and *P. maximus* abundance were ascertained. It is clear that scallops inhabit areas which are not dredged due to seabed obstacles including rocks and manmade structures. Consequently, there is a need to surveys over areas representative of the full range of scallop habitats are required to improve spawning stock biomass estimates.

Further visual surveys were conducted over the entire 12 nm territorial sea on a 5 km grid. Over 150 tows of 200-400 m were undertaken. Temperature, salinity, benthic chlorophyll, chlorophyll fluorescence, seabed roughness, and sediment characteristics were also recorded. This data has allowed the spatial extent of fished species to be mapped, and biotopes are being indentified through analysis of the still images. Important oceanographic features were also identified; stratification, in particular, may be important in influencing larval settlement.

Trials of an alternative dredge design, the hydrodredge, were conducted in the Isle of Man. This dredge design was found to reduce substantially the quantity of damaged by-catch and discards, including undersized scallops, but was less efficient than conventional dredges (Shephard *et al*., 2007). Further technical measures to reduce bycatch and bycatch mortality will be given consideration. In particular, the effects of hand sorting versus mechanical sorting of undersized queen scallop bycatch will be determined.

At present commercial fishing vessels are utilised to undertake [visual] stock assessment surveys. While this is desirable from a stakeholder engagement view-point, it constrains the scientific work (amount and precision) that can be undertaken due to conditions on-board. In October 2008 we undertook a gear/ship catchability trial to investigate the feasibility of utilising the RV Prince

Madog for survey work in the future. The initial results suggest no significant differences in the reported data, although higher numbers of queen scallops were recorded aboard the research vessel which more likely relates to a better working environment (precision) rather than a gear sampling issue. The RV Prince Madog would enable a wider range of scientific information to be obtained in relation to by-catch and environmental data necessary for an ecosystem based approaches to management. We will present a paper with formal recommendations for consideration.

Immediate science requirements:

- Either obtain or re-enter the fishery log book data for king and queen scallops.
- Undertake a stock assessment for both fisheries, implement self-sampling of size-classes landed.
- Obtain historical VMS data (may require additional expenditure) to map temporal patterns in fishing effort.
- Short-term field and survival tank experiment to compare survival of queen scallops sorted using different techniques.
- Determine the composition of by-catch resulting from queen scallop fishing.
- Construct a database to integrate VMS, survey and logbook data.

Longer-term science requirements:

- Maintain the fishery independent surveys, with review of adequacy of data.
- Apply for additional funding to test the predictions of particle-tracking models of scallop larvae. Approaches utilised would include the use of markers and genetic analyses to examine possible population structure in the Irish Sea and wider west coast of the UK.
- Develop a programme to quantify the effects of closing the second proposed area of the seabed to scallop fishing. This will include towed underwater video and still image surveys and diver collection of scallops for scientific purposes.
- Determine the carrying capacity of the newly established fishing exclusion area and the existing fishing exclusion area at Port Erin.
- Expand the fishery-independent population data collection programme to include scallops in undredged areas to improve estimates of spawning stock biomass.
- Quantify scallop mortality resulting from predation

In summary, historical data on the Isle of Man scallop fisheries are potentially available from numerous sources. However, much of these data have yet to be processed. In particular, no stock assessments have been conducted for either the *A. opercularis* or *P. maximus* fisheries. Investigating available data and possible approaches to this is the priority for both scallop fisheries.

Brown crab and lobster

The brown crab and common lobster fishery in the Isle of Man currently employs 31 vessels of which the majority are >10 m l.o.a. The brown crab fishery is focussed entirely on the west coast of the Island whereas the lobster fishery occurs in all areas around the Island. Areas frequented by potters are restricted by the possibility of negative interactions with the towed fishing gear sector. Vessels are required to provide log-book records of landings which extend over the last 20 years. Vessels tend to prosecute the same areas of seabed from year to year and individual boats tend to fish the same areas. Despite the availability of these data there has been little specific research on these crustacean fisheries to date. Hobby fishing occurs in coastal waters but this is also regulated.

There are several difficulties associated with the assessment of lobster and crab stocks. In particular, estimates of mortality based on length cohort analysis may not be valid for brown crab or lobster stocks because size differences cannot be reliably related to age (Sheehy and Prior, 2008). There is currently a paucity of information on the Isle of Man crustacean fisheries. However, there are a number of fishery and effort regulations in place, these include:

- A cap on the number of pots that can be fished in Isle of Man waters (currently 7500).
- MLS for lobsters (87 mm carapace length) and brown crab (13 cm shell width).
- Ban on the landing of berried female crab or lobster.
- Isle of Man controls extend to 12 nm offshore.
- Only 2 outside vessels currently prosecute the fishery.
- There is a vessel limit of 300 pots per boat inside 3 nm and 500 pots per boat in total.
- The recent introduction of a pot tagging scheme (with funds recycled into research).
- Compulsory use of escape hatches to release undersized individuals (from 2008/2009). 7500 escape panels will be given to fishermen during 2008.
- There is a voluntary V-notching scheme for berried lobsters and it is illegal to land V-notched individuals.
- Hobby fishers are limited by license and limited to 5 pots per person with a bag limit of 1 lobster and 5 brown crab per day.
- Hobby fishers take approximately 1-2% of the total catch of lobster and minimal catches of brown crab compared to the commercial fishery.
- Hobby fishers must make annual returns.

Following the successful voluntary introduction of lobster trap escape gaps in Sussex (Clark, 2007) escape panels are already being distributed to IoM fishermen for voluntary use, each with an 80 mm x 45 mm escape gap, having been installed in 750 lobster traps so far. Although their use is currently aimed at protecting juvenile lobsters, these escape gaps will also allow undersized crabs to escape. Lobster fishermen are currently assisting in a study on the effectiveness of escape gaps by measuring and recording catches in traps with and without escape gaps.

De-clawing of crabs is still illegal in Manx waters. Live crab de-clawing was previously illegal in the United Kingdom but this law was revoked in 2000/2001. It is common practice to de-claw crabs in processing factories, often with the body being either discarded or used as whelk bait. The use of brown crab as bait has been identified as a threat to crab stocks in the south western Irish Sea (Fahy, 1999).

Immediate science requirements:

- Extract landings data from the 20 year time-series of log-books and integrate into GIS format.
- Integrate hobby fisher records with commercial landings (lower priority).
- Collate fishers' knowledge from over-arching questionnaire survey.
- Commence crab / lobster or both ?tagging programme to elucidate stock size and migration patterns.
- Engage fishers in 'self-sampling' programme to estimate size distribution of crab and lobster and resolve this information spatially and across seasons.
- Undertake study into lobster trap escape panels to ascertain the optimal size and design of escape gap.

Longer-term science requirements:

- Seek funding for PhD focussed on (1) the brown crab fishery and (2) the lobster fishery. Research on the brown crab fishery to integrate by-catch information on brown crab discards from scallop fishery. Scallop dredges act as good sampling tools of crab, particularly when inactive and perhaps buried in sediments. PhD to include at sea sampling and tagging programme. Research designed to understand better the seasonal and spatial distribution of male and female crab. Particle tracking models used to understand movements of larvae in conjunction with at-sea sampling using plankton surveys. This research may identify key breeding grounds where male crabs aggregate prior to mating.
- Determine crab predation impact on *P. maximus* and *A. opercularis* fisheries.
- Initiate tagging programme to obtain lobster population data

Whelk fishery

The whelk fishery remains a relatively small fishery in which only five vessels participate at present. Nevertheless the price of whelk is generally high, although the market is tightly controlled by buyers in the Far East. Whelk landings in 2006 totalled 275,033 kg, worth £135,760, more than lobster landings in the Isle of Man, which totalled £128,000. Whelks are fished largely as an additional source of income by scallop fishermen, either using whelk pots or through landing of whelk bycatch. In general, whelk biology has been poorly studied apart from one PhD study in the early 1990s undertaken at the Port Erin Marine Laboratory that provides information on the basic ecology of this species. Typically the fishery is characterised by boom and bust and probably constrained the limited distributional capabilities of the larvae (which crawl away from egg masses laid on the seabed). This means that populations are likely to occur in discrete areas of the seabed with limited potential for migration between areas over short timescales. Consequently, small-scale spatial differences in size and growth rates may exist making large-scale management of the fishery inadequate (Shelmerdine *et al*.2007). In addition, slow growth and a high reproductive age make whelks vulnerable to being over-fished (Valentinsson *et al*., 1999). Beam trawling has been reported as causing severe shell damage in up to 83% of whelks, leading to almost 70% mortality (Mensink *et al*., 2000). Therefore, whelks must be considered vulnerable to over-fishing.

Current regulations limit the number of whelk pots to 3600 within the 3 nm zone. Individuals are limited to 600 whelk pots. From 2006 all fishing vessels have been required to return logbooks documenting fishing activities and catches. There are no data to determine whether whelk stocks are threatened by the current level of fishing activity targeting whelks, or the effects of other fishing activities, scallop dredging in particular, on stocks.

Immediate science requirements:

- Extract data from logbook records into useable GIS and database format.
- Initiate at-sea self-sampling programme to monitor population recruitment, size and age (if possible) distribution.
- Integrate fishers' knowledge to understand temporal and spatial distribution of whelk populations around the Isle of Man.

Longer-term science requirements:

- Update management strategy in light of scientific findings.
- Improve understanding of population stock structure through genetic analyses of IoM and wider Irish Sea population.

Summary

Management of the Isle of Man fisheries to date appears to have been effective, if somewhat arbitrary in terms of the implementation of effort restrictions. There is a fundamental need for reliable data on the stocks of queen and king scallops, whelks, brown crab and the common lobster to allow fishing effort to be maintained at an appropriate level. Recent particle tracking studies represent the first step in understanding the potentially complex relationship between scallop spawning stock biomass and recruitment. Only the king scallop fishery is endowed with a notable historical dataset, the continuation of which, in conjunction with logbook data, can be used to relate CPUE to scallop stock size. Long-term monitoring of all fished species together with fishing effort must continued or initiated as soon as possible where it is not already taking place. The oceanographic and visual seabed surveys will allow habitat features to be related to scallop distribution, and, together with smaller scale manipulative ecological studies, will begin to allow the fisheries to be considered in an ecosystem context.

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