The Isle of Man *Aequipecten opercularis* Fishery: Science and Management

Final Draft

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INTRODUCTION

Fisheries for both *P. maximus* and *A. opercularis* are prosecuted almost exclusively in the North East Atlantic. *Aequipecten opercularis* are landed chiefly in the Faroe Islands, UK and France. The queen scallop, *Aequipecten opercularis*, is fished using several types of fishing gear. Both toothed and toothless dredges are used to target the species as well as otter trawls. Queen scallops show an active swimming response when disturbed especially during summer and autumn when water temperature is relatively high (Jenkins *et al*., 2003). During these months they are more successful in evading capture by dredges; therefore, otter trawling represents a very effective method of fishing at this time. Conversely, trawls are less effective during the colder months, as the queen scallop swimming response occurs more slowly. Furthermore, otter trawls cannot be used on cobbles or over rocky reefs.

Scallop dredges, which can be used in most habitats, cause more damage to stable habitats compared to the damage caused to the more mobile, softer sediment habitats in which otter trawls are used (Kaiser *et al*., 2000); thus the overall impact of scallop dredging is likely to be greater than that of trawls (Collie *et al*., 2000; Kaiser *et al*., 2006). Some sensitive habitats, including maerl, *Lithothamnion* sp. and *Phymatolithon calcareum*, beds and horse mussel, *Modiolus modiolus*, beds are particularly vulnerable to fishing activity. Dredging can lead to degradation of maerl beds through a reduction in structural complexity (Hall-Spencer *et al*., 2003).

The exclusion of fishing activity from certain areas may benefit populations of the target species by safeguarding parts of the population. Several fishing exclusions have been enforced in Strangford Lough, principally to protect parts of the queen scallop population from the dredge-based queen scallop fishery (Rogers, 1997). In the Isle of Man, *Pecten maximus* densities are much greater within the closed area at Port Erin (Beukers-Stewart, 2005), and these scallops may be an important spawning stock. This closed area, and the more recently established fishing exclusion zone in Douglas Bay also protect queen scallops from fishing in these areas.

The queen scallop fishery prosecuted around the Isle of Man is relatively small, typically with less than 2000 tonnes landed into the Isle of Man annually, and a further 2000 tonnes landed into Scotland. This report summarizes the availability of data on the Isle of Man *A. opercularis* fishery and provides management recommendations. Specifically, the fishery is discussed in relation to Marine Stewardship Council (MSC) principles 1 and 2.

OVERVIEW OF THE FISHERY

Fishing gear used to target Aequipecten opercularis

Four fishing gears have been used to fish for *A. opercularis* during recent years. These are: a) traditional toothed Newhaven dredges, with up to 17 teeth of 6 cm length; b) skid dredges, which use a bag mounted on skids and a tickler chain; c) a modified dredge using a rubber flap in place of teeth; and d) otter trawls. Otter trawls range from 18 to 32 m wide using a mesh size of 80 to 100 mm. Otter trawls and the new toothless dredge (Figure 1) are currently the most commonly used gears.

Figure 1. Typical trawling vessel and otter trawl (top) and one of three dredging vessels and toothless dredges (bottom) used to fish for *Aequipecten opercularis* around the Isle of Man.

Extent and magnitude of fishing activity

The fishery comprises around 25 otter trawling vessels and three dredging vessels, although these numbers vary between years. Between November 2007 and October 2008, the mean area of seabed swept by the new queen dredges was 3.7±1.0 per 25km^2 (0.15±0.04 per km^2), including only 25km^2 statistical cells that were fished. The estimated area of seabed swept per km^2 is shown in Figure 2. The mean area of seabed swept by otter trawls was 1.9±0.6 per km^2 (0.08±0.03 per km^2), again including only those statistical cells that were fished; the estimated area of seabed swept per km^2 is shown in Figure 3. Neither skid dredges nor toothed queen scallop dredges have been used widely in the fishery since November 2007. Given the limited use of dredges it is recommended that the use of toothed dredges and skid dredges is prohibited in the queen scallop fishery.

It is estimated that with the 12 nautical zone, 58 km^2 of seabed were swept by Manx vessels between November 2007 and 2008, compared to 125 km^2 by UK vessels. While outside of the 12 nautical mile zone, in the vicinity of the Isle of Man (in what could, geographical and biologically, be considered the same fishery), Manx vessels swept 17 km^2 of seabed, compared to 337 km^2 by UK vessels. For these estimates it is assumed that all Scottish vessels were using 14.4 m wide fishing gear. For Manx vessels the calculations are based on the reported fishing gear used. Based on this distribution of fishing effort it is estimated that 1455 tonnes of queen scallops were caught within the territorial sea in 2007 and 2050 tonnes in 2008.

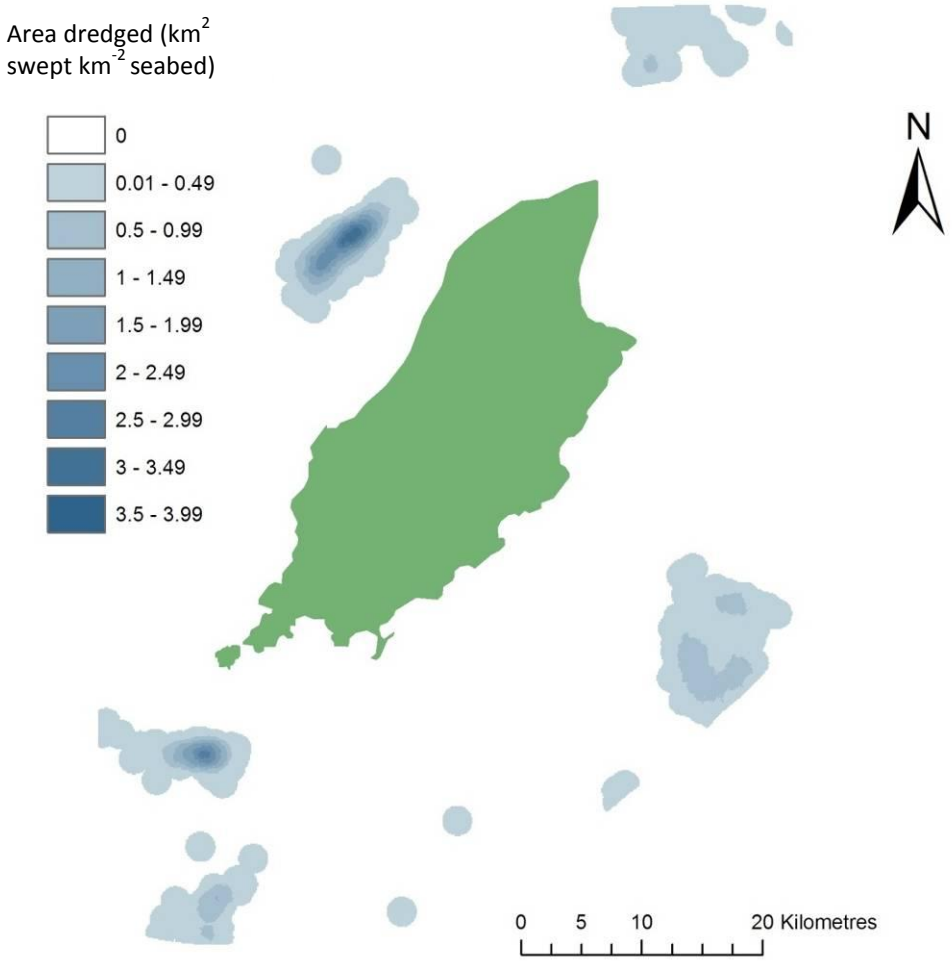

Figure 2. Estimated area of seabed swept by modified, toothless dredges between mid-November 2007 and mid-November 2008.

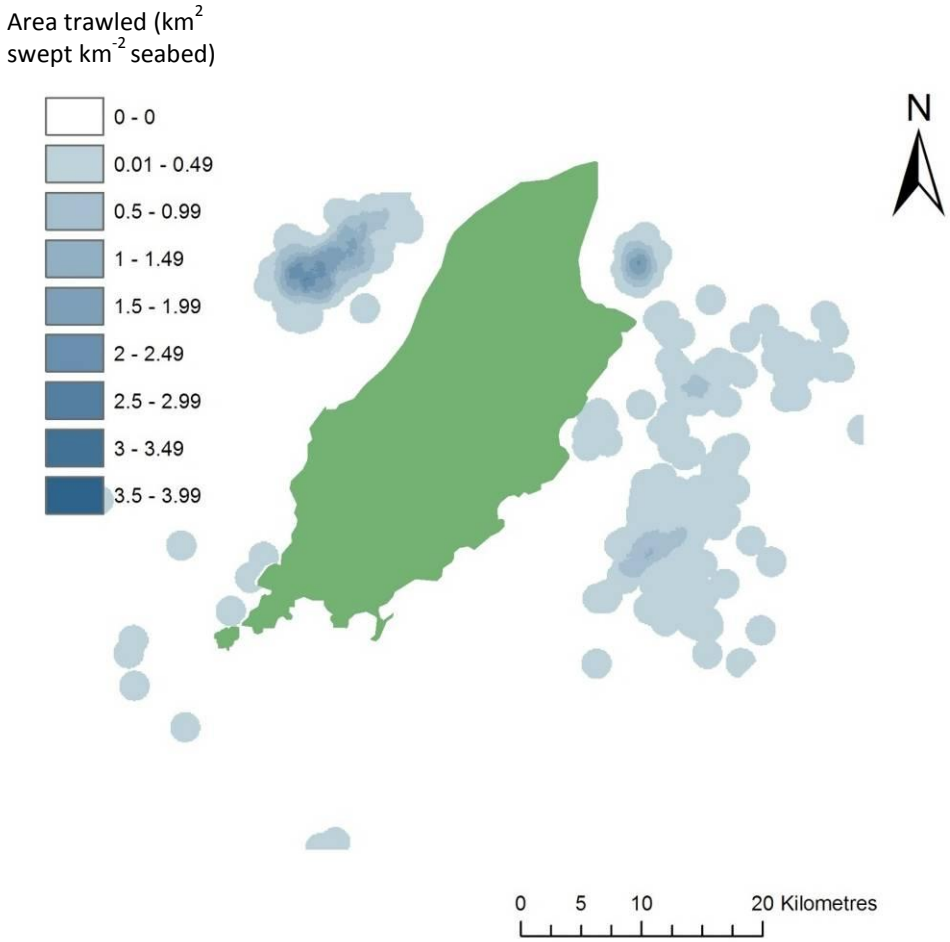

Figure 3. Estimated area of seabed swept by otter trawls between mid-November 2007 and mid-November 2008.

SUMMARY OF AVAILABLE DATA

Satellite vessel monitoring system (VMS)

Received from all Isle of Man registered vessels fishing for *A. opercularis*, and by all vessels >15 m in length. Records are received at two hourly intervals. DAFF currently has access to data from June 2007 onwards. All available VMS data from within the 12 nautical mile territorial sea has been requested from the Marine and Fisheries Agency.

Fisheries logbooks

Logbooks are returned by all fishers landing into the Isle of Man. Sales notes are not requested by DAFF. Data is available on landings of *A. opercularis* into Scotland, spatially referenced to ICES statistical rectangles.

Biannual surveys

Research surveys are undertaken in June and October each year. These surveys have been conducted since 1992 from several vessels. Presently, surveys are undertaken from RV Prince Madog. Eight core sites are visited during each survey period. Further sites are sampled if possible. These surveys sample queen scallops >60 mm, but do not effectively sample smaller queen scallops, and thus provide a poor recruitment index. The most recent survey was completed in October 2009.

Queen scallop discard survival

Data presented by Montgomery (2008) suggest that survival rates of undersized queen scallop discards are likely to be high. Queen scallops do not appear to suffer a high level of damage from mechanical sorting, continue to exhibit an escape response following capture, and showed no mortality in aquaria following capture in otter trawls.

Visual surveys of closed areas and habitats around the Isle of Man

Video and digital still images were taken within Laxey Bay, Douglas Bay and Port Erin closed area in March 2008. Additional images were taken at Targets, Ramsey Bay, Douglas Bay, East of Douglas and Laxey Bay in June 2008. Analysis of these images is currently being undertaken by PhD students at Bangor University (See Appendix I for examples of image analysis). The most recent surveys of the closed areas took place in October 2009. Furthermore, a comprehensive habitat survey of the territorial waters of the Isle of Man was undertaken during summer 2008. Overall, 142 stations were sampled on a 5 km grid around the Island (see Murray et al. 2009). Analysis of these images is currently being undertaken.

Queen scallop fishing gear impact comparison

Data was collected before and after fishing activity using three gear types, namely: toothed dredges, toothless dredges, and an otter trawl. Results are presented by Hinz *et al.* (2009). Some further analysis of grab samples may be undertaken.

Future research

The biannual surveys together with VMS and fisheries logbook data will form the basis of the research for this fishery during the next year. The results of this work will be complemented by oceanographic measurements collected by FPV Barrule and RV Prince Madog. Image analysis from habitat surveys is on-going and will be completed over the next year. Spatial referencing of catches at the end of each fishing season will be fundamental to monitoring catch per unit effort and fishing effort.

THE FISHERY IN TERMS OF MSC PRINCIPLES I AND II

Principle I: Stocks

Overview

Formal stock assessments require information on the geographical boundaries of the stock under study in order to quantify the relationships between spawning stock biomass and recruitment to the fishery. Particle tracking models predicting the distribution of *Pecten maximus* larvae suggest that larval sources exist in both English, Scottish, Irish and Welsh waters, as well as around the Isle of Man (Neill and Kaiser, 2008). It is likely that *A .opercularis* populations around the Isle of Man will also depend partly on larvae from outside the Isle of Man's territorial waters. There are no apparent relationships between larval settlement and queen scallop densities around the Isle of Man (Vause *et al*., 2007).

Landings of *A. opercularis* into the Isle of Man have decreased markedly from a maximum of 7600 tonnes in 1972. Given the increasing densities of queen scallops in Manx waters it is suggested that fishing levels are maintained close to current levels. From ICES statistical rectangles 36E5 and 37E5, landings of queen scallops into the Isle of Man were 1580 tonnes in 2007 and 654 tonnes in 2008. Landings into Scotland from the same area were 2213 tonnes in 2007 and 3137 tonnes 2008. Assuming the spatial distribution of fishing effort remains consistent between years, it is advised that for queen scallops, a Total Allowable Catch (TAC) of 1750 tonnes within the Isle of Man's 12 nautical mile territorial sea for the period between 1st November 2009 and 31st October 2010 (see *Stock status and reference level* section) would be an appropriate precautionary level. This value is based on landings and the distribution of fishing activity in 2008. The TAC could also be divided between individual vessels or Manx and UK vessels.

Biannual surveys will be continued and spatial referencing of catches will allow detailed fishery-dependent CPUE data to be obtained. Spatial referencing of catches using VMS data from the entire fleet will replace the use of the Isle of Man statistical rectangles and scientific logbook data, from which previous CPUE estimates were made. These data will be processed at the beginning of each king scallop dredging season, in November. Consequently, the TAC can be increased or decreased depending on trends in stock abundance indices. There has been an increase in relative abundance of queen scallops since 1992 together with an increase in effort. Should the increase in abundance indices halt or any decline be detected then the TAC should be decreased to current levels or lower. The TAC could be increased as long abundance indices show increasing densities of queen scallops. However, market demand currently limits the size of the fishery so this may not affect actual landings. It is suggested that the 95% confidence intervals, or ±2 SE, are used as the threshold which triggers a change in the TAC. An abundance index greater than the mean +2 SE would trigger an increase in the TAC, while an abundance index less than the mean -2 SE would trigger a decrease in the TAC. Alternatively, a precautionary approach would be to decrease the TAC if any decrease in abundance is detected. Even if spawning stocks become depleted outside of Manx territorial waters, this will be reflected in reduced recruitment to the fishery, and a lower abundance index. Complete removal of all spawning stocks outside of Manx territorial waters would result in a smaller fishery, with a lower TAC, entirely dependent on local spawning stock biomass.

Stock status and reference point

Queen scallop stocks have been monitored around the Isle of Man since 1992 by means of dredge-based biannual surveys. The methodology and results of these surveys are presented by Brand *et al*. (2005) and Murray *et al*. (2009). Since June 2008 *A. opercularis* has been sampled at all sites that are visited, with at least eight sites visited during each survey. It is hoped that this will improve estimates of overall queen scallop abundance. Additional data has also been obtained on CPUE in the fishery by means of scientific logbooks submitted by a sub-sample of the Manx fishing fleet (Brand *et al*., 2005). This data is now obtained for the entire Manx fleet using VMS and fisheries logbooks. There has been a significant exponential increase in the relative abundance of queen scallops since 1992 (Figure 4). Landings of queen scallops into the Isle of Man and Scotland decreased between 1972 and 1994 but there has been a trend of increasing landings up to 2008 (Figure 5).

The relationship between the predictors time (t) and landings at t_{i-1} and the response, $\log_{10}$ relative abundance, can be described using a Generalized Additive Model (GAM). Thus, E(y) = t + f(c), where, y = linear predictor, t = time, and c = landings. Intercept = 0.639±0.061, t = 10.447, p = <0.0001, time coefficient t = 5.467, p = 0.0001, landings coefficient F = 4.58, p = 0.034. R^2 = 0.759, Deviance explained = 80.2%, n = 17. Relative abundance increased approximately linearly with landings (Figures 6 and 7); thus, both landings and relative abundance have increased over time (Figure 7). The fitted value ±2SE of the GAM ($\log_{10}$ relative abundance) for 2008 was 1.337 ±0.15 (21.73 ±1.41 individuals $100m^{-2}$). Assuming landings remain at the same level, 4311 tonnes, then the forecast abundance index for 2009 is 1.37 ±0.16 (23.44 ±1.45 ind. $100m^{-2}$).

Thus, if the 2009 abundance index is >24.89 then an increase in TAC should be allowed, while if the abundance index is <21.99 then the TAC should be decreased. If the abundance index is ≥21.99 but ≤24.89, it is suggested that the TAC is maintained at the same level, or decreased slightly. It is important to note that the landings values used in this model are for ICES statistical rectangles 36E5 and 37E5. The TAC can only be set appropriately if landings from within the Isle of Man's 12 nautical territorial sea can be determined. It is estimated that of landings in 2007 and 2008, an average of 1753 tonnes per year were caught within the Isle of Man's territorial waters; however, the magnitude of historical catches within the Isle of Man's territorial sea are unknown. Therefore, based on present data, a theoretical TAC will need to be set for ICES rectangles 36E5 and 37E5, before a suitable proportion of this TAC can be set and implemented in the Isle of Man's territorial waters. In 2008 this proportion stood at 34%.

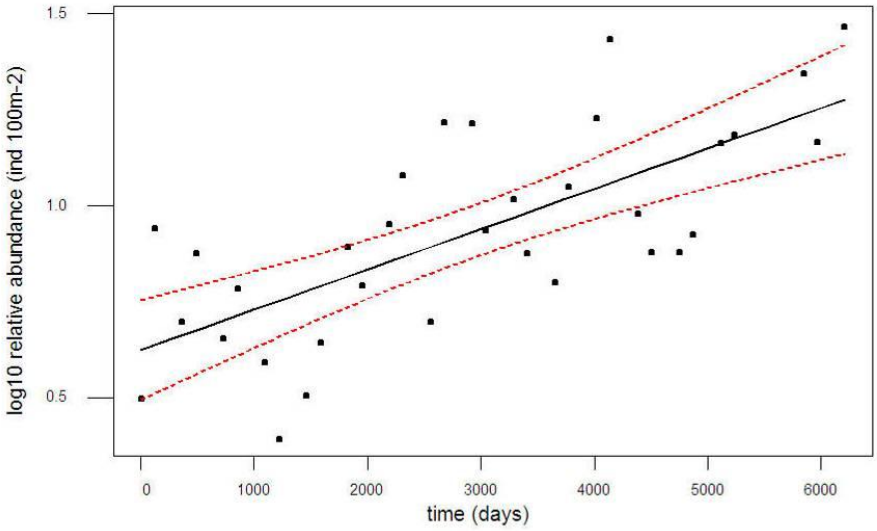

Figure 4. Mean relative abundance of queen scallops from October 1992 to June 2009. Linear regression line is shown (solid line, y = 0.0001052x + 0.623, R^2 = 0.508, $F_{1,31}$ = 31.949, p<0.001) with 95% confidence intervals (dotted lines). Values are the mean abundance, averaged from relative abundance at Laxey, Port St. Mary, East Douglas and Chickens fishing grounds.

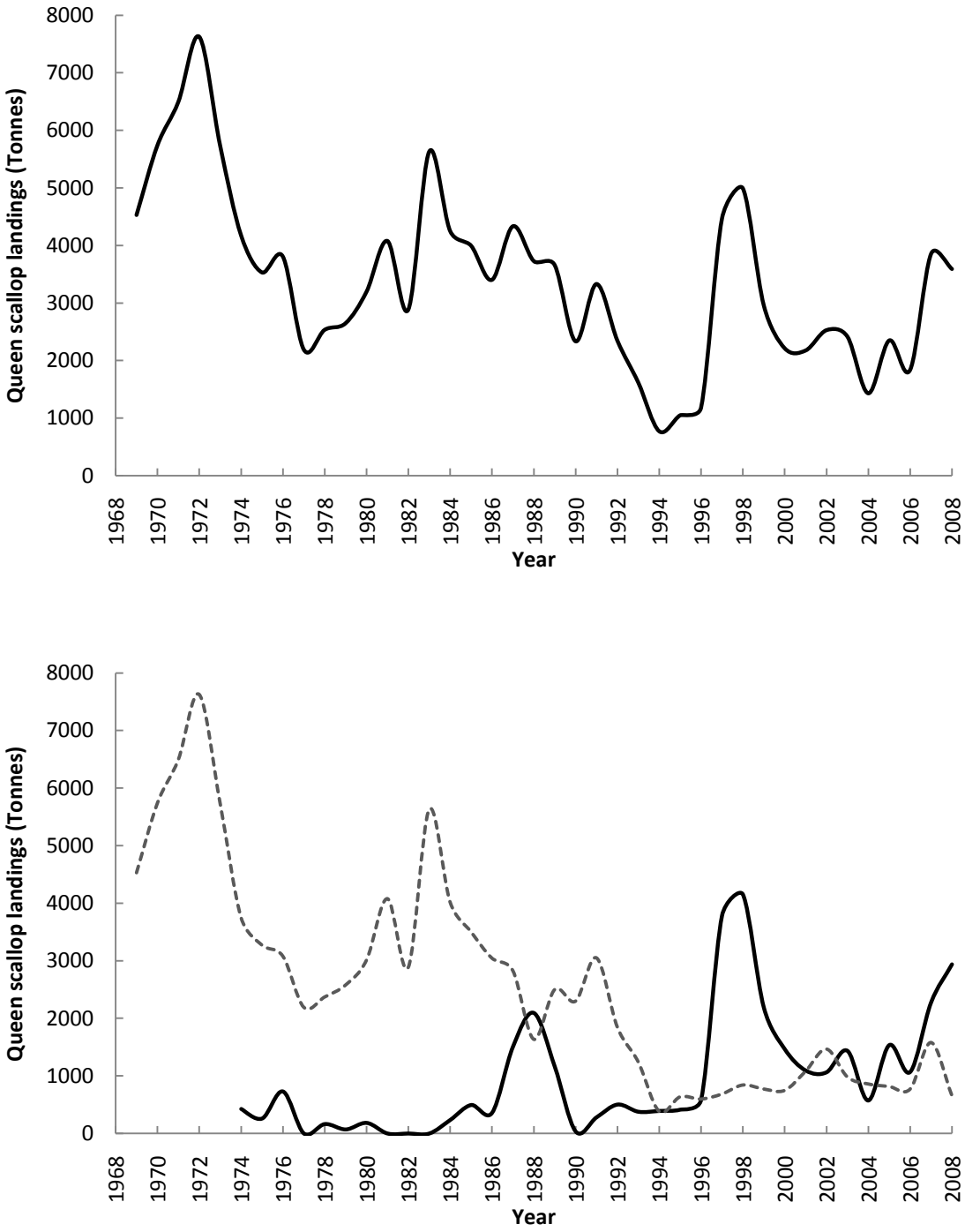

Figure 5. Total annual landings of queen scallops (*Aequipecten opercularis*) into Scotland and the Isle of Man (top), and landings into Scotland (solid line) and Isle of Man (dashed line) independently (b). Landings are those fished by vessels of any nationality and caught in ICES statistical rectangles 37 E5 and 36 E5.

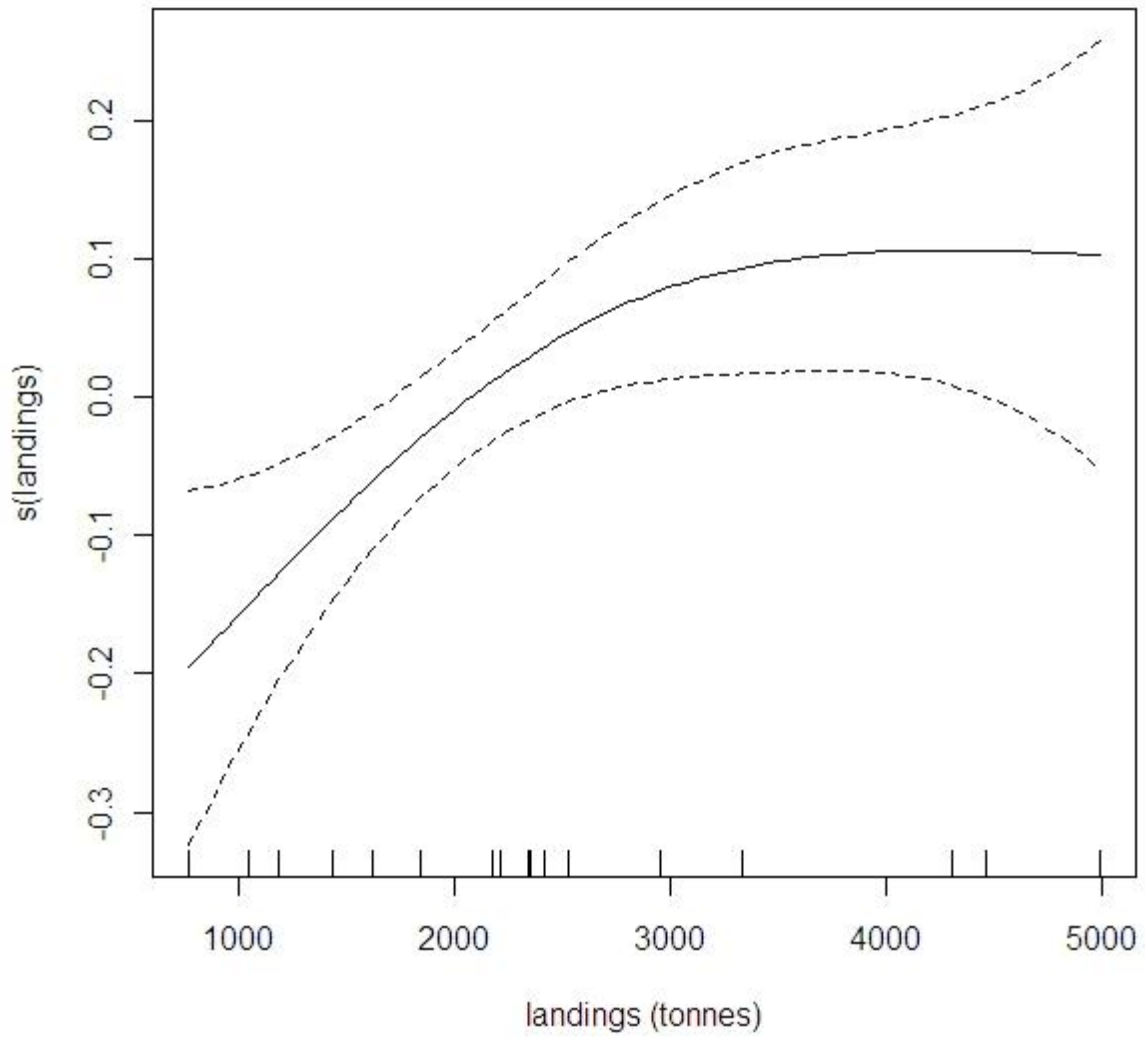

Figure 6. Annual landings between 1992 and 2007 against the non-parametrically smoothed term relating landings to $\log_{10}$(abundance index). Dashed lines indicate ±2 SE. Dashes on x-axis indicate the values of the predictors.

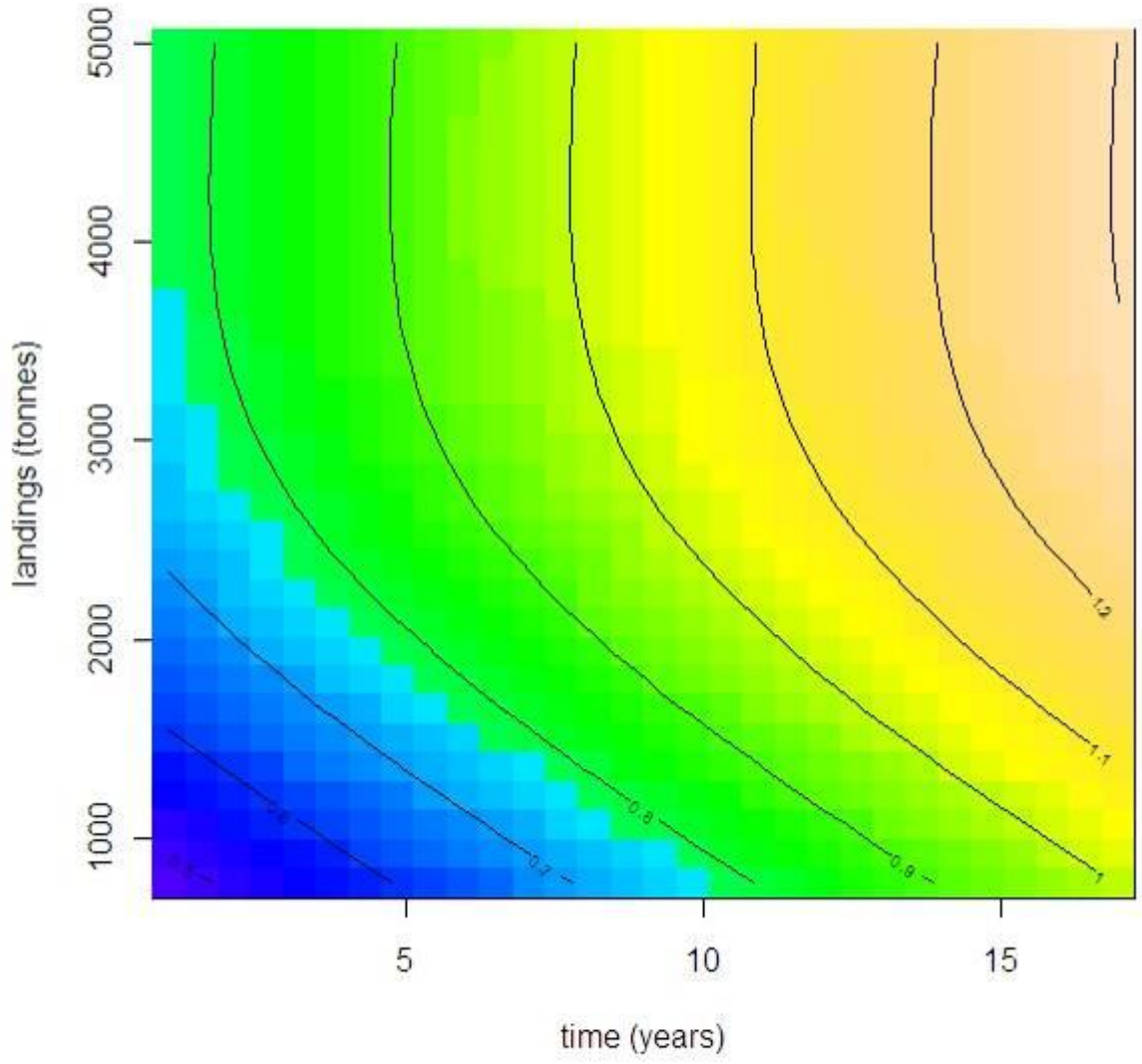

Figure 7. Relationship between time, landings and log_{10}abundance index (contours) derived from Generalized Additive Model (GAM).

Stock surveys June 2009

The present scientific sampling methodology does not provide a good recruitment index, as queen scallops of <60 mm are under-sampled; this is apparent in Figure 8. Only at the Bradda Inshore site did smaller scallops form a substantial proportion of the catch. At Chickens and Targets, the proportion of queen scallops caught that were greater than 60 mm was particularly high (Figure 8). The mean height of queen scallops was greatest at Chickens and Targets in June 2009. These sites received the greatest fishing effort prior to the June 2009 survey, but were clearly not depleted of queen scallops. The lowest mean height was found at Bradda Inshore and Offshore (Figure 9), where abundance was also low. Queen scallops are not present at the Peel Site, and are presently found at low relative abundance in Laxey. The greatest abundance of queen scallops inshore are presently found in Ramsey Bay. The East Douglas site had a particularly high density of queen scallops in October 2008 and June 2009 (Figures 10 and 11), despite being heavily fished in the previous year (Figures 2 and 3).

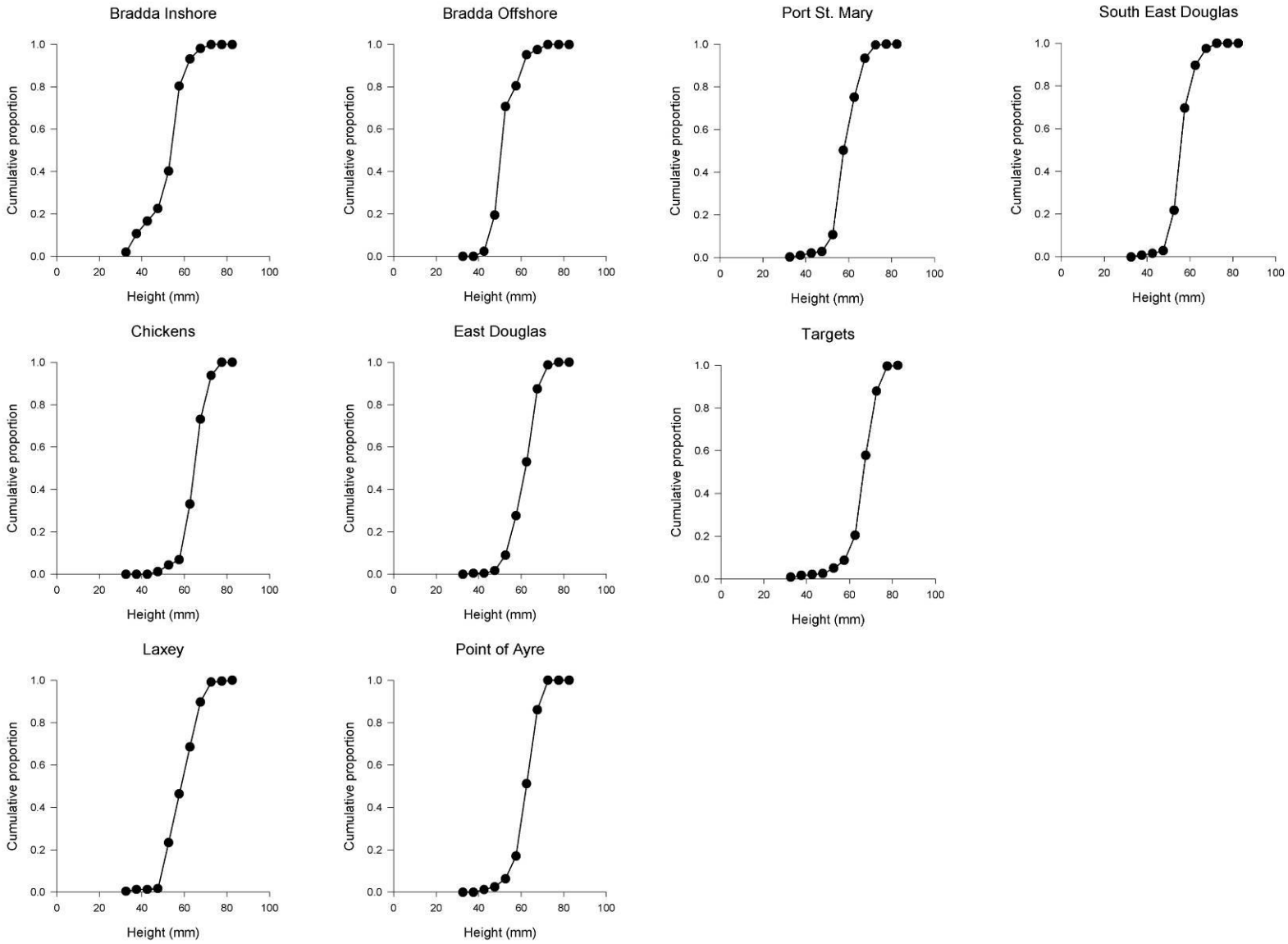

Figure 8. Cumulative height-frequency distributions of *Aequipecten opercularis* at sites around the Isle of Man in June 2009.

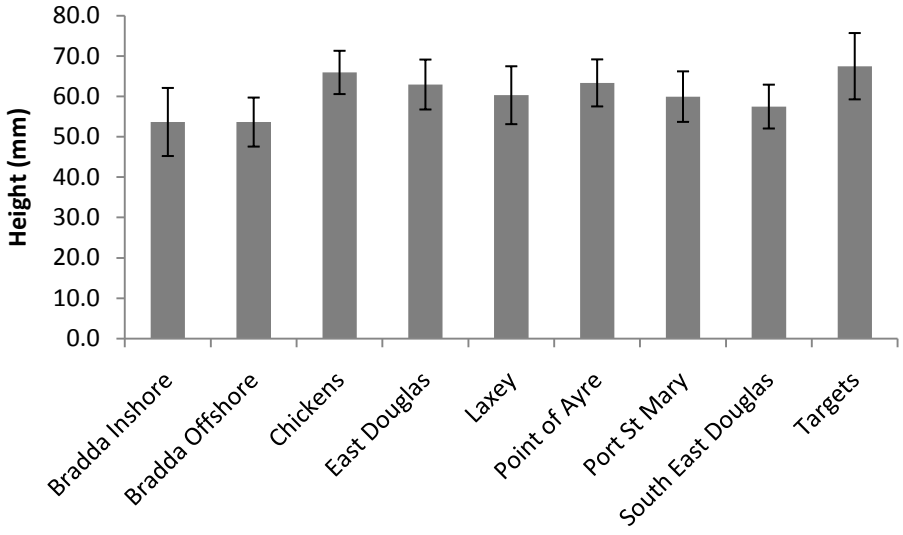

Figure 9. Mean height (±1 S.D.) of *Aequipecten opercularis* caught in surveys at sites around the Isle of Man in June 2009.

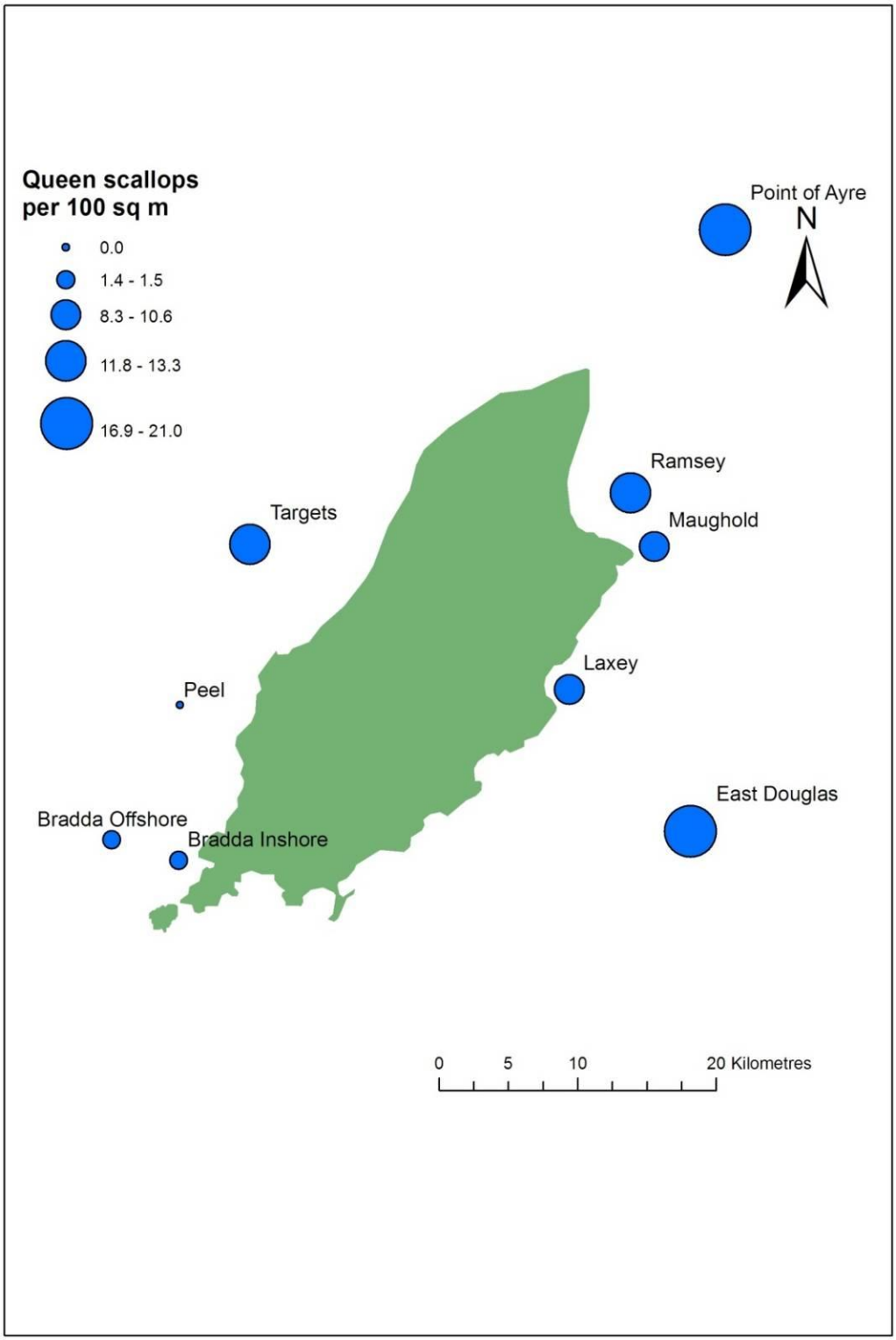

Figure 10. Relative abundance of queen scallops at sites around the Isle of Man in October 2008.

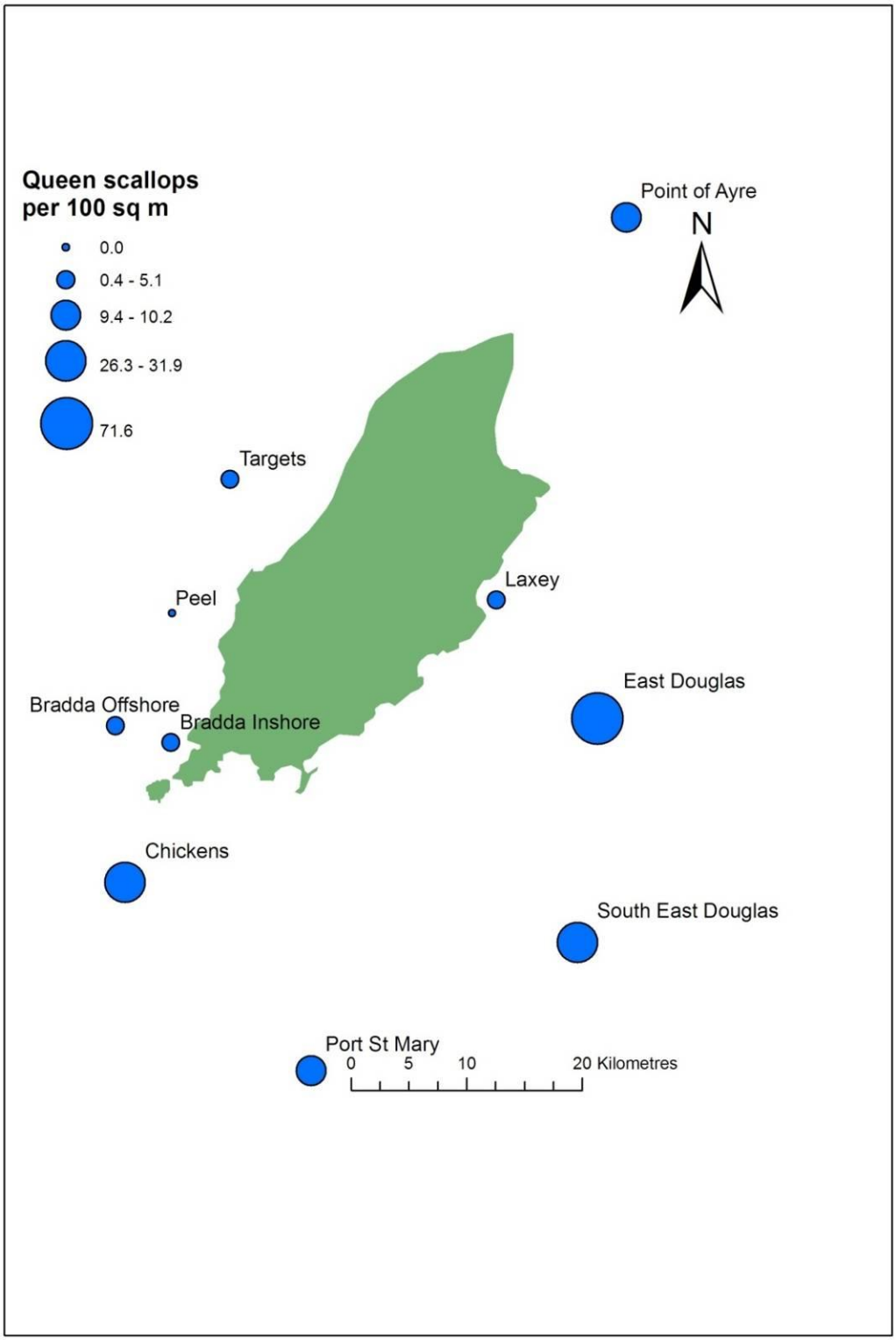

Figure 11. Relative abundance of queen scallops at sites around the Isle of Man in June 2009. Note the difference in scale from Figure 10.

Present management system

The information available on the queen scallop fishery is characterised by detailed and complete data on fishing effort distribution and magnitude but incomplete data on catches. Therefore, under the present management system restricting fishing effort is the most practicable means of ensuring sustainable harvesting of *A. opercularis*. It is particularly important to note that the quantity of landings caught within the 12 nautical zone is not known, as landings into Scottish ports are spatially referenced to ICES statistical rectangles only. However, the proportion of catches originating from within and outside the 12 nautical territorial sea have been estimated based on the distribution of fishing effort as derived from VMS data. Of landings into the Isle of Man, 23 % were caught outside of the territorial sea in 2008.

In order to implement effective catch limits collection and management of data on catches would need to be improved substantially. Many of these problems will be solved by the introduction of a European Union-wide electronic logbook system. However, this may take several years to implement. It is suggested that data collection can be improved in a number of ways:

- Log sheets should be returned within reasonable time of fishing having occurred. Current legislation stipulates that this should occur within 48 hours.
- Log sheets should be accompanied by sales notes verifying the quantity of the catch.
- Processors should submit monthly sales records.
- The introduction of an electronic catch logging system which can provide near real-time data to spatially reference catches.

Current systems would not allow spatial referencing of catches until the end of the fishing season. Therefore, it would not be possible to distinguish MSC certified from non-MSC certified queen scallops (i.e. those caught from outside the 12 nautical territorial sea) until many months after fishing had occurred. Furthermore, the Isle of Man Government are currently entitled to view VMS records originating from within the 12 nautical mile territorial sea only. Attempting to obtain agreement from Manx fishers to restrict fishing activity to within the 12 nautical mile zone should be considered given the limited spatial extent of the otter trawled fishery. However, this is unlikely to be possible for the dredged portion of the fishery. Consequently, a secondary vessel monitoring system is the most feasible means of monitoring effort. The 'Youngstrace' system would provide an excellent means of spatially referencing and recording catches. Further details of the 'Youngstrace' system are presented by Andrews *et al*. (2009).

Harvest strategy and controls

There is no harvest strategy in place at present. Catches are limited predominantly by market demand. Given that MSC certification would probably increase demand for queen scallops alternative controls may be required. This could be achieved largely by the introduction of a TAC.

The fishery in the 3 nautical zone

The waters within 3 nautical miles of the Isle of Man are entirely under Manx jurisdiction. Only a small percentage of the fishery occurs within this area, with landings amounting to 40.5 tonnes between November 2007 and October 2008. Most fishing in this area occurs on the east coast, around Ramsey Bay and Laxey Bay (Figure 12). Some fishing also occurs around Niarbyl and along the edge of the Targets ground. Particle tracking models suggest that Ramsey Bay is self-seeding in terms of scallop larvae (Neill and Kaiser, 2008), and the live maerl beds in this bay may provide a nursery ground for juvenile queen scallops. It is possible that the fishery occurring within the 3 nautical zone could be managed as a separate unit. A simple management strategy could be adopted for this area including, but not restricted to:

- A total allowable catch based on previous landings. The TAC would be set at 40 tonnes based on 2007/2008 landings. Any apparent decline in queen scallop abundance based on survey data and fishery CPUE would prompt a precautionary annual decrease in the TAC until a rise in abundance was detected. Increasing the TAC above 40 tonnes could occur by small increments as long as surveys revealed continued increases in recruitment to the fishery.
- A ban on the use of mobile fishing gear on the maerl beds in Ramsey Bay and Laxey Bay (further surveys would be required).
- A ban on the use of dredges in the queen scallop fishery.

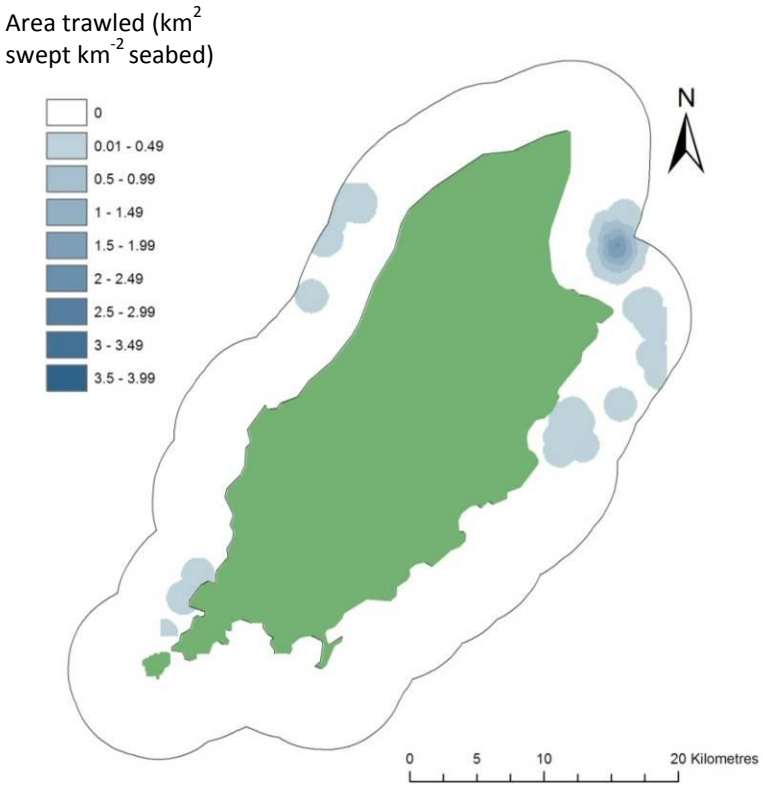

Figure 12. Extent of the *Aequipecten opercularis* fishery within 3 nautical miles of the Isle of Man from November 2007 to November 2008.

Principle II: Habitats and bycatch

Overview

The data on bycatch provided in fisheries logbooks are insufficient to establish whether Endangered, Threatened and Protected species (ETPs) are being landed. Data on bycatch is presented by Montgomery (2008) and Hinz *et al*. (2009), and a further report on bycatch in the queen scallop fishery is due to be completed by November 2009. Bycatch in the otter trawl fishery consists predominantly of pelagic species and demersal fish, while bycatch in the dredge fishery consists of both sessile and motile benthic fauna. Equivalent levels of damage have been observed in both bycatch and in species encountering dredges without being caught, with the majority of damage occurring in animals remaining on the seabed (Jenkins *et al*., 2001).

Endangered, threatened and protected species

The Isle of Man is a not signatory to the Convention on Biological Diversity (CBD), although the Isle of Man government aims to become party to the convention. Presently, no plan is in place for the management of ETP species in relation to the queen scallop or other fisheries. Moreover, no national strategy is in place within the Isle of Man to prevent the loss of marine biodiversity and no indicators have been identified. However, a Marine Nature Reserve (MNR) will be established by 2012, and the specific objectives of this MNR will be established in the near future. The use of mobile fishing gear is also prohibited in two zones, totalling 7.6 km^2 in area, which although designated to protect *Pecten maximus*, will also afford protection to *A. opercularis*.

Among the species vulnerable to otter trawling are spurdog, *Squalus acanthias*, and other small sharks such as tope, *Galeorhinus galeus*. *S. acanthias* is slow growing and matures late in life, and thus has a low rate of population increase (2 to 7% per annum); moreover, the aggregation of mature, and especially pregnant, females makes the species extremely vulnerable to fishing activity (Fordham *et al*., 2009). There is thought to be a single North East Atlantic stock of *S. acanthias* (ICES, 2009). There has been over a 95% decrease in total biomass of this stock and the population size continues to decrease (Fordham *et al.*, 2009). Spurdog is classified as critically endangered by the International Union for Conservation of Nature (IUCN), while tope is classified as vulnerable. The ICES elsmobranch working group recently recommended a TAC of zero and a maximum landing size of 100 mm for the North East Atlantic spurdog stock (ICES, 2009).

Post-trawling mortality of *S. acanthias*, is low (5.9%) in trawls up to 45 minutes in length when nets are moderately packed (Mandelman and Farrington, 2007a) but is much higher when nets are heavily packed (Mandelman and Farrington, 2007b). Therefore, advising fishers to limit tow lengths and discard shark bycatch as rapidly as possibly may help to minimize mortality in the discards of this species. This may be best achieved through an education programme including

presentations, newsletters, and management meetings which specifically address the issue of bycatch and discards in the Isle of Man's fisheries.

The otter trawl fishery for queen scallops is restricted by a days at sea limit under the Cod recovery plan due to widespread overfishing of Atlantic cod, *Gadus morhua*. Sole, *Solea solea*, is also a bycatch species in the fishery and is classified as depleted by ICES. Nevertheless, it is thought that these species do not constitute a large proportion of the catch in the queen scallop fishery. Further information on bycatch within the fishery will become available by November 2009.

Overall, ratification of the CBD by the Isle of Man and adoption of the relevant aspects of the UK Biodiversity Action Plan, or a similar plan, would help to ensure that all the Isle of Man's fisheries operate within an ecosystem context. A TAC combined with spatial fishing restrictions would help to ensure that the fishery can only have a limited impact on bycatch species. Furthermore, the proportion of bycatch (both discards and landings) in the otter trawl fishery appears to be relatively low.

Habitat structure

Both otter trawling and scallop dredging have the most severe initial impacts on biogenic substrata (Kaiser *et al*., 2006), such as maerl or horse mussel beds. Visual surveys were carried out across the entire Isle of Man territorial sea during summer 2008. The images taken during these surveys are currently being analysed (see Appendix I for example analysis). Further details of this work are presented by Murray *et al*. (2009). Among the sensitive habitats identified to date are maerl beds in Ramsey Bay (Figure 13; Appendix II) and *Modiolus modiolus*, beds north of the Isle of Man (see Hinz *et al*., 2008) and to the south of Douglas Bay.

The Isle of Man's maerl beds, in particular, are likely to be a supporting habitat of the queen scallop fishery. Juvenile queen scallops (<30 mm) settle preferentially on pristine live maerl rather than on sand or gravel, although significantly more scallops settle on gravel than dead mearl (Kamenos *et al*., 2004a). Pristine live maerl also provides greater refuge to juvenile queen scallops from crab and starfish predation than gravel (Kamenos *et al*., 2004b). Maerl species are not protected under the Wildlife Act (1990). However, several Special Areas of Conservation (SAC) have been selected in the UK for their maerl coverage. Maerl beds are included in four habitat types in the EC Habitats Directive (Annex I). The maintenance of the geographical range, and the variety and quality of maerl beds and their associated species is also an objective of the UK BAP. Currently, no protection is afforded to any maerl species in the Isle of Man.

The otter trawled fishery occurs over a smaller area than the great scallop fishery, with most effort focused on areas that are heavily dredged for *Pecten maximus*. However, fishing activity does occur within <1 km of live maerl beds in Ramsey Bay (Figure 13). The *A. opercularis* fishery does therefore pose a threat to this sensitive habitat, on which at least some of the fishery may

depend. It is recommended that further survey work is undertaken in Ramsey Bay to establish the extent of the maerl beds. The use of mobile fishing gear should then be prohibited over these areas of maerl. Horse mussel beds are also likely to be at risk from exploratory fishing for queen scallops, and are not afforded any legal protection. Spatial restrictions on fishing activity would also protect this sensitive biogenic habitat.

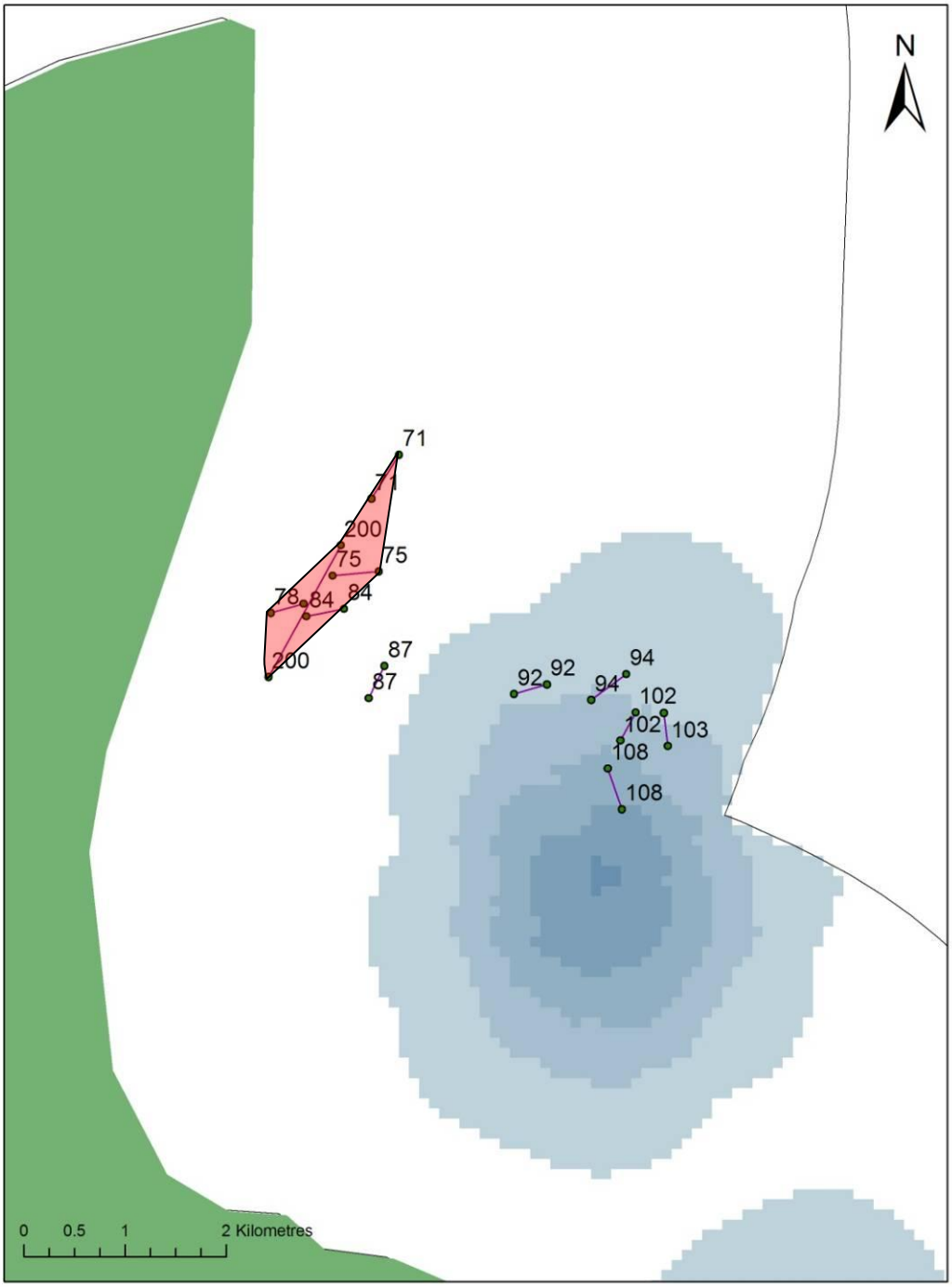

Figure 13. Visual survey tows undertaken in Ramsey Bay in June 2008. Contours indicate fishing activity (see Figure 12). Shaded red area (0.85 km^2) shows the minimum extent of the live maerl bed.

CONCLUSIONS AND MANAGEMENT RECOMMENDATIONS

The otter trawled and dredged queen scallop fishery prosecuted in the Isle of Man's 12 nautical sea is part of a larger queen scallop fishery that occurs around the Isle of Man, but both within and outside the 12 nautical mile zone. Furthermore, both skid dredges and toothed dredges have been used in the fishery in the past. Several changes in management systems may be required for an MSC certified queen scallop fishery to operate as part of the larger fishery. Due to the present spatial resolution attributed to catches, ICES statistical rectangle 37E5 would provide a suitable alternative management unit. Similarly, the small scale queen scallop fishery prosecuted within 3 nautical miles of the Isle of Man would provide a suitable alternative unit of assessment. Alternatively, restricting the unit of MSC assessment to otter trawling vessels only would greatly simplify management of the fishery. Fitting all of these vessels with a tracking and catch logging system such as 'Youngstrace' would allow precise spatial management and catch limits to be enforced where necessary.

Detailed data on effort distribution is available from vessels landing into the Isle of Man, but not for other vessels. Likewise, no vessel specific landings data is provided by vessels landing catches outside the Isle of Man. The current management system generates information on the fishery at the end of each year, but is not sufficient to provide real-time data from the fishery. If catch or effort restrictions are imposed on the fishery then real-time, or close to real-time, data will be required to effectively enforce these restrictions. Such restrictions will help to protect both the target species and its supporting habitats as well as bycatch and discard species. Analysis of seabed images is still being undertaken. Completion of this work will be necessary to estimate the potential impacts of the queen scallop fishery on benthic habitats around the Isle of Man.

The protection afforded to endangered, threatened and protected species would be enhanced if the Isle of Man ratifies the Convention on Biological Diversity and implements a biodiversity action plan. This would allow fisheries to operate within a wider management framework which will help to safeguard endangered species and sensitive habitats. Fishing with mobile gear is presently permitted over 98.8% of the Isle of Man's territorial sea and marine ETP species and habitats are not afforded protection other than through the Wildlife Act (1990). Biogenic habitats, such as those composed predominantly of maerl or horse mussels, are especially vulnerable to queen scallop fishing activity. Queen scallop populations may also be partly dependent on maerl beds, and thus removal of this habitat would degrade the fishery.

Several specific recommendations for management are proposed:

1. Monthly returns of sales notes from processors in the Isle of Man will help to ensure landings data is accurate and that missing log sheets can be requested from fishers. It would be of equal value to obtain sales notes from Scottish processors if possible. At present it is not possible to determine whether vessels are fishing within or outside the Isle of Man's 12 nautical mile territorial sea until several months after fishing has occurred. Improved vessel monitoring systems (such as the 'Youngstrace' system) and catch recording will be necessary if real-time (or near real-time) spatial referencing of catches is required.
2. It is recommended that a total allowable catch is set for *Aequipecten opercularis.* This would be set at no more than 1750 tonnes from 1st November 2009 to 31st October 2010. This TAC should be altered proportionally with changes in relative abundance indices.
3. Maerl beds in Ramsey Bay and possibly Laxey Bay are vulnerable to exploratory fishing. As these habitats may enhance the fishery by facilitating the settlement of larvae and providing refuge to juvenile queen scallops, it is recommended that fishing with mobile gear is prohibited in these areas. Further surveys will be necessary to determine the extent of the maerl beds.
4. To ensure sustainable management of *A. opercularis* stocks, their supporting habitats and bycatch species, further spatial restrictions should be imposed on fishing effort.
5. The current minimum landing size of 40 mm is ineffective as queen scallops of <50 mm are not landed. The possibility of setting a larger minimum landing size could be considered, although should not be necessary if sufficient caps on effort and total catches are imposed.
6. Spatial referencing of catches using logbook and VMS data should be continued. Together with biannual research surveys these data should form the basis of the queen scallop fisheries research. The introduction of electronic catch recording systems could replace the use of logbooks and VMS for scientific purposes.
7. The Isle of Man Government should ratify the Convention on Biological Diversity, and implement a biodiversity action plan which includes marine species and habitats.
8. If necessary, and possible, the MSC unit of assessment should include only otter trawling vessels.

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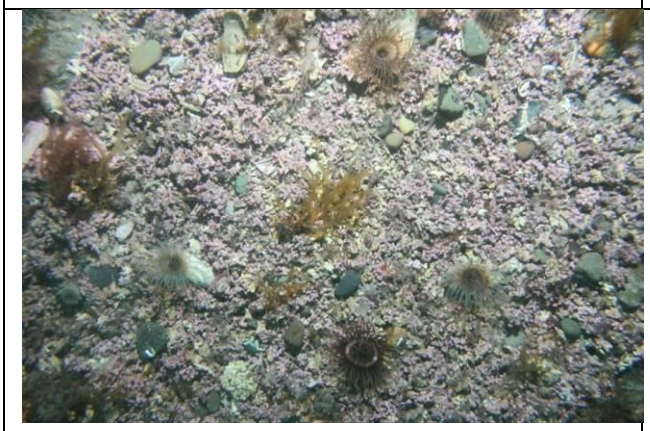
APPENDIX I

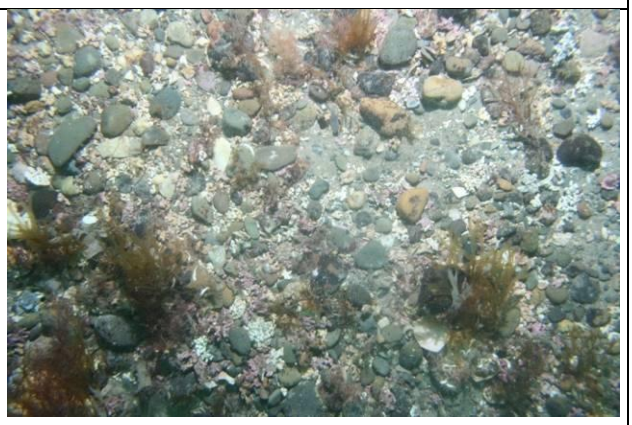
Example image taken during habitat survey around the Isle of Man, and output from the image analysis (below).

Station	File no	Description	Species	Picture	Percent cover	Ab/Pr	Id conf%	Area	Circonf	Width	Length
23	109	Modiolus bed	Myxilla incrustans			1	60				
23	109	Modiolus bed	Hemimycale columella		1	1	80	60154	1180		
23	109	Modiolus bed	Coralline algae		1	1					
23	109	Modiolus bed	Gibbula cineraria			1					
23	109	Modiolus bed	Alcyonium digitatum		2	1		141219	1599		
23	109	Modiolus bed	Sponge 8			1					
23	109	Modiolus bed	Hemimycale columella			1	20				
23	109	Modiolus bed	Pomatoceros tubes			1					
23	109	Modiolus bed	Crust sponge		1	1					
23	109	Modiolus bed	Spirorbis sp.			1					
23	109	Modiolus bed	Terebellid		1	1					
23	109	Modiolus bed	Shrimp 1	y		1					
23	109	Modiolus bed	Alcyonium digitatum		1			51532	925		
23	109	Modiolus bed	Halecium halecinum		1		20	26196	679		178
23	109	Modiolus bed	Alcyonium digitatum		1			45366	841		269
23	109	Modiolus bed	Suberites sp.			1	60				
23	109	Modiolus bed	Hydroid 5		1	1		22223	550		
23	109	Modiolus bed	Dysidea fragilis			1					
23	109	Modiolus bed	Crustacea			1					
23	109	Modiolus bed	Calliostoma zizyphinum			2					
23	109	Modiolus bed	Liocarcinus sp.	y						229	
23	109	Modiolus bed	Echinus esculentus			1					291
23	109	Modiolus bed	Crust bryozoa			1	1				
23	109	Modiolus bed	Alcyonium digitatum			1		19371	535		
23	109	Modiolus bed	Dysidea fragilis			1		91401	1258		
23	109	Modiolus bed	Alcyonium digitatum			2		152030	1433		
23	109	Modiolus bed	Dentaliidae				1				
23	109	Modiolus bed	Indet decapoda				1				
23	109	Modiolus bed	Sabellid tube				1				

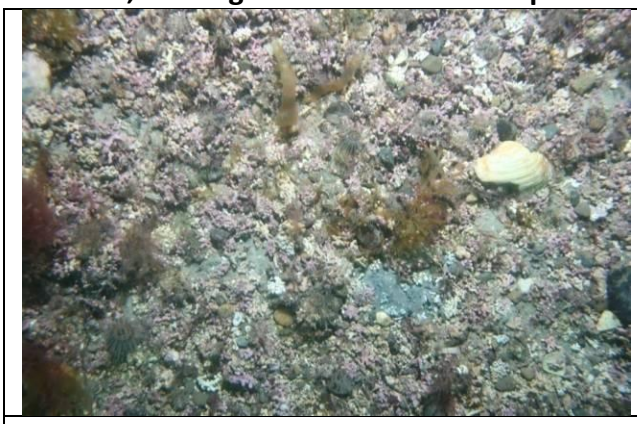
APPENDIX II

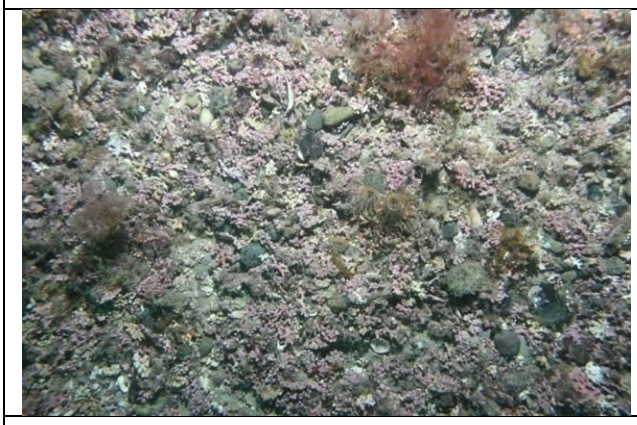
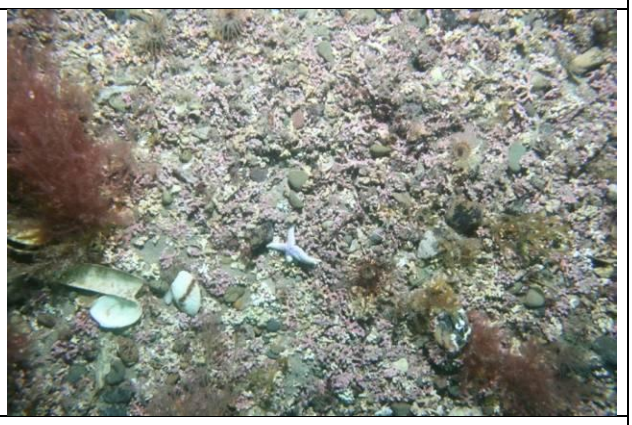
Examples of images taken from along transect 200. Live maerl was apparent along the entire transect.

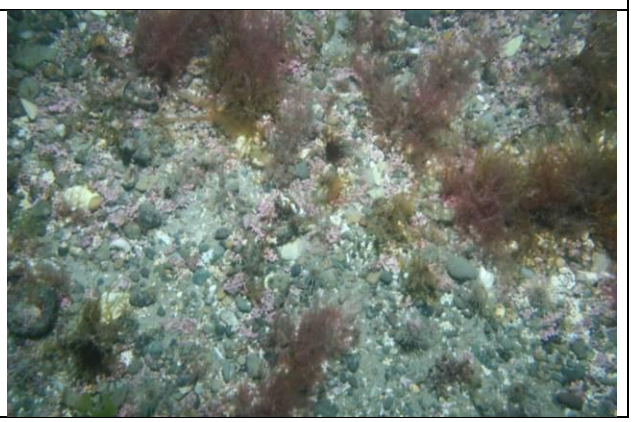




Examples of images taken from along transect 78. Live maerl was apparent along the entire transect, although its distribution was patchier than along transect 200.





Examples of images taken from along transect 75. Live maerl was apparent along most of the transect, although coverage was sparse in several areas.