# OUTER HEBRIDES INSHORE FISHERIES GROUP MANAGEMENT PLAN


Outer Hebrides Inshore Fisheries Group

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## ACKNOWLEDGEMENTS

Archie Campbell, Chairman of the Outer Hebrides Inshore Fisheries Group, would like to thank all those involved in the formation of the Fisheries Management Plan for the area. In particular, all those that have given time to attending both Executive Committee and Advisory Group meetings.

Particular thanks to Anne McLay and the Marine Scotland Science Inshore Team for their contribution to the science background of the Plan and to Roddy McMinn and his colleagues at Scottish Natural Heritage for their environmental input to the Plan. The Marine Scotland Statistics Department, the Scottish Government GIS Team and Marine Scotland Compliance for providing valuable information.

Acknowledgement is also made to Comhairle Nan Eilean Siar, Scottish Natural Heritage and Scottish Environment Agency for providing meeting rooms with video and telephone conferencing facilities, to enable members to participate in meetings without losing valuable travel time and incurring travel costs.

Whilst agreement couldn't be reached on all the issues raised at Executive Committee meetings, the Chairman would like to thank all members for reaching consensus on a wide range of issues that will improve future management of inshore fisheries that will provide the foundations for a more profitable and sustainable industry. The chairman is grateful for the work of the IFG Coordinator, Duncan MacInnes, whose knowledge of the industry coupled with his patience and negotiating skills has been crucial to the construction of the management plan.

Finally, thanks to the many fishermen who attended the public meetings at Barra, Uist, Harris and Lewis, to discuss the Management Plan and the issues raised at those events have been included in the final version of the Management Plan.

## EXECUTIVE SUMMARY

The Outer Hebrides Inshore Fisheries Group (OHIFG) is one of six pilot Inshore Fisheries Groups (IFGs) which were established by the Scottish Government. The Strategic Framework for Inshore Fisheries in Scotland identified the need for more localised management of inshore fisheries around Scotland and recommended the formation of Inshore Fisheries Groups.

The remit of the IFGs is to engage with all sectors of the catching sector that have vessels fishing within the IFG area and to develop management measures that will make the industry more profitable, sustainable and well managed. An Executive Committee comprising of catching sector representatives, an independent Chairman and a Co-ordinator develop a Fisheries Management Plan for the area, assisted by an Advisory Group of stakeholders from Government Agencies and a wide range of other Organisations with an interest in the Marine Environment.

All Management Plans will be considered by the Scottish Inshore Fisheries Advisory Group (SIFAG) and will be subject to a Strategic Environmental Assessment (SEA) before Ministerial approval and future implementation.

Priority has been given, within the Management Plan, to address management measures for improving the shellfish stocks of most economic importance to the inshore fleet. A number of potential new fisheries could be developed and the various stakeholders will consider the most appropriate way forward for the sustainable development for those fisheries. Consideration has been given to address the need for additional amendments and removal of current unnecessary prohibitions within the Inshore Act.

The area covered by the OHIFG is an area in the Minches and Sea of the Hebrides bordering with the North West IFG in the North and with Mull and the Small Isles IFG in the South. The area to the West of the Hebrides following the 6 nautical mile fishery limit and a 6 mile radius around St Kilda, Flannan Isles, North Rona and Sula Sgeir.

The characteristics of the Outer Hebrides clearly show the significant importance of the shellfish sector to the inshore fleet operating within inshore waters around the Outer Hebrides. Whilst pelagic and white fish fisheries used to be of importance within inshore waters, migratory patterns for pelagic species and restrictive catch composition rules coupled with reduced quota allocations for white fish, has now resulted in minimal effort being directed at those fisheries.

An increasing number of renewable energy companies are showing a keen interest in developing wave and tidal projects to the west of the Hebrides and it's of paramount importance that the interests of the fishing industries are protected. The Outer Hebrides Inshore Fisheries Group is represented on the various Renewable Groups that will be discussing all future developments of marine renewables within the inshore area.

Implementation of the Management Plan will require amendments to existing legislation for some of the management measures. Other measures can be progressed with improved data collection from new logbooks returns from inshore fishermen.  Considerable financial support from both Comhairle Nan Eilean Siar (CNES) and Highlands and Islands Enterprise (HIE) has been of significant benefit to the inshore industry over the past number of years. Continued support from the various industry/government stakeholders coupled with assistance from European Funds will be required to progress the other measures to ensure that sustainable inshore fisheries are maintained to protect the future interests of the fragile communities that are permanently dependent on fisheries.

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**APPENDICES**

## ACCRONYMS

| | |
|---|---|
| **CL** | **Carapace Length** |
| **CFP** | **Common Fisheries Policy** |
| **CNES** | **Comhairle Nan Eilean Siar** |
| **CPUE** | **Catch Per Unit Effort** |
| **CW** | **Carapace Width** |
| **EFF** | **European Fisheries Fund** |
| **EPS** | **European Protected Species** |
| **EU** | **European Union** |
| **Ex Com** | **Executive Committee** |
| **GIS** | **Geographical Information System** |
| **HIE** | **Highlands and Islands Enterprise** |
| **HLO** | **High Level Objective** |
| **ICES** | **International Council for the Exploration of the Seas** |
| **IFG** | **Inshore Fisheries Group** |
| **JNCC** | **Joint Nature Conservation Commission** |
| **LCA** | **Length Cohort Analysis** |
| **LCC** | **Lews Castle College** |
| **MPA** | **Marine Protected Area** |
| **MS-C** | **Marine Scotland – Compliance** |
| **MS-P** | **Marine Scotland - Policy** |
| **MS-S** | **Marine Scotland – Science** |
| **MSY** | **Maximum Sustainable Yield** |
| **NGO** | **Non Government Organisation** |
| **OHIFG** | **Outer Hebrides Inshore Fisheries Group** |
| **PMF** | **Priority Marine Feature** |
| **SAC** | **Special Area of Conservation** |
| **SEA** | **Strategic Environmental Assessment** |
| **SEPA** | **Scottish Environment Protection Agency** |
| **SFC** | **Scottish Fisheries Council** |
| **SI** | **Statutory Instrument** |
| **SIFAG** | **Scottish Inshore Fisheries Advisory Group** |
| **SISP** | **Scottish Industry Science Partnership** |
| **SNH** | **Scottish Natural Heritage** |
| **SPA** | **Special Protection Area** |
| **SSSI** | **Site of Special Scientific Interest** |
| **TAC** | **Total Allowable Catch** |

## 1. INTRODUCTION

1.1 The Outer Hebrides is one of the most peripheral and economically disadvantaged areas of the European Union. The Islands are located in the midst of some of the richest fisheries resources in Europe.

1.2 Fisheries are of vital importance to the local economy with the majority of fishing activities of the local fleet being in inshore areas within six nautical miles. The lack of alternative employment opportunities means that the Outer Hebrides is heavily dependent on marine resources for the future social and economic survival of its communities. Maximising the benefits from fisheries is of paramount importance to the local economy.

1.3 The Strategic Framework for Inshore Fisheries in Scotland identified the need for more localised management of inshore fisheries around Scotland and recommended the formation of Inshore Fisheries Groups. This new approach to inshore management places fishermen and other key stakeholders at the heart of the decision making process.

1.4 High level objectives set out by the Scottish Inshore Fisheries Advisory Group (SIFAG) in the Strategic Framework address, biological, economic, environmental, social and governance issues associated with inshore fisheries.

1.5 The Outer Hebrides Inshore Fishery Group (OHIFG) management plan has been developed by the OHIFG Executive Committee and an Advisory Group, to formulate local objectives that will contribute to the delivery of the SIFAG's high level objectives and help to ensure that Scotland's inshore fisheries are well managed, sustainable and profitable.

1.6 The OHIFG's management plan proposes measures to improve the management of all creel fisheries in the IFG area; the introduction of new conservation measures for key fisheries; investigation of the potential for developing new fisheries managed on a sustainable basis; the provision of marketing support
encourage the industry to 'catch for the market', the development of more selective
fishing gear; training and support to encourage new entrants to the industry; and a review existing local fisheries legislation.

1.7 Despite the many challenges facing Scotland's fishing industry, the future for inshore fishing, in particular high valued shellfish fisheries should remain buoyant provided measures to ensure their long term sustainable management are adopted at local level. Local inshore fisheries should continue to provide excellent career opportunities for young fishermen willing to invest in the future of the industry.

## 2. BACKGROUND TO INSHORE FISHERIES GROUPS

2.1. Since 1984, inshore fisheries in Scotland have been regulated primarily through the Inshore Fishing (Scotland) Act 1984. This Act provides for Ministers to regulate fishing for sea fish in inshore waters. A variety of Orders have been made under this Act since 1984, introducing a number of local and national measures for a range of fishery management purposes.

2.2 A strategic review of inshore fisheries was begun in 2002. The key output of this was the Strategic Framework for Inshore Fisheries in Scotland, which set out the strategic direction for policy and a network of Inshore Fisheries Groups (IFGs) around Scotland to plan the management of inshore fisheries at a local level.

2.3 It is the responsibility of each IFG to produce and implement a management plan for inshore fisheries in their area, which is in keeping with Scottish Ministers' objectives of sustainable and well-managed inshore fisheries that support thriving coastal communities. Even though they are not statutory bodies, IFGs must conduct their business in accordance with a constitution, as developed by each IFG along the guidelines set out by the Scottish Government, which is committed to supporting the IFGs in their work.

2.4 On most occasions IFGs will have the ability to implement many of the actions that stem from their management plans. However, there will be some measures which require implementation by the Scottish Government through legislation. Scottish Ministers may possibly consider positively any IFG legislative proposals which are in keeping with the high level objectives (set out at a national level by SIFAG), stem from or complement local objectives, and have been formulated in an open and transparent manner.

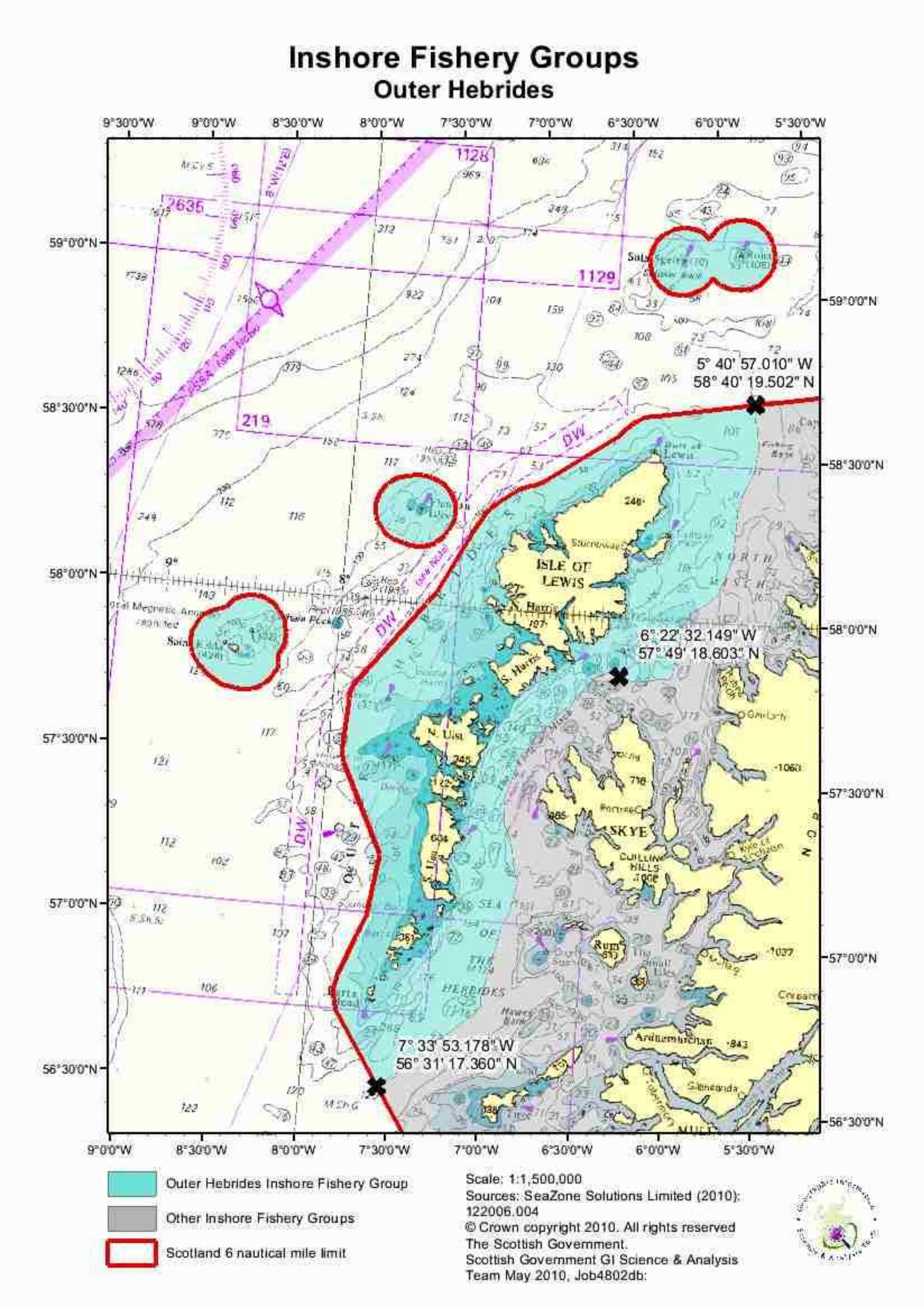
## 2.1 SCOPE OF THE OUTER HEBRIDES IFG

### Geographic Scope

2.1.1 The sea area between the Outer Hebrides and the Scottish mainland is divided into three main areas, the North Minch, the Little Minch and the Sea of the Hebrides. In the North Minch, the OHIFG forms a boundary with the neighbouring North West IFG between Kinlochbervie and the northern tip of Skye. A further boundary with the Small Isles and Mull IFG lies between the northern tip of Skye and an area south of Barra Head. The boundaries with neighbouring IFGs delineate a similar sea area to that proposed for the Western Isles Marine Region the Marine (Scotland) Bill.

2.1.2 The OHIFG boundary to the west extends out to six nautical miles from baselines between the Butt of Lewis and Barra Head. The sea six nautical miles out from St Kilda, the Flannan Isles, North Rona and Sula Sgeir are also included within the IFGs geographical scope.

**Figure 1. Geographical Range of the Outer Hebrides Inshore Fisheries Group**



**Management Scope**

2.1.3 The IFG Executive Committee may consider management measures for all commercial fishing operations within the intertidal area and out to six nautical miles in all areas covered by the OHIFG. All management measures considered will be consulted on with all Fishing Associations having members operating in the area.

**Species Scope**

2.1.4 Consideration can be given to the management of fisheries for all shellfish, white fish and pelagic species within the OHFG area

## 3. STRUCTURE OF THE IFG

### 3.1 MEMBERSHIP & PROCEDURES

3.1.1 The IFG comprises representatives of various fishermen's associations, (representing a minimum of ten owners of fishing vessels) which fish in the area, an elected representative of non-affiliated fishermen, and an independent co-ordinator, who manages the group, deals with membership requests and is employed on the basis of an initial three year tenure.

3.1.2 The representatives of each fishermen's association, the representative of non-affiliated fisherman, Chairman and co-ordinator make up the Executive Committee (ExCom), which is charged with the running of the group.

3.1.3 The Outer Hebrides Inshore Fisheries Group Executive Committee comprises representatives of the:

Anglo-Scottish Fishermen's Association

Clyde Fishermen's Association

Orkney Fisheries Association

Mallaig & North West Fishermen's Association

Scallop Association

Scottish Pelagic Fishermen's Association Ltd

Scottish White Fish Producers Association Ltd

Western Isles Fishermen's Association

3.1.4 The Executive Committee is chaired by Archie K Campbell, who was selected, for a three year term, following a Marine Scotland approved appointments procedure. Under the IFG Constitution , the Chairman shall be a person who has no financial or commercial interests, as are likely to affect him or her in the discharge of his or her function as a Chairman independent of the sea fish industry.

3.1.5 The Ex Com is assisted by an Advisory Group. This group is responsible for advising the Ex Com in the drawing up of a management plan, and is comprised of various inshore and environmental stakeholders, government bodies and NGOs including Scottish Natural Heritage (SNH), Marine Scotland Science, Marine Scotland Compliance, Comhairle Nan Eilean Siar (CNES) and LINK.

3.1.6 The Outer Hebrides Inshore Fisheries Group Advisory Group comprises representatives of:

Marine Scotland Science

Marine Scotland Compliance

Scottish Natural Heritage

Scottish Environment Protection Agency

Comhairle Nan Eilean Siar

Highlands and Islands Enterprise

Leader Group

Seafish

Seafood-Scotland

University of the Highlands and Islands

Visit Scotland Outer Hebrides

RSPB

Aquaculture Sector

Shellfish Processing Sector

The Crown Estate

Marine Renewables Sector

3.1.7 The ExCom meets on a regular basis (approximately every six weeks), and the minutes of each meeting are made publicly available on the IFG's website. The ExCom will consult extensively with the members of the organisation they represent and work collectively to achieve as high a level of agreement as possible for the measures proposed. The Coordinator consults with the Advisory Group on a regular basis, in order to engage stakeholders and to ensure that the IFG management plan has support from all stakeholders.

3.1.8 The issues raised by industry to make the main shellfish stocks more profitable and sustainable, within the OHIFG area, have been discussed at length at meetings with both the ExCom and Advisory Group. Marine Scotland Science has provided valuable information on the current state of the stocks and how recruitment could be increased with additional measures proposed.

## 3.2 CONSULTATION

### OUTER HEBRIDES IFG PROCEDURES

3.2.1 Four public meetings were held in Barra, Uist, Harris and Lewis, between 18 November and 23 November 2011, to allow fishermen and members of the public to hear at first hand the management measures being proposed within the IFG management plan. These meetings were also attended by members of the ExCom and the Advisory Group. The Chairman and Coordinator agreed to give careful consideration to all matters raised at the public meetings and that those matters would be discussed by both the Executive Committee and the Advisory Group.

### CONFLICT RESOLUTION

3.2.2 The protocol for dealing with conflict within the IFG is outlined in the Constitution which the OHIFG has been working under. The Executive Committee has reached consensus on all the management measures being taken forward. Some of the original measures proposed were discarded, due to lack of support from some ExCom members. Copy of Constitution is at **Appendix 1**.

## 4. CHARACTERISTICS OF THE AREA

4.1 The Western Isles economy is narrowly based with a focus on the provision of public services and primary industries such as fisheries and aquaculture, agriculture, construction, textiles and tourism.

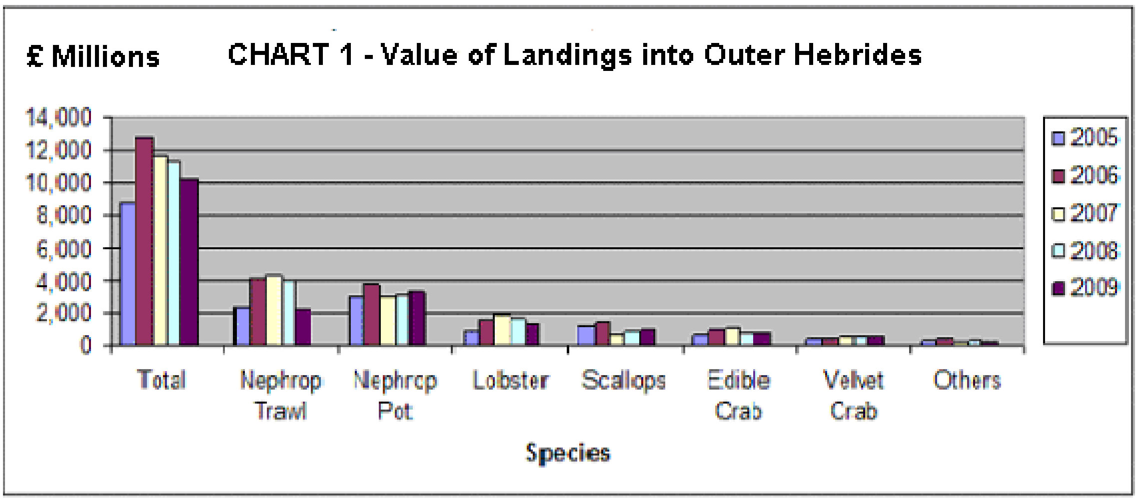
4.2 The Western Isles are located in the midst of some of the richest fisheries grounds, in Europe. In the Minches, the main species targeted are *Nephrops*, scallops, crab and lobster, whilst inshore waters to the west and north provide the main grounds for lobster, brown crab and crawfish. Most white fish and pelagic species caught to the west of the Hebrides and are not landed into the area.

4.3 Shellfish account for virtually all landings by value into Western Isles ports and the majority are landed by boats that are owned and crewed by local residents. In some places such as Barra and Grimsay over 10% of the population is involved in fish catching activities.

4.3 Following government funded decommissioning schemes there has been a gradual downsizing of the fleet. The majority of the locally based fleet is now under 10 metres in length.

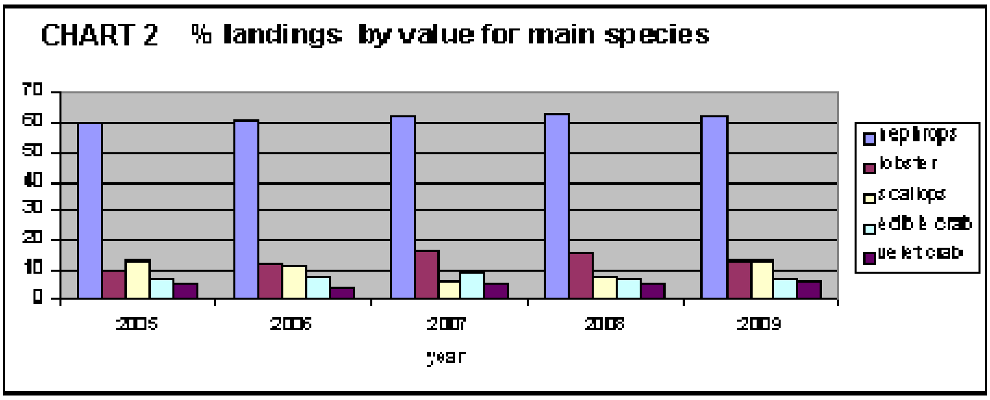
4.4 Shellfish prices have remained relatively static over the last 15 years, except for creel caught *nephrops*, against increasing operating costs. This has not encouraged new entrants to the industry and resulted in an unfavourable age profile of the vessels in the Western Isles fleet. Furthermore, the age profile of owners and skippers of the over 12 metre sector is of major concern to both the catching and processing sectors.

4.5 The value of the combined shellfish landings into the Outer Hebrides increased from £8.8M in 2005 to a peak of £12.7M in 2006, declining gradually thereafter to
£10.2M in 2009.



## 4.1 KEY FISHERIES

4.1.1 *Nephrops* are the most valuable species landed in the Outer Hebrides accounting for over 60% by value of all landings between 2005 and 2009. Trawled *Nephrops* landings, have fluctuated in volumes from 1,121 to 1,762 tonnes; whilst creel caught *Nephrops* have been in the range of 561 to 416 tonnes. The price for creel caught *Nephrops* has increased by 48% since 2005 whilst that for trawled caught *Nephrops* has only increased by 6% since 2005. Effort in the creeling sector has increased over this period, whilst effort in the trawling sector has decreased. Considerable quantities of *nephrops* are caught in the OHIFG area by nomadic trawlers that land their catch into mainland ports. Creel caught *Nephrops* was the highest value fishery in 2009 accounting for around a third of the total shellfish landings. This reflects both the transfer of effort from *Nephrop* trawling to potting and the higher (premium) prices obtained for creel caught *Nephrops* which have increased by nearly 50% between 2005 and 2009.




4.1.2 Lobster is the second most valuable species landed into the Outer Hebrides. Annual landings average around 150 tonnes, accounting on average for 13% of landings by value over the last five years. Prices have only increased by 3% over the last five years. An estimated 20% of landings are held locally in live storage facilities for the Christmas market. Further catches from St Kilda, Flannans, North Rona and Sula Sgeir are landed into Ullapool, Scrabster and Orkney.

4.1.3 Scallops are the third most valuable species landed into the Outer Hebrides between 2005 and 2009, accounting on average for 10% of the landings by value. Landed volumes have fallen from 755 tonnes in 1995 to an average of 413 tonnes during the period 2006 - 2009. Most of the landings come from the Minches, with limited amounts caught by divers in Loch Roag and to the west of Harris.

4.1.4 Edible (or brown) crab is the fourth most valuable species landed in the Outer Hebrides during the last five years, accounting for an average 8% of landings by value. Annual catches have fluctuated from a peak of 988 tonnes in 2007 to 611 tonnes in 2005. Prices have remained fairly constant over the five year period. Most of the catches are taken to the west of the Hebrides with seasonal catches from the Butt of Lewis to Stornoway and South Uist and

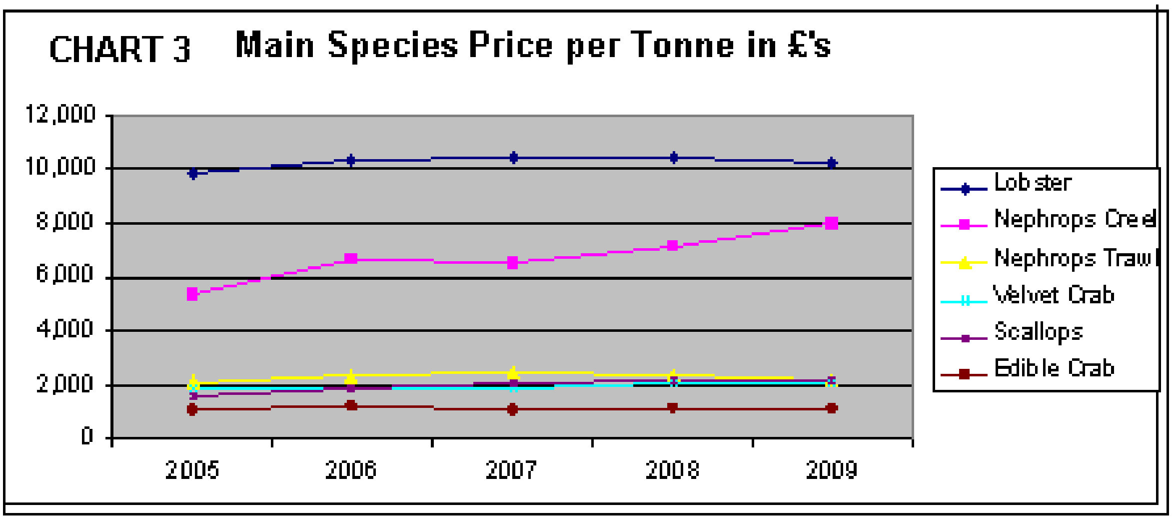
Barra in the winter months. Further catches from St Kilda, Flannans, North Rona and Sula Sgeir are landed into Skye, Ullapool, Kinlochbervie, Scrabster and Orkney. Fishing activity was curtailed in 2008 and 2009 due to lack of demand caused by over-supply on the European market.

4.1.5 Significant quantities of brown crab caught within the OHIFG area by vivier crabbers are landed elsewhere as detailed in the table below:

| Brown crab | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|
| Value | £1.1M | £1.92M | £1.78M | £1.3M | £1.56M |
| Tonnage | 1,019 | 1,444 | 1,427 | 1,116 | 1,388 |

**Table 4.1.5 Brown crab catches caught in OHIFG area and landed elsewhere**

4.1.6 Velvet crab is the fifth most valuable species landed in the Outer Hebrides during the last five years, accounting for an average 5% of landings by value. An annual average of around 267 tonnes is landed in the Outer Hebrides. Prices increased by 13% over the five year period. Most of the velvet crab is caught by under 8 metre vessels fishing in the sheltered waters of the Minch, the Sound of Harris and the Sound of Barra.




4.1.7 Volumes of *Nephrops* trawl landings in 2009 of 1,339 tonnes, were much lower than in the three preceding years. This may reflect several factors; the effects of increasing the minimum mesh size from 70 mm to 80 mm; a reduction in fishing effort in the sector; a reduction in the stock size and or the size of the animals within the stock, acting alone or in combination.

4.1.8 Volumes of creel caught Nephrops have declined to 420 tonnes in 2009 from a high of 561 tonnes in 2006. Effort in the fishery has increased both in terms of the number of vessels targeting the fishery and the number of pots per vessel.

4.1.9 All the landings by Scottish based vessels, the structure of the Scottish fishing fleet, numbers of fishermen employed in Scotland, UK quota uptake and effort uptake by the Scottish fleet can be viewed at:

**http://www.scotland.gov.uk/Topics/Statistics/Browse/Agriculture-Fisheries/PubFisheries**

### 4.2 FISHING ACTIVITY

4.2.1 The number of active vessels based in the Outer Hebrides has reduced gradually, by nearly a quarter, from 335 in 2004 to 256 in 2009. The main reasons for this are government funded decommissioning schemes for over 10 metre vessels and inactive vessels non compliance with MCA requirements for remaining on the UK Shipping Vessel Register. Reduced profitability in the mobile gear sector, in *Nephrops* and scallops, due to higher operating costs and relatively static prices has meant that all recent additions to the fleet have been to the static gear sector. A new trend is for larger single rig *Nephrop* trawlers diversifying into *Nephrop* creeling, attracted by higher prices and lower fuel operating costs.

Number of active vessels in Outer Hebrides:

| | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|
| Number | 335 | 311 | 303 | 281 | 267 | 256 |
| Change | -1 | -24 | -8 | -22 | -14 | -11 |

Size distribution of Outer Hebrides fleet - 2009

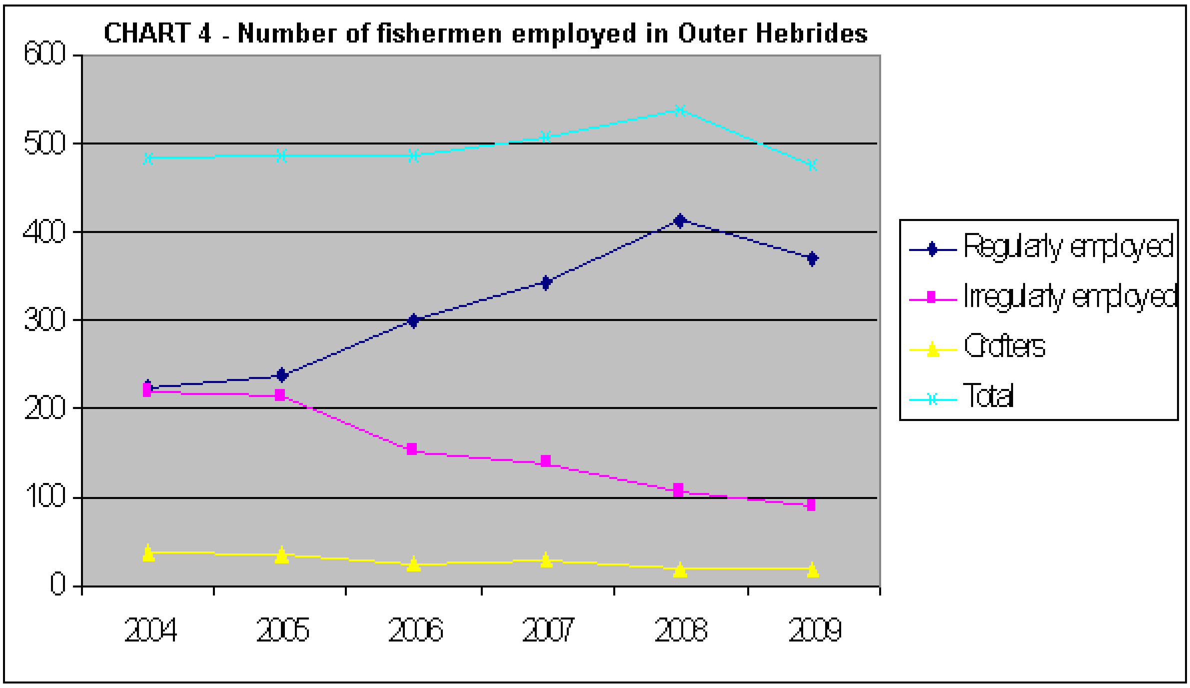
| Under 8 metres | 8–10 metres | 10-12 metres | 12-15 metres | Over15 metres | TOTAL |
|---|---|---|---|---|---|
| 155 | 46 | 22 | 8 | 25 | 256 |

4.2.2 The shellfish processing sectors in Lewis, Uist and Barra are all dependent on shellfish landings from over 10 metre vessels. The most worrying trend is the average age of the *nephrop* trawl fleet in the Stornoway.

Average age profile of vessels and skippers for over 10 metre categories:

| | Vessel | Skipper |
|---|---|---|
| Static Gear | 25 | 44 |
| Scallop | 25 | 45 |
| Stornoway *Nephrop* Trawl | 38 | 45 |
| Barra *Nephrop* Trawl | 30 | 44 |

4.2.3 The total number of fishermen employed in the industry has increased due to downturn in weaving, crofting and fish farming. This trend is unlikely to continue as these sectors are now showing signs of recovery with new employment opportunities being created. Furthermore, due to reduced profitability, trawlers are reducing the numbers employed on deck and this is reflected in 2009 figures.




## 4.3 PROCESSING

4.3.1 Scottish Seafoods Ltd is the main processor in Lewis and Harris employing around 50 people. The company is mainly involved in primary processing for the UK scampi market, with secondary processing being completed in Grimsby. Whole trawled *Nehprops* are selected and sold either fresh or frozen to UK and European markets. The company was at the forefront of gaining Marine Stewardship Council (MSC) accreditation for the North Minch *Nephrop* fishery. Accreditation has opened up new marketing opportunities across Europe in whole *Nephrops* and in UK supermarkets for scampi.

4.3.2 Kallin Shellfish Ltd, in Uist, process scallops and brown crab and employ 14 people. They also buy winkles and store lobster for the Christmas market in live storage facilities at Kallin Pier.

4.3.3 Barratlantic Ltd, in Ardveenish, process *Nephrops*, scallops and white fish species, employing around 40 people. Recent investment in top of the range freezing facilities has shown significant product quality improvements and enabled the company to develop new marketing opportunities across Europe.

## 4.4 LIVE SHELLFISH

4.4.1 Significant investment supported by Highlands and Islands Enterprise and European funding has provided a network of strategically located live shellfish storage infrastructure throughout the Outer Hebrides.

4.4.2 Live storage facilities are used on a weekly basis by some companies to keep shellfish prior to distribution by vivier lorries, mainly destined for the Spanish market. Most shellfish buyers use their live storage facilities, from late summer to December, to store live lobsters for selling to the premium Christmas markets. Lobster buyers pay on average £2,000 per tonne more for lobsters that are stored compared to the usual seasonal selling price.

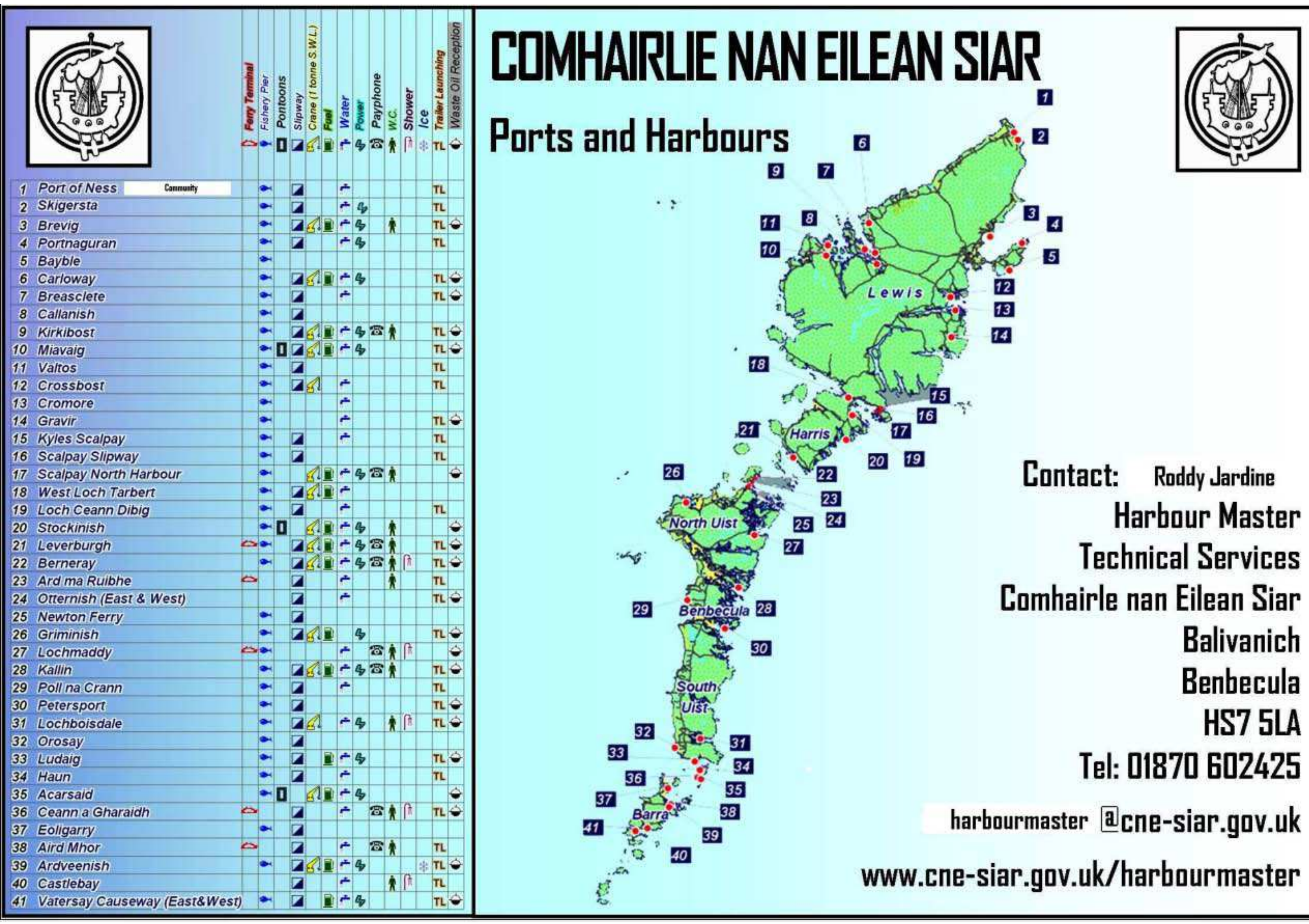
4.4.3 Aurora Shellfish and Sandray Shellfish are the main live shellfish buyers in Barra, buying lobster, brown and velvet crab, crawfish, cockles and *Nephrops*. All the live shellfish bought in Barra is destined for the Spanish market.

4.4.4 Kilbride Shellfish, North Uist Fish Marketing, W Stewart Live Fish, W MacDonald Shellfish, Live Langoustine, Sutherland Game and Scot West all have live storage facilities in the Uists. They all buy a full range of different live shellfish for the European markets.

4.4.5 Hebridean Marine, Sandray Shellfish, Keltic Seafare, Sutherland Game, Scot West and Mar Scot are the main live shellfish buyers in Lewis and Harris, with five live shellfish storage facilities in the area.

## 4.5 PORTS AND SERVICES

4.5.1 Comhairle Nan Eilean Siar (CNES) own 42 landing facilities which are all used by the Outer Hebrides fishing industry. Stornoway Port Authority and Caledonian MacBrayne own, Stornoway, Tarbert, Lochboisdale and Castlebay, which are the other facilities used by both local and visiting fishing vessels.




**Fiqure 4.5.1 Location of all CNES owned piers**

4.5.2 Scottish Fuels are the main fuel suppliers throughout the Outer Hebrides, with bulk storage depots at Stornoway and Loch Carnan. Barratlantic own storage tanks in Barra, whilst Highand Fuels have limited storage tanks close to Stornoway Airport.

4.5.3 Assistance from HIE and European funding enabled (CNES) to purchase 10 fuel tanks at their own piers which are operated through a swipe card system to supply fuel to all marine users. European Fisheries Fund (EFF) assistance has recently been awarded to CNES to provide a similar service to users at Stornoway Harbour.

4.5.4 Engineering slipway facilities, operated by Stornoway Port Authority (SPA) exist at Goat Island, Stornoway, for vessels of 40 metres with a maximum displacement of 720 tonnes hull. An enclosed boatshed for vessels of under 12 metres was built several years ago at Kallin, with assistance from FIFG.

4.5.5 The only fish market is located in Stornoway, where *Nephrops* and any whitefish landed as by-catch by *Nephrops* trawlers white fish by-catch are kept in chilled facilities before consignment to Youngs Bluecrest and Scottish Fishermen's Organisation.

4.5.6 Ice plants at Stornoway and Ardveenish service the mobile sector of the fleet. A new ice plant, owned by CNES, was commissioned in 2010 to service the catching, processing and aquaculture sectors in the Uists. CNES with assistance from HIE and European Fisheries Fund have recently completed, in March 2011, a new ice plant in Barra to service the requirements of both the processing sector and vessels operating in the South Minch.

**4.6 REGULATIONS AND LEGISLATION**

4.6.1 Marine Scotland Compliance (MS-C) covers the Outer Hebrides IFG area from its office in Stornoway. The office has two 2 full time fishery officers plus one full time and one part-time administrative staff.

4.6.2 The IFG area has one of the largest inshore fleets in Scotland and vessels target a wide range of shellfish species.

4.6.3 MS-C monitors compliance by sub dividing the area into 13 creeks covering the 256 registered and licensed local vessels that operate in the area. Fishery Officers monitor and record the landings of all vessels throughout the area.

4.6.4 There are a number of EU and domestic pieces of legislation that cover fisheries within the area. The main Legislative tool used for Inshore Fisheries is the Inshore (Scotland) Act 1984. The latest updated version can be viewed at:

http://www.legislation.gov.uk/ssi/2004/276/pdfs/ssi_20040276_en.pdf

*PROHIBITIONS WITHIN THE OUTER HEBRIDES*

- Lochmaddy to Stuley Island to Barra Head and Gurney Point

Mobile gear prohibitions 1 March – 31 October, scallop dredging permitted 1 March – 31 April and 24 August – 31 October, sandeel fishing permitted 1 March - 31 October in Stuley Island – Barra Head area

- Sound of Harris

Mobile gear prohibitions 1 March – 30 September, scallop dredging permitted during that period

- Broad Bay

All year prohibition on mobile gear to protect juvenile plaice

- Loch Roag

All year prohibition on mobile gear

- Flannan Isles

Prohibition of creel fishing 1 November – 31 March

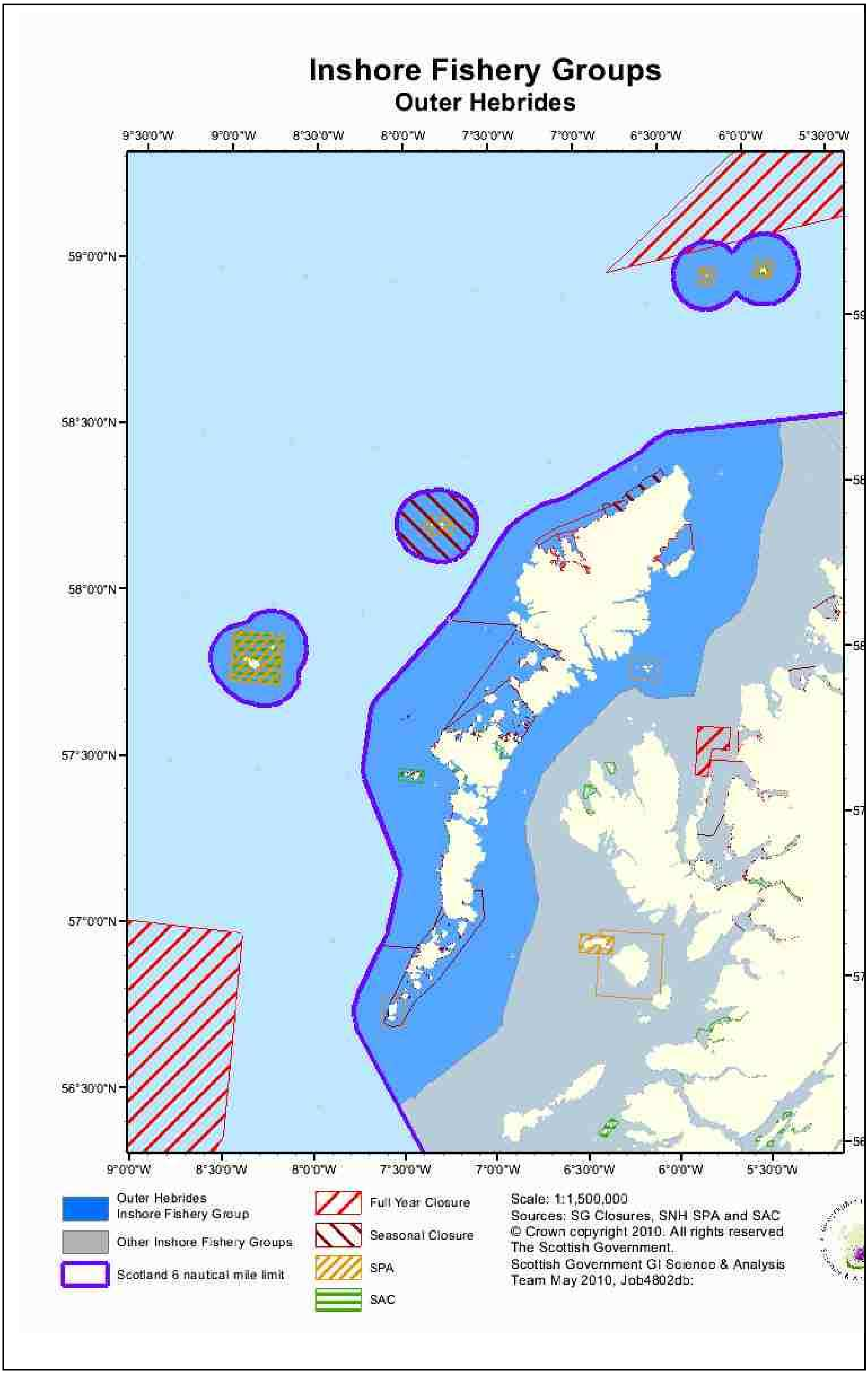
- West of Barra – Scarp Island

Prohibition of creel fishing 1 November – 31 March

- Bragar to Dell - West of Lewis

Prohibition of creel fishing 1 July – 30 September

**Figure 4.6.4 Prohibitions for mobile and static gear plus SPA and SACs in the Outer Hebrides Inshore Fisheries Group area**



***LOCAL CODE OF CONDUCTS***

**Trawl area off Harris**

4.6.5 An area off Harris has been identified as grounds suitable for trawlers and a local agreement on access has been reached between both static and mobile gear sectors. Trawlers must give prior notification to static gear operators before they intend to commence fishing in the area, so that static gear can be shifted to allow access for the trawlers. Trawl activity in the area is usually on a seasonal basis.

Details of the code and chart for the area are given at **Appendix 2.**

**Scallop Dredge Code**

4.6.6 An area between Chicken Head and Cellar Head has a high concentration of brown crab creels from 1 November until 31 March. Scallop dredgers also dredge in the area on a limited basis during this period and an agreed code has been developed to accommodate both methods of fishing.

Details of the code for the area given at **Appendix 3.**

## 4.7 WATER CLASSIFICATION SHELLFISH SITES

4.7.1 CNES has two sampling officers, one covering Uist and Barra and another covering Lewis and Harris, who undertake water classification sampling on behalf of the Food Standards Agency(FSA).

4.7.2 All razorfish and cockles must come from an area where the waters have been classified and sold through an approved dispatch centre. Razorfish and cockles from a Class A area can be sold directly to the market, otherwise they must be depurated or heat treated within species specific time frames. All depuration systems must have an approval certificate from the environmental food health officer.

| | |
|---|---|
| Local Authority | UB (Comhairle nan Eilean Siar: Uist & Barra) |

| Production Area | Map No | Species | Classification | Boundaries | Comments | Sanitary Survey | Site Name |
|---|---|---|---|---|---|---|---|

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Cidhe Eolaigearraidh | | Pacific oysters | 2010 = B - April to August A - September to December<br>2011 = A - January B - February to March | Bounded by lines drawn between NF 7107 0827 to NF 7173 0827 and between NF 7173 0827 to NF 7173 0782 and between NF 7173 0782 to NF 7133 0782 extending to MHWS | New Production area | | Sound Of Barra: Pacific Oysters (UB-427-830-13) |
| South Ford | 22 | Common cockles | 2010 = A - April to December<br>2011 = A - January to March | Area in between lines drawn between NF 7919 4727 to NF 7990 4804 and NF 8100 4545 to NF 8300 4712 | Classification remains the same | | South Ford (UB-259-162-04) |
| Traigh Cille Bharra Cockles | | Common cockles | 2010 = A - April to July, October to December B - August & September<br>2011 = A - January to March | Area bound by lines drawn between NF 7122 0734 and NF 7145 0727 and between NF 7145 0727 and NF 7169 0679 and between NF 7169 0679 and NF 7185 0620 and between NF 7134 0637 and NF 7103 0648 and extending to MHWS. | Classification remains the same | Complete | Traigh Cille Bharra Cockles (UB-392-790-04) |
| Traigh Mhor | 31 | Common cockles | 2010 = A - April & May, December B - June to November<br>2011 = A - January to March | NF 7103 0649 and NF 7135 0635 and between NF 7180 0600 and NF 7123 0450 and between NF 7002 0504 and NF 7013 0521 and between NF 7013 0521 and NF 7019 0561 and between NF 7019 0561 and NF 7098 0630 and between NF 7098 0630 and NF 7080 0644 extending to M | Change in Classification - Unfavourable | | Traigh Mhor (UB-282-165-04) |

**Table 4.7.2 water classification sites in Uist and Barra**

| Local Authority | LH (Comhairle nan Eilean Siar: Lewis & Harris) |
|---|---|

| Production Area | Map No | Species | Classification | Boundaries | Comments | Sanitary Survey | Site Name |
|---|---|---|---|---|---|---|---|
| East Loch Tarbert | 14 | Common mussels | 2010 = A - April to December<br>2011 = A - January to March | Area bounded by lines drawn between NG 2000 9653 to NG 2000 9810 then from NG 2281 9753 to NG 2281 9706 and from NG 2095 9596 to NG 2037 9619 | Change in Classification - Favourable | | Fuam an Tolla (LH-057-104-08)<br>Sound of Scalpay (LH-057-106-08) |
| Loch Erisort Outer | 14 | Common mussels | 2010 = A - April to July<br>B - August to December<br>2011 = B - January<br>A - February & March | Area bounded by lines drawn between NB 3300 2069 to NB 3300 1993 and between NB 3700 2064 to NB 3700 2144 | Change in Classification - Unfavourable | | Garbh Eilean (LH-357-747-08)<br>Gob Glas (LH-357-711-08) |
| Loch Leurbost | 14 | Common mussels | 2010 = A - April to July, November & December<br>B - August to October<br>2011 = A - January to March | Area bounded by lines drawn between NB 3700 2544 and NB 3700 2503 and between NB 3800 2476 and NB 3800 2404 extending to MHWS | Classification remains the same | | Creag an Rainich (LH-168-113-08)<br>Eilean Mhiabhaig (LH-168-732-08)<br>Loch Leurbost (LH-168-114-08) |
| Loch Leurbost: Crosbost | 14 | Pacific oysters | 2010 = B - April to December<br>2011 = B - January to March | Area bounded by lines drawn between NB 3800 2476 to NB 3800 2404 and between NB 3939 2368 and NB 4000 2410 | Change in Classification - Unfavourable | | Site 1 Crosbost (LH-339-795-13)<br>Site 2 Crosbost (LH-339-721-13) |
| Loch Roag: Barraglom | 13 | Common mussels | 2010 = A - April & May, December<br>B - June to November<br>2011 = A - January to March | Area within lines drawn between NB 1860 3322 and NB 1886 3365 extending to MHWS and the B8059 | Change in Classification - Unfavourable | Complete | Loch Barraglom (LH-185-120-08) |
| Loch Roag: Ceabhagh | | Common mussels | 2010 = A - April to July<br>B - August to December<br>2011 = A - January to March | Area bounded by lines drawn between NB 1914 3460 and NB 1983 3460 and between NB 2014 3465 and NB 2073 3438 and between NB 2027 3360 and NB 2011 3359 and between NB 1939 3360 and | Change in Classification - Unfavourable | Complete | Keava (LH-381-772-08) |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | NB 1908 3361 extending to MHWS | | | |
| Loch Roag: Drovinish | 8 | Common mussels | 2010 = A - April to December<br>2011 = A - January to March | Area within lines drawn between NB 1439 3311 and NB 1353 3268 extending to MHWS | Classification remains the same | Complete | Loch Drovinish (LH-186-121-08) |
| Loch Roag: Eilean Chearstaigh | 8 | Common mussels | 2010 = A - April to May, December<br>B - June to November<br>2011 = A - January to March | Area bounded by lines drawn between NB 1891 3352 and NB 1867 3308 and between NB 2094 3244 and NB 2114 3260 and between NB 2028 3360 and NB 2011 3360 and between NB 1941 3360 and NB 1908 3360 | Change in Classification - Unfavourable | Complete | Buckle Point (LH-344-791-08)<br>Eilean Scarastaigh (LH-344-697-08) |
| Loch Roag: Eilean Teinish | 13 | Common mussels | 2010 = A - April to December<br>2011 = A - January to March | Area within lines drawn between NB 1166 3440 to NB 1281 3444 and between NB 1178 3519 and NB 1254 3516 | Classification remains the same | Complete | Eilean Teinish (LH-338-720-08) |
| Loch Roag: Linngeam | 13 | Common mussels | 2010 = A - April to December<br>2011 = A - January to March | Area bounded by lines drawn between NB 1500 3370 and NB 1500 3442 and between NB 1419 3470 and NB 1356 3470 and between NB 1300 3435 and NB 1300 3342 and between<br>NB 1300 3310 and NB 1353 3268 and between NB 1353 3268 and NB 1439 3311 | Classification remains the same | Complete | Cliatasay (LH-187-699-08)<br>Hacklete (LH-187-698-08)<br>Linngeam (LH-187-122-08)<br>Mol Mor (LH-187-710-08) |
| Loch Roag: Miavaig | 13 | Common mussels | 2010 = A - April to July, December<br>B - August to November<br>2010 = A - January to March | Area within lines drawn between NB 1000 3327 and NB 1040 3438 extending to MHWS | Change in Classification - Unfavourable | Complete | Miavaig (LH-188-123-08) |
| Loch Roag: Torranish | 13 | Common mussels | 2010 = A - April to December<br>2011 = A - January to March | Area within lines drawn between NB 1500 3370 and NB 1500 3442 extending to the B8059 | Change in Classification - Favourable | Complete | Loch Torranish (LH-189-124-08) |
| Loch Seaforth | 14 | Common mussels | 2010 = A - April to December<br>2011 = A - January to March | Area bounded by lines drawn between NB 2065 0800 to NB 2166 0800 then from NB 2047 0600 to NB 2263 0600 | Change in Classification - Favourable | | Loch Seaforth (LH-193-126-08) |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Loch Stockinish | 14 | Common mussels | 2010 = A - April to June, October to December<br>B - July to September<br>2010 = A - January to March | Area bounded by lines drawn between NG 1222 8956 to NG 1352 8971 and between NG 1331 9058 to NG 1346 9087 and from points NG 1227 9200 to NG 1290 9200 | Classification remains the same | | Loch Stockinish (LH-203-127-08) |
| Seilebost | 14 | Common cockles | 2010 = A - April to May, December<br>B - June to November<br>2010 = A - January to March | Area inshore of line drawn between NG 0650 9913 and NG 0605 9727 extending to MHWS | Change in Classification - Favourable | | Seilebost (LH-249-129-04) |

**Table 4.7.3 water classification sites in Lewis and Harris**

## 4.8 ENVIRONMENT

### 4.8.1 INTRODUCTION

4.8.1.1 Marine and coastal areas of particular ecological and conservation interest in the Outer Hebrides include sealochs, lagoons, seabird and wader breeding areas, reefs, and intertidal and near shore soft sediment habitats. Much of Scotland's mportant flora and fauna is contained within these areas, including beds of maerl, horse mussels and seagrass. The marine environment of the Outer Hebrides is also important for otters, seals, cetaceans and numerous seabirds and waders.

4.8.1.2 Scottish Natural Heritage have a statutory duty to secure the conservation and enhancement of Scotland's wildlife, environment and landscape, and encourage its sustainable use. This includes helping the Scottish Government meet its responsibilities under European environmental laws, particularly in relation to the Habitats and Birds Directives.

4.8.1.3 Inshore Fisheries Groups (IFGs) exist as a co-operative organisation of individuals representing the interests of many small businesses. However because IFGs are publicly funded, there is an expectation that their work will take full account of the Scottish Government's biodiversity duty and other environmental commitments.

4.8.1.4 The following sections provide a summary of key features of the Outer Hebrides marine environment that can help inform the work of the Inshore Fisheries Group, including protected areas and species, selected important species and habitats in the wider seas and the status of any invasive non-native species.
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### 4.8.2 PROTECTED AREAS[1]

**4.8.2.1 Special Areas of Conservation (SACs)**. Designated by Scottish Ministers under the EC Habitats Directive, these areas represent the range and variety of habitats and (non-bird) species within the EU, as listed in Annexes I & II of the directive. The Outer Hebrides IFG area has 11 SACs with qualifying marine and/or coastal features (Table 1). Box 1 summarises generic advice on the vulnerability and sensitivity of the features of these SACs to fisheries operations.

[1] For complete information on protected areas, including complete lists of qualifying features and conservation objectives, see Sitelink at www.snh.org.uk/snhi/

**Box 1**

Marine SACs in the Outer Hebrides are designated for particular features. Generic advice can be given on the vulnerability and sensitivity of these features to fisheries operations:

- **Coastal lagoons** – interaction with sea fisheries generally unlikely.
- **Large shallow inlets and bays** – various fisheries operate in these areas, where biological and substrate conditions can also be variable. Highly mobile substrates and associated fauna tend to recover relatively quickly from physical disturbance.
- **Intertidal mudflats and sandflats** – accessed for intertidal fisheries and bait-digging. The severity of physical disturbance is influenced by various factors including: gear type; fishing intensity; substrate type; and the biology of species therein. Highly mobile substrates and associated fauna tend to recover relatively quickly from physical disturbance.
- **Reefs** (including patchy cobble & boulder reefs) – Reef biota tends to be slow-growing and highly sensitive to physical disturbance.
- **Shallow subtidal sandbanks** – various fisheries operate within these areas. The vulnerability and sensitivity of features to fisheries depends on various factors including: the substrate type; fishing gear and fishing intensity. Habitats such as maerl and seagrass beds are associated with this feature and are particularly sensitive to physical disturbance.
- **Sea caves** – interaction with sea fisheries generally unlikely.
- **Grey seals** – fisheries and grey seals may compete for some of the same fish resources. Near haul-out sites, seals may be sensitive to disturbance.
- **Otters** – potentially relevant to some intertidal and shallow subtidal fisheries, otters are sensitive to disturbance in the vicinity of their land-based resting and breeding sites. Competition for marine food resources is unlikely to be an issue.

Some non-marine features within SACs may be relevant to marine features. **Coastal vegetation and dune systems** may be vulnerable to damage where access to intertidal fisheries occurs through these areas. Also, although **Atlantic salmon** are designated within freshwater SACs, their exposure to possible human-induced impacts during the marine phase of their life-cycle is relevant. SACs with these features are included in Table 1.

*Table 1*

| **SAC name*** | **Qualifying features** |
|---|---|
| North Rona | Grey seals, reefs, sea caves, vegetated sea cliffs |
| Loch Roag Lagoons | Lagoon |
| Langavat | Atlantic salmon |
| North Harris | Atlantic salmon, otter |
| Monach Islands | Grey seals, machair, shifting dunes with marram, dune grassland |
| St Kilda | Reefs, sea caves, vegetated sea cliffs |
| Loch nam Madadh | Lagoons, shallow inlets and bays, otter, inter-tidal mudflats and |

| | |
|---|---|
| | sandflats, reefs, sub-tidal sandbanks |
| North Uist Machair | Annual vegetation on drift lines, Atlantic salt meadows, dune grassland, humid dune slacks, machair, shifting dunes, shifting dunes with marram |
| Obain Loch Euphoirt | lagoon |
| South Uist Machair | Annual vegetation on drift lines, dune grassland, humid dune slacks, lagoons, machair, otter, shifting dunes with marram |
| Traigh na Berie | machair |

∗ Scottish Government may proceed to consultation on the possible designation of the Sound of Barra (sandbanks, reefs and harbour seals) and East Mingulay Reefs (cold water coral reef) as new SACs (pending decision from Scottish Government).

**4.8.2.2 Special Protection Areas (SPAs)**. Classified by Scottish Ministers under the EC Birds Directive[2], these are areas identified as the most important for rare and regularly occurring migratory birds in the EU. The Outer Hebrides IFG area has 10 SPAs with qualifying species with links to the marine environment (including human access across coastal breeding habitat to intertidal beaches) (Table 2). Box 2 summarises generic advice on the vulnerability and sensitivity of the features of SPAs within the Outer Hebrides to fisheries operations.

**Box 2**

SPAs in the Outer Hebrides are designated for particular bird species or aggregations of birds. For the purposes of this document, those that are relevant to the marine environment can be categorised for the provision of generic advice on the vulnerability and sensitivity of these features to fisheries operations:

- **Breeding seabirds** – some breeding seabirds are particularly dependent on marine food sources, which may be adjacent to their nesting sites or may be further offshore. Where prey species include small gadoids and sandeels there is potential for fisheries to impact seabird populations through either direct or indirect impacts of food sources. Disturbance of seabirds by fisheries operations is generally unlikely, except potentially terns, which often breed on nearshore coastal vegetation and shingle, rather than on sea cliffs; some intertidal fisheries operations may disturb breeding terns when accessing beaches.
- **Breeding and feeding waders** – wading birds breeding in coastal habitats may be vulnerable to disturbance along access routes to beaches. Waders feeding in the intertidal may be disturbed by intertidal fisheries operations and some species, such as oystercatchers, may be in direct competition for shellfish resources (i.e. cockles).

*Table 2*

| SPA name | Qualifying features |
|---|---|
| North Rona & Sula Sgeir | Leach's petrel, storm petrel, gannet, guillemot & breeding seabird assemblage |
| Flannan Isles | breeding seabird assemblage, fulmar, guillemot, kittiwake, |

[2] DIRECTIVE 2009/147/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 30 November 2009 on the conservation of wild birds

| | |
|---|---|
| | Leach's petrel, puffin, razorbill |
| Shiant Isles | Shag, razorbill, puffin & breeding seabird assemblage |
| St Kilda | Leach's petrel, storm petrel, gannet, great skua, puffin & breeding seabird assemblage |
| North Uist Machair & Islands | Waders (various) |
| Monach Islands | Little tern |
| South Uist Machair & Lochs | Little tern, corncrake, dunlin, oystercatcher, redshank, ringed-plover, sanderling |
| Lewis Peatlands | Red-throated diver |
| Loch Scadavay | Red-throated diver |
| Mingulay & Berneray | breeding seabird assemblage, fulmar, guillemot, kittiwake, puffin, razorbill |

**4.8.2.3 Sites of Special Scientific Interest (SSSIs)**. These areas provide protection for the best examples of the UK's biological, geological or physiographical features, down to mean low water of spring tides (MLWS). Many SSSIs overlap with SACs and SPAs. The Outer Hebrides IFG area has 32 SSSIs with biological[3] features that are intertidal or have a link with the marine environment (Table 3). Box 3 puts the features into broad categories summarise generic advice on the vulnerability and sensitivity of the features of SSSIs within the Outer Hebrides to fisheries operations.

**Box 3**

SSSIs in the Outer Hebrides are designated for particular species, habitats and geological features. For the purposes of this document, those that are relevant to the marine environment can be categorised for the provision of generic advice on the vulnerability and sensitivity of these features to fisheries operations:

- **Breeding seabirds** – as in Box 2
- **Breeding and feeding waders** – as in Box 2
- **Maritime cliff** – interaction with sea fisheries unlikely
- **Saltmarsh** – potential damage to saltmarsh habitat through access to intertidal fisheries.
- **Intertidal mudflats and sandflats** – as in Box 1
- **Reefs (intertidal)** – as in Box 1
- **Lagoons** - as in Box 1
- **Tidal rapids** interaction with sea fisheries unlikely
- **Coastal vegetation and dune systems** – as in Box 1
- **Geological features** - interaction with sea fisheries unlikely
- **Grey seals** as in Box 1
- **Otters** as in Box 1

*Table 3*

| SSSI name | Designated features |
|---|---|
| Rona & Sula Sgeir | Fulmar, gannet, great black backed gull, grey seal, guillemot, kittiwake, Leach's petrel, puffin, razorbill, breeding seabird colony, storm petrel |
| Loch Stiapavat | Machair, breeding bird assemblage |
| Loch na Cartach | Maritime cliff |
| Gress Saltings | Saltmarsh |
| Tong Saltings | Breeding bird assemblage, mudflats, saltmarsh, sand dunes |

[3] Sites for solely geological features have been excluded from this list on the assumption that interaction with fisheries is unlikely.

| | |
|---|---|
| Tob Valasay | Saline lagoon, tidal rapids |
| Loch Siadar | Saline lagoon, tidal rapids |
| Flannan Islands | Fulmar, guillemot, kittiwake, Leach's petrel, maritime cliff, puffin, razorbill, seabird colony, storm petrel |
| Small Seal Islands | Grey seals |
| Shiant Islands | Breeding bird assemblage, fulmar, guillemot, puffin, razorbill, shag |
| Luskentyre Banks and Saltings | Breeding bird assemblage, coastal geomorphology, machair, saltmarsh, sand dune, sand flat |
| Northton Bay | Breeding birds, machair, saline lagoon, saltmarsh, sand dune, sand flat, transition saltmarsh |
| St Kilda | Coastal geomorphology, gannet, guillemot, Leach's petrel, maritime cliff, puffin, razorbill, breeding seabird colony, storm petrel |
| Pabbay | Machair, coastal geomorphology, breeding birds |
| Berneray | Machair |
| Vallay | Machair, saltmarsh, sand dunes, breeding birds |
| Machairs Robach & Newton | Machair, sand dunes, coastal geomorphology |
| Loch an Duin | Brackish water cockle, breeding birds, coastal geomorphology, otter, saline lagoon, tidal rapids |
| Loch nam Madadh | Coastal geomorphology, mudflat, reef, saline lagoon, tidal rapid |
| Obain Loch Euphoirt | Saline lagoon |
| Loch Obisary | Saline lagoon |
| Lochs at Clachan | Saline lagoon |
| Baleshare & Kirkibost | Breeding bird assemblage, machair, saltmarsh, sand dune |
| Balranald Bog & Loch nam Feithean | Breeding bird assemblage, machair, mudflats, salt marsh, sand dune |
| Monach Isles | Black guillemot, breeding bird assemblage, machair, sand dune |
| Loch Bee | Brackish water cockle, breeding bird assemblage, coastal geomorphology, machair, saline lagoon, saltmarsh |
| Loch Bee Machair | Breeding bird assemblage, coastal geomorphology, machair |
| Loch Druidibeg | Breeding bird assemblage, coastal geomorphology, machair, machair loch, sand dune |
| Howmore Estuary, Lochs Roag & Fada | Breeding bird assemblage, machair, dunlin, redshank, saline lagoon |
| Loch Hallan | Breeding bird assemblage, machair, machair loch |
| Eoiligarry | Coastal geomorphology, machair, sand dune |
| Mingulay & Berneray | Fulmar, guillemot, kittiwake, razorbill, breeding seabird colony |

**4.8.2.4 Ramsar**. Meeting UK commitments under the Ramsar Convention, these sites are recognised as wetlands of international importance. The Outer Hebrides IFG area has 3 Ramsar sites with features relevant to the marine environment (Table 4). Generic advice on the vulnerability and sensitivity of these features to fisheries operations can be taken from Box 1 and 2.

*Table 4*

| **Ramsar Site** | **Designated features** |
|---|---|
| Loch an Duin | Saline lagoon, tidal rapids |
| North Uist Machair & Islands | Dunlin, ringed plover, turnstone |
| South Uist Machair & Lochs | Dunlin, machair, machair loch, ringed plover, saline lagoon |

### 4.8.3 PROTECTED SPECIES

**4.8.3.1 European Protected Species (EPS)**. Listed on Annex IV of the EC Habitats Directive as species in need of strict protection, marine EPS that occur in the Outer Hebrides are otters, cetaceans and marine turtles. It is an offence to deliberately or recklessly injure, capture, kill, harass or disturb an EPS (for legal detail see the Conservation Regulations 1994).

- Otters are distributed widely throughout the Outer Hebrides region and were recorded as present in 97% of sites surveyed during the last national otter survey. They appear to be most numerous on the more sheltered eastern coasts of Harris, North Uist, Benbecula and Barra.

- Little is known about cetaceans in the waters around the Outer Hebrides other than that all the following species are found regularly in the IFG area:

  - Porpoise (*Phocoena phocoena*)
  - Risso's dolphin (*Grampus griseus*)
  - bottlenose dolphin (*Tursiops truncatus*)
  - white beaked dolphin (*Lagenorhynchus albirostris*)
  - common dolphin (*Delphinus delphis*)
  - minke whale (*Balaenoptera acutorostrata*)
  - killer whale (*Orcinus orca*)

Other cetacean species do occur but are only occasional visitors to the inshore waters. The main period of cetacean activity in the inshore area is May to September for all species but porpoise have been recorded year round. A Whale and Dolphin Society survey of Broad Bay in the late 1990s suggests that it may be an important nursery for Risso's dolphins. There is a small resident population of bottlenose dolphins in the Sound of Barra.

- **Marine turtles** are rare in Scotland but it is likely that they are annual visitors to the Outer Hebrides area. Most records have been of leatherback turtles, the largest and most cold-tolerant species. Turtles are at risk from entanglement in fishing nets and from collisions with boats and their propellers. No offence is committed if turtles are caught accidentally in fishing gear. Nor is it an offence to help turtles if entangled or stranded, or temporarily to hold dead turtles for later examination by experts. The UK Turtle Code gives information on what to do if one is seen or accidentally caught.

**4.8.3.2 Wildlife & Countryside Act, 1981.** Marine species with special protection under schedules 5 and 8 of this act include basking shark, otters and all cetaceans and marine turtles. Schedules 5 and 8 are reviewed every 5 years. Schedule 1 lists various protected bird species. For more information see the JNCC pages.

**4.8.3.3 Seals.** From the 1st February 2011 it is an offence to kill, injure or take a seal at any time of year except to alleviate suffering or where a licence has been issued to do so by Marine Scotland under the [Marine (Scotland) Act 2010]. The method of killing or taking seals will be detailed by licences issued and regular reporting is required. It is also an offence to intentionally or recklessly harass seals at significant haul-out sites.

The Marine (Scotland) Act 2010 also provides for Scottish Ministers to designate "seal conservation areas". The areas previously covered by the Conservation of Seal (Scotland) Orders namely Shetland, Orkney, the Moray Firth and the East Coast of Scotland have been transcribed into seal conservation areas and in addition the Outer Hebrides has also been scheduled as a seal conservation area under the Act. Marine Scotland must not grant a seal licence authorising the killing or taking of seals in a seal conservation area unless they are satisfied that there is no satisfactory alternative way of achieving the purpose for which the licence is granted, and that the killing or taking authorised by the licence will not be detrimental to the maintenance of the population of any species of seal at a favourable conservation status in their natural range

More information is available at:
www.scotland.gov.uk/Topics/marine/Licensing/SealLicensing

Two species of seal live and breed in the Outer Hebrides' waters; the grey seal (*Halichoerus grypus*) and the harbour seal (*Phoca vitulina*), which is also known as the common seal.

The Outer Hebrides has approximately 25% of the UK's grey seal population, with about 12,000 pups being born in the region each year (SMRU survey 2008). Numbers have increased here since the 1960s but have stabilised since 1992 and now appear to have levelled off. Grey seals pup, then breed during the autumn months (sept - nov) and favour remote and uninhabited islands/coasts such as the Monachs, Gasker and Rona. Pups are born with a white fur covering (laguno) and will go to sea aged approximately one month. Grey seals will range over great distances for feeding but will normally stay within 100km of their haul outs. They mainly feed on the sea bed on demersal fish species.

The last survey of Harbour seals in the Outer Hebrides (SMRU 2008) estimates 1,800 individuals in the area which is approximately 7% of the UK population. Numbers here have reduced steadily since 1996 and are now 35% lower than at that time (even more dramatic declines have been recorded in Orkney, Shetland and the Moray Firth). The reasons for this reduction are not well understood and are the subject of research at present. Unlike grey seals, harbour seals come ashore in sheltered waters on sandbanks and skerries to pup in June/July, their pups are not born with a white coat and can swim immediately. In the Outer Hebrides harbour seals tend to favour the sealochs and the sounds (e.g. Bays of Harris, Lochmaddy, Grimsay, Sound of Barra). They will forage up to 40-50km from their haul out site and feed on a wide range of prey (including sand eels, gadoids, flatfish, herring and octopus).

For further information on seals in the Outer Hebrides (and Scotland) see the latest Special Committee on Seals report at the following link.

### 4.8.4 WIDER SEAS

4.8.4.1 There are some marine species and habitats present in the Outer Hebrides IFG area which do not receive explicit protection (except where designated as features of protected areas), but are particularly important in the context of biodiversity conservation and/or ecosystem function – many are listed under the Scottish Biodiversity List, UK Biodiversity Action Plan and OSPAR lists and may be vulnerable to fisheries impacts. The information below provides a summary of key species and habitats selected from the '*SNH Draft Priority Marine Features List*'[4] for which SNH has records[5]. Mobile fish and shellfish of conservation importance, including commercial species, are not included here as this data is mostly held by other organisations, focussing instead on attached and low-mobility seabed species and habitats.

- **Maerl beds** – well developed around Scottish islands and in sealoch narrows, maerl beds support exceptionally high biodiversity, including juveniles of some fisheries species (e.g. scallops; cod). Known locations include Loch Boisdale, Loch Euphort, Loch Eynort, Tob Valasay, Sound of Stuley, Sound of Barra  Eriskay, Loch Maddy, East Loch Tarbert, Loch Seaforth, Loch Resort and Loch Roag but likely to also occur elsewhere. Maerl is slow growing and very sensitive to physical disturbance. **Maerl or coarse shell gravel with sea cucumbers** is classified as a separate habitat of conservation interest, occurring in similar areas with additional records in Loch Tealasavay, Loch Uiskevagh, Loch Eport and West Loch Tarbert.
- **Horse mussel beds** – sensitive to mobile gear, horse mussel beds also support high biodiversity and juveniles of some commercial species. Known locations include Sound of Barra,  Loch Euphoirt, East Loch Tarbert, Loch Erisort and Loch Roag,  but likely to occur elsewhere.
- **Seagrass beds** – important for juveniles of many fish and shellfish species, including some commercial species. Seagrass beds are primarily sensitive to mobile gear, though at low-tide may also be damaged by vehicles accessing intertidal fisheries. Known locations include West Loch Roag, Loch Maddy, Sound of Barra, Loch Boisdale, Tob Valasay, Loch Bee, East Benbecula and the Sound of Eriskay.
- **Inshore burrowed mud** – associated faunal communities can be sensitive to mobile gear. Known locations include Loch Seaforth, Loch Claidh and Loch Erisort, but likely to occur in other sea lochs. **Tall sea pens** are of particular conservation importance in this habitat, being rare in the UK and, unlike other sea pen species, unable to withdraw into the

[4] The SNH Priority Marine Features list is intended to focus future work on the conservation of marine species and habitats. Currently in draft form, this list will go to public consultation during 2010. Consequently, the list may change and require subsequent amendment to this document.
[5] SNH marine data is updated regularly, as should this information, forming part of the IFG Management Plan as a living document.

sediment. **Burrowing heart urchins** are also of conservation interest in this habitat; known to occur in Loch Roag, but likely to occur elsewhere.

- **Cold water coral reef** - comprised of the coral *Lophelia pertusa*, reefs occur east of Mingulay, being the only known to occur in UK inshore waters. Coral habitats support very high biodiversity and are very sensitive to physical disturbance.
- **Northern seafan communities** – seafans are very sensitive to physical disturbance and exist on rocky substrates supporting high biodiversity. Known locations are distributed mostly on the east coast of the Outer Hebrides, including Loch Seaforth, Loch Claidh, Loch Boisdale, Loch Skipport, Loch Uiskevagh, Loch Eport, East Loch Tarbert, Loch Erisort and Loch Eynort.
- **Intertidal sediment flats** – intertidal mudflats and sediment flats may be commercially exploited, particularly for various bivalves, but are also often of conservation importance. Intertidal sandflats and mudflats are widely distributed in the Outer Hebrides, but are particularly prominent features of the Uists and Barra.
- **Iceland cyprine** – *Arctica islandica* is a large, long-lived bivalve capable of inhabiting a wide range of sediment types and water depths. Records range from Vatersay Bay and Oitir Mhòr to Loch Erisort, Loch Seaforth, West Loch Roag, and in Village Bay (St Kilda).

The above is **not** a comprehensive list of species and habitats of conservation interest in the Outer Hebrides, but identifies some of the most important benthic features which are most relevant to fisheries and for which SNH has data. Others which are less likely to be impacted by fisheries, but are still worthy of note include **Shallow tideswept coarse sands with burrowing bivalves, Tideswept algal communities, Kelp and seaweed communities on sublittoral sediment** and **Low or variable salinity habitats.** Features which may be impacted by fisheries but for which data is limited include **Native oyster beds, Blue mussel beds, Heart cockle, White cluster anemone, Feather star and Burrowing sea anemone.** Further to those mentioned in sections 2 and 3, other unprotected **bird species** may be subject to direct or indirect impacts from fisheries operations. Also note that **fish and shellfish** species of conservation importance are not listed here.

**4.8.4.2 Seabed mapping resources.** Various projects have sought to compile existing data and use modelling techniques (and knowledge of physical environmental attributes) to fill gaps with predictive mapping of biotopes, habitats and dominant biota. These are available at various scales and resolutions. Such modelled data should be used with caution, being more accurate in some areas than others, but may provide a useful starting point in data deficient areas.

- **MESH** (www.searchmesh.net) maps broad habitat types over a very large area (to the EEZ of 5 countries in NW Europe), but at a limited resolution.

- **UKSeaMap 2006** (www.jncc.gov.uk/Default.aspx?page=2117) mapped marine landscape features at the scale of the UK marine area.

- **UKSeaMap 2010** (http://www.jncc.gov.uk/page-2117) will produce a new seabed habitat map for the UK marine area, building on the 2006 work and the MESH project.

- **HHOME** (Highland, Hebridean and Orkney Marine Environment) GIS project used modelling techniques on a similar scale and resolution to the SSMEI projects to refine predictive habitat and biotope maps within the Moray, Orkney, North Coast, North West, Outer Hebrides and Small Isles & Mull IFG areas. This GIS resource is held by SNH – example extracts from the Outer Hebrides IFG area are shown in Figures 1 & 2. SNH can provide more detailed extracts and interpretation of this information if required for particular areas.

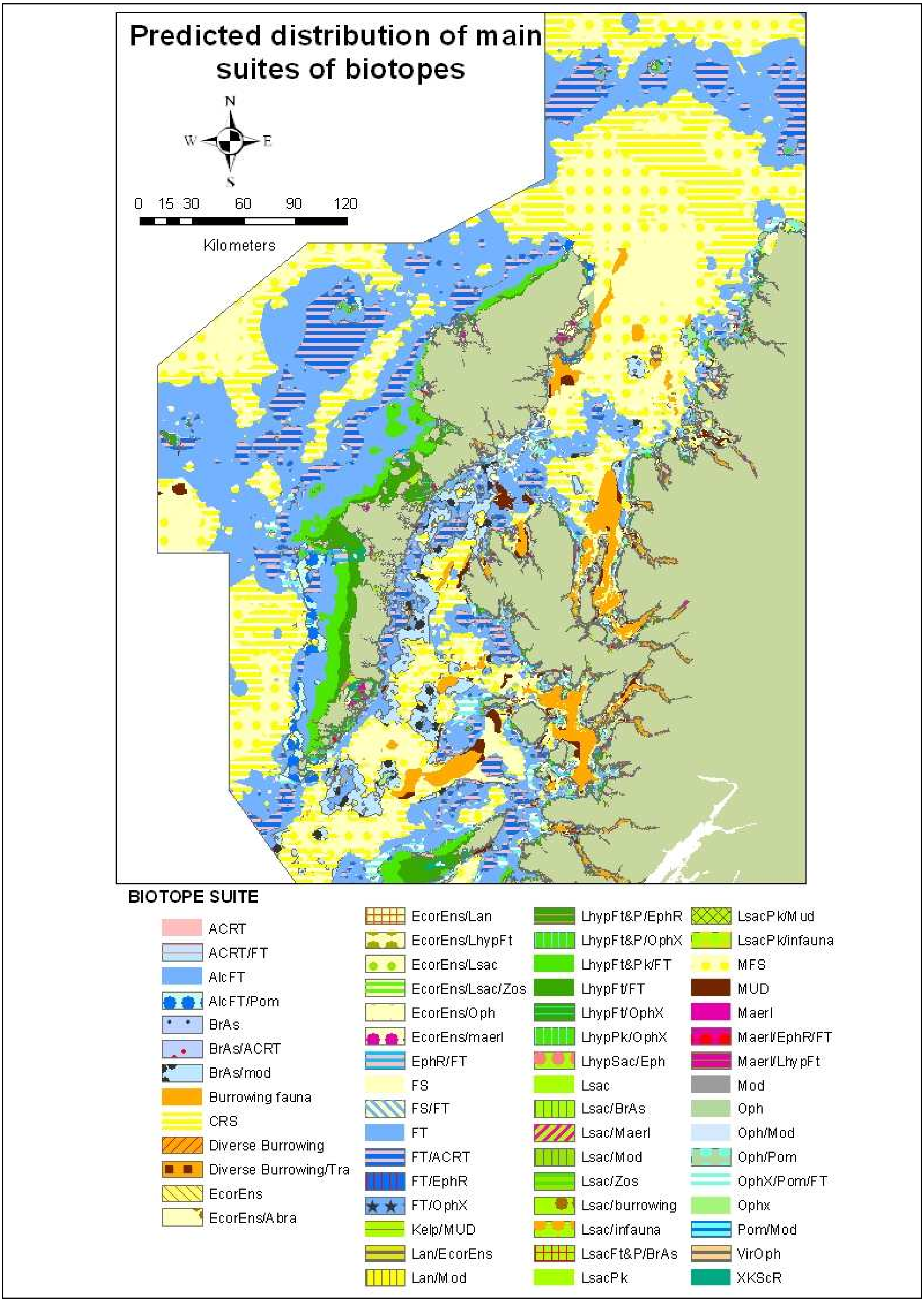



***Figure 1***: Predicted distribution of major biotopes in the Outer Hebrides IFG (and surrounding) Area. Where only substrate is shown, data was insufficient to predict biota with an acceptable degree of confidence.

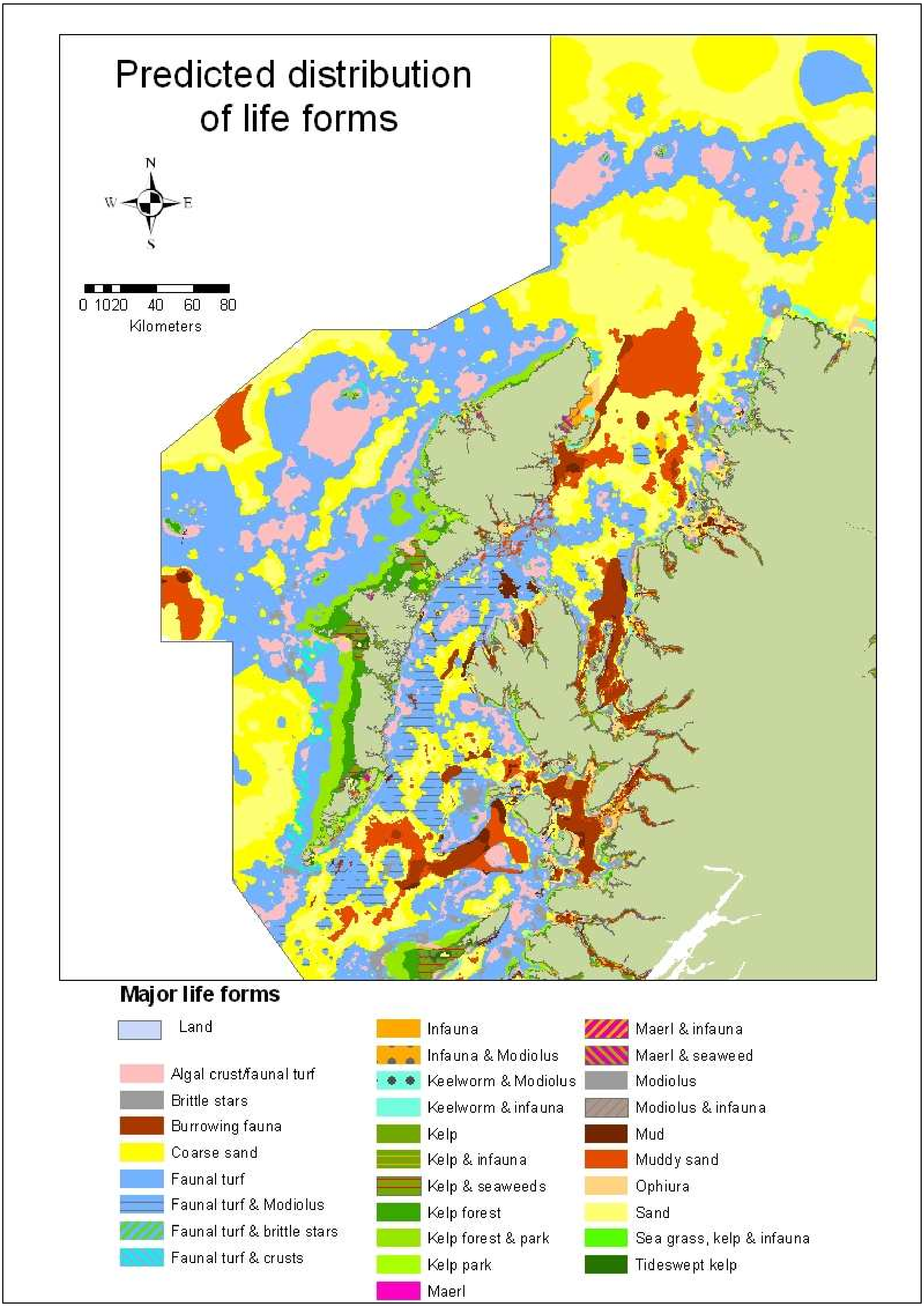



***Figure 2***: Predicted distribution of major life forms in the Outer Hebrides IFG (and surrounding) Area. Where only substrate is shown, data was insufficient to predict biota with an acceptable degree of confidence.

### 4.8.5 INVASIVE NON-NATIVE SPECIES

4.8.5.1 The introduction of non-native species can be a risk to some fisheries sectors by competing with native species, causing imbalance in natural food-webs or interfering with the operation or efficiency of fishing gear. Non-native species can thrive in a new environment where there is a lack of natural predators or competitors[6]. Vectors for the introduction of non-natives include ships ballast, fouled hulls and fishing gear or through the movement or release of live plants and animals. Fishermen may be in a good position to report on the presence of non-native species and to take action to reduce the risk of introducing non-native species. Table 5 provides specific information on risk species, identifies which may be a particular issue for the Outer Hebrides IFG area, possible consequences for fishing activities, actions to reduce risk of introduction and relevant links for more information and reporting sightings.

*Table 5*

| **Species** | **UK Status** | **Outer Hebrides likelihood of introduction*** | **Potential fisheries impacts** | **Other impacts** | **Actions to reduce risks** | **More information** |
|---|---|---|---|---|---|---|
| Wireweed | Well established in England, Wales & N Ireland. Found on west coast of Scotland as far north as Skye | High; Short-term | May inhibit oyster bed recovery. Entanglement in propellers and fishing gear | Competition with native species. Hazard to commercial and recreational boating through entanglement of propellers or blocking engine cooling systems | Keep boat hulls, buoys and pontoons clean.<br><br>Keep fishing gear clean | www.snh.org.uk/wireweed<br><br>www.nonnativespecies.org |
| Carpet sea squirt | Found in Wales, N Ireland & south coats of England. 1 population in Scotland (Firth of Clyde) | High; Long-term | Important nursery habitats (e.g. maerl) and some fishing grounds may be smothered. Static fishing gear may be smothered. | Smothers native species. Smothering of aquaculture equipment and other underwater structures e.g. pontoons | Keep boat hulls, buoys and pontoons clean. Keep fishing gear clean (allow to dry out periodically) | www.snh.org.uk/carpetseasquirt<br><br>http://woodshole.er.usgs.gov/project-pages/stellwagen/didemnum/ |
| Leathery sea squirt | Found in England, Wales, SW Scotland | Medium; Long-term | Fouling on hulls. Fouling of oyster and mussel beds | Competition with native species. A fouling pest on ships' hulls and oyster beds | | www.marlin.ac.uk/marine_aliens/species.asp?SpID=17 |

[6] Climate change also enables species to populate new areas; where existing species are unable to adapt at the rapidity of climate change the consequence of these distribution shifts may be similar to non-native introductions.

| | | | | | | |
|---|---|---|---|---|---|---|
| Slipper limpet | England and Wales. Not yet in Scotland | Medium; Long-term | Where attached to bivalves, additional processing costs for cleaning. Habitat loss for mussels and oysters. | Competition with native species. Causes increased sedimentation which smothers other species | Keep hulls clean.<br><br>Avoid relaying of shellfish from locations outwith Scotland. | www.nonnativespecies.org<br><br>www.marlin.ac.uk/speciesfullreview.php?speciesID=3086 |
| Chinese mitten crab | England and Wales. Not yet in Scotland | Low; Long-term | Juveniles inhabit estuaries, predating upon invertebrates & fish eggs, including commercial species. | Structural damage to riverbanks. Predation on native species Competition with native species | | www.nonnativespecies.org<br><br>www.marlin.ac.uk/marine_aliens/species.asp?SpID=19 |

*Time scales could be dramatically shortened if species are directly transported by

## 4.9 OTHER ACTIVITIES

### 4.9.1 MARINE RENEWABLES

4.9.1.1 The waters around the Outer Hebrides provide ideal conditions for significant development opportunities for offshore wind, wave and tidal power.

4.9.1.2 No short term developments have been identified around the Outer Hebrides, however, a number of areas have been earmarked for medium term (2020 – 2030) development.

Details of Marine Scotland's proposals for offshore wind can be viewed at:

http://www.scotland.gov.uk/Resource/Doc/346375/0115264.pdf

4.9.1.3 Most of the areas identified for possible future development are of significant importance to different sectors of the fishing industry and extensive consultation must be undertaken with the fishing industry to identify areas of least economic importance to the fishing industry.

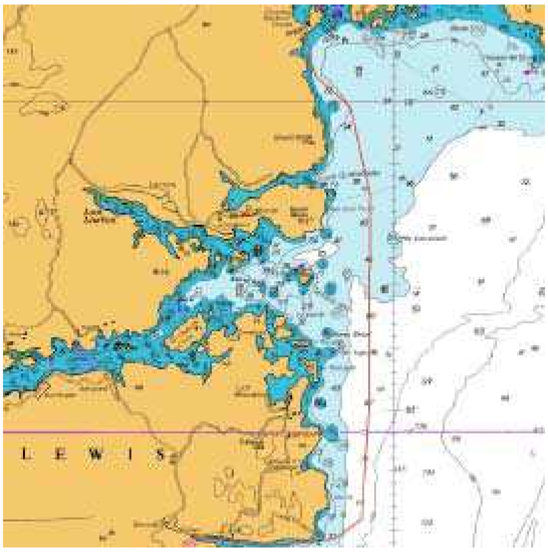
Details on Blue Sea – Green Energy post adoption statement can be viewed at:

**http://www.scotland.gov.uk/Resource/Doc/346131/0115201.pdf**

### 4.9.2 SCOTTISH AND SOUTHERN ENERGY

4.9.2.1 Scottish and Southern Energy are planning to install a 132kV Submarine Power Cable from Arnish to Grabhair during the summer of 2012. Following consultation with the local fishing industry , the Company agreed that the cable would be buried to a target depth of 1 m in all areas possible, throughout the route. Vessels operating in the area are satisfied that the proposed route will not have any negative impact on fishing operations in the area.

**ROUTE OF CABLE**




4.9.2.2 In addition, Scottish and Southern Energy propose to lay a subsea cable from Grabhair to Little Loch Broom, burying the cable to a depth of at least 1 m. Several meetings have been held with the local fishing industry and they are satisfied that the cable lying operation should have minimal impact on fishing activity. The cable will transfer electricity from the four proposed wind farms at 150 MW each for Beinn Mor and Stornoway Wind Farm Projects, a 138 MW for Pentand and a 94MW for Pairc to the mainland.

**4.9.3 NpOWER**

4.9.3.1 NpOWER renewables have been successful in a planning application for oscillating turbines in Shader Bay. The Scottish Government approved the project in January 2009. When developed and built, the Siadar Wave Energy Project will be one of the first wave power stations in the world, providing up to 4MW and could provide electricity to 1800 homes in Lewis and Harris. The local community are very supportive of this development. The fishing industry did not raise any concerns regarding this project.

**4.9.4 AQUAMARINE POWER**

4.9.4.1 Aquamarine Power have been granted a lease from Crown Estate to develop a 40MW project using 40 Oyster wave machines, in the area between Carloway and Galson, off the West of Lewis. The Company has already met with local fishermen fishing in that area to explain their proposals. An Environmental Impact Assessment will be undertaken in 2011. The first 3 structures should be on site in 2014.

Further information about North West Lewis project can be viewed at:

http://www.aquamarinepower.com/projects/north-west-lewis/

### 4.9.5 PELAMIS WAVE POWER

4.9.5.1 Pelamis Wave Power are proposing to develop a 20MW capacity wave farm project off Lewis. The location would be in water depths of 50 metres or more East of the Old Hill directly out from the entrance to East Loch Roag. This location has been shifted further East to reflect concerns raised with their initial location which coincided with white fish trawl grounds.

4.9.5.2 An area of 2 kms would be occupied by a 20 MW farm. The identified area is currently fished by static gear boats fishing pots for lobster and brown crab. Up to 25 Pelamis wave energy converters would be required, with several machines joined together to share a single subsea cable back to shore. The Company intends to have more finalised plans drawn up by end of summer with a target date of 2015 for installation of first machines.

### .4.9.6 OUTER HEBRIDES REGIONAL INITIATIVE

4.9.6.1 In March 2009, CNES,0 established a Marine Energy Zone Steering Group to progress the outputs from the Halcrow Study relating to future development of marine renewables around the Western Isles. At a meeting with the Scottish Government (Marine Spatial Planning) in May 2009, it was agreed that the Outer Hebrides should become the second Scottish Government Regional Initiative, after Pentland Firth and Orkney waters.

4.9.6.2 As part of the Outer Hebrides Regional Initiative, a Project Board was formed and will engage with fishing interests to ensure that the development zone put in place is compatible with fishing and navigational interests and other sea users.

4.9.6.3 The Outer Hebrides Regional Initiative Project Board is comprised of Member Organisations as follows:

Scottish Government

The Crown Estate

Comhairle Nan Eilean Siar

Highlands and Islands Enterprise

Scottish Natural Heritage

Scottish Marine Renewables

Marine Coastguard Agency

EMEC

Outer Hebrides Inshore Fisheries Group

4.9.6.4 Feedback from all meetings will be circulated amongst all members of the Executive Committee and the Advisory Group and this will ensure that the OHIFG is fully consulted with on all matters relating to future developments of marine renewables within the area.

## 4.10 AQUACULTURE

4.10.1 Salmon farming had played an important role in the Outer Hebrides economy for over 30 years. The industry is now mostly concentrated in the hands of three large Salmon Producers with one large processing unit in Stornoway and two smoking units in Uist. Most of the salmon grown in the Outer Hebrides are transported to the mainland for further processing.

4.10.2 Recent expansion has been in deeper and more exposed sites, in the Minches, with Marine Harvest investigating expansion of more sites off South Uist and Barra.

4.10.3 Concern has been expressed by fishermen, in some sheltered sea lochs of the Outer Hebrides, that chemicals used for sea lice treatments could be impacting on shellfish recruitment at locations in close proximity to salmon cages.

4.10.4 Mussel farming has grown steadily in Loch Roag, East of Lewis and Harris, providing employment in more remote areas. Proposals for significant mussel farming developments in the Uists have had EFF approval and production is scheduled to commence there in 2011.

## 5. OBJECTIVES

### 5.1 INTRODUCTION

5.1.1 The Outer Hebrides Inshore Fisheries Group (OHIFG) management plan includes local objectives aimed at ensuring well managed, profitable and sustainable inshore fisheries in the IFG area.

5.1.2 The local objectives were developed by the OHIFG ExCom within the Strategic Framework for Inshore Fisheries in Scotland, developed by the Scottish Inshore Fisheries Advisory Group (SIFAG) and published in 2005.

http://www.scotland.gov.uk/resource/doc/149129/0039637.pdf

5.1.3 They have been formulated to be consistent with existing national and UK legislation and ongoing management initiatives including the Scottish Fisheries Council (SFC) Groups

5.1.4 All the local objectives have been assessed against the High Level Objectives (HLOs), developed by SIFAG and set out in the Strategic Framework, to ensure that they are consistent with or contribute to the HLOs Some of the local objectives support more than one HLO.

### 5.2 HIGH LEVEL OBJECTIVES

The High Level Objectives set out in the Strategic Framework for Inshore Fisheries area as follows:

**BIOLOGICAL**: to conserve, enhance and restore commercial stocks in the inshore and its supporting ecosystem.

**ECONOMIC**: to optimise long-term and sustained economic return to communities dependent on inshore fisheries, and to promote quality initiatives.

**ENVIRONMENTAL**: to maintain and restore the quality of the inshore marine environment for fisheries and for wildlife.

**SOCIAL**: to recognise historical fishing practices and traditional ways of life in managing inshore fisheries, to manage change, and to interact proactively with other activities in the marine environment.

**GOVERNANCE**: to develop and implement a transparent, accountable and flexible management structure that places fishermen at the centre of the decision-making process, and that is underpinned by adequate information, legislation and enforcement.

5.2.1 An overview of the OHIFG local objectives and rationale, aligned with SIFAG HLOs is presented in Table 1 below. The fisheries or issues addressed in the Plan, the measures proposed, information requirements, partners and resources required, are summarised in Table 2. More detail and supporting information is presented in Section 6.

| High Level Objectives | Local Objectives and Rationale |
|---|---|
| **Biological:**<br>To conserve, enhance and restore commercial stocks in the inshore and its supporting ecosystem. | **Improve management of creel fisheries/propose additional conservation measures for key fisheries**<br>Effort in all creel fisheries is effectively uncontrolled, indications are that target stocks are fully or overexploited. Some form of effort cap in creel fisheries, and in some instances a reduction in effort, is therefore a priority.<br>**Assist industry in developing new sustainable fisheries**<br>New fisheries have the potential to diversify existing fishing effort and create new employment opportunities. A diverse sector is more flexible and able to respond to changes in availability, market price and demand for particular products. |
| **Economic:**<br>To optimise long-term and sustained economic return to communities dependent on inshore fisheries, and to promote quality initiatives. | **Encourage the fishing sector to 'catch for the market'.**<br>**Assist the industry in implementing cost reduction measures.**<br>A sustainable industry must be profitable. Improved profitability for the sector is likely to come from maximising the value of the catch and reducing costs.<br>**Provide marketing support to current and developing fisheries.** |
| **Environmental:**<br>To maintain and restore the quality of the inshore marine environment for fisheries and for wildlife. | **Reduce fishing's impact on the environment, particularly sensitive species and habitat**<br>All fisheries should integrate with wider marine management, including the management of designated nature conservation sites.<br>**Develop more selective catching practices to reduce unwanted catch of target and non-target species.**<br>Fishing method and gear design should be adapted to support measures to reduce any negative environmental impacts associated with fishing. |
| **Social:**<br>To recognise historical fishing practices and traditional ways of life in managing inshore fisheries, to manage change, and to interact proactively with other activities in the marine environment. | **Provide advice, training and facilitate access to available funding for fishermen**<br>Support training, access to funding, group purchasing agreements to reduce key costs such as fuel and gear.<br>**Encourage new entrants into the fishing industry at a sustainable level.**<br>**Promote appropriate engagement with all other marine stakeholders to ensure fisheries issues are fully integrated with wider decision-making on the marine environment** |

| | |
|---|---|
| **Governance:**<br>To develop and implement a transparent, accountable and flexible management structure that places fishermen at the centre of the decision-making process, and that is underpinned by adequate information, legislation and enforcement. | **Improve decision-making and reduce conflict in the sector and between other marine sectors**<br>Decision-making in fisheries management to be improved through agreed actions, developing access arrangements for all users. |

## Table 1 - local objectives and rationale, aligned with SIFAG HLOs

| Biological – Conserve, enhance and restore commercial stocks | | | | | | |
|---|---|---|---|---|---|---|
| **Local Objective: Improve management of creel fishing effort in the Outer Hebrides Inshore Fisheries Group Area** | | | | | | |
| | **Fishery** | **Status (2010) and Management Advice?** | **Measures / actions proposed** | **Information requirements** | **Partners** | **Resources needed** |
| **1.1** | Nephrops Creel | ICES 2010. Advice is for a reduction in fishing mortality towards $F_{MSY}$ (proxy) in both North and South Minch. Implies landings of less than 3100 tonnes (North Minch) and <4,000 tonnes (South Minch) in 2011.<br><br>ICES notes i) management should be at functional unit level. ii) Overall effort in creel numbers is not known and measures to regulate creel fisheries are not in place | Limit creel numbers by vessel length<br>‹ 8 metre 600 – verified crew of 2 limit 800<br>8-10 metre 1,000 – verified crew of 3 1,200<br>10-12 metre 1,200 verified crew of 3 1,500<br>›12 metre 1,800 | See MS-SCI Report. Information on numbers of creels and catch per unit effort (CPUE) data (log book scheme).<br>Numbers of vessels fishing in the area | Marine Scotland<br>SFC Langoustine working group, | MS-Compliance<br>Industry self policing.<br>Creel tagging system<br>Logbook costs |
| | *Nephrops* Creel | | Evaluate effects of creel mesh size and escape panel on creel catch composition | Detailed in SISP application | Marine Scotland<br>SFC Langoustine working group,<br>Other IFGs | SISP |

| | | | | | | |
|---|---|---|---|---|---|---|
| **1.2** | Brown Crab | MS-Sci Brown crab fishing mortality close to $F_{MAX}$ (2006-2008). No increase in effort | Limit creel numbers by vessel length and 50% max number being parlours.<br>‹ 8 metre 600 – verified crew of 2 limit 800<br>8-10 metre 1,000 – verified crew of 3 limit 1,200<br>10-12 metre 1,200 verified crew of 3 limit 1,500<br>12-15 metre 1,800<br>›15metre2,000<br>Increase MLS to 150mm | See MS-SCI report<br>Develop logbook scheme | Marine Scotland, SFC Crab and lobster working group | MS-Compliance<br>Industry self policing.<br>Tagging system<br>Logbook costs |
| **1.3** | Lobster | Male lobsters growth overfished, females fished close to $F_{MAX}$ | Limit creel numbers same as for crab<br>Phased increase in MLS.<br>Reduction in maxLS for females. Ban on landing crippled females | See MS-SCI report<br>Develop logbook scheme | Marine Scotland, SFC Crab and Lobster working group | MS-Compliance<br>Industry self policing.<br>Tagging system<br>Logbook costs |
| **1.4** | Velvet crab | Fished close to $F_{MAX}$ | Limit creel numbers by vessel length same as for crab and lobster<br>Encourage improved grading practices | See MS-SCI report | Marine Scotland, SFC Crab and lobster working group. Seafish | Leaflet distribution of good practice procedures |
| **Local objective: Propose additional conservation measures for key fisheries** | | | | | | |
| **#** | **Fishery** | **Status (2010)** | **Measures proposed/actions** | **Information requirements** | **Partners** | **Resources needed** |
| **1.5** | Nephrops trawl | As in 1.1. | Increase MLS to 25 mm carapace length 85 mm overall length to correspond with North Sea MLS | Size data from buyers | Marine Scotland<br>SFC Langoustine working group.<br>Other IFGs | Link in with National Policy development |
| **1.6** | Scallops | MS-SCI. Spawning stock biomass and recruitment declining. Fishing mortality (F) above $F_{0.1}$<br>No increase in effort and increase in | Increase from 100 mm to 105 mm | See MS-SCI report | Marine Scotland, Scallop working group | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | MLS to 110 mm to increase chances of improved recruitment. | | | | |
| **1.7** | Crawfish | Stock status unknown | Prohibit landing of berried females and introduce max landing size males and females | Initiate programme of data collection | MS-C, Industry, Buyers | Logbook design |

| **Local objective: Assist industry in developing new sustainable fisheries** | | | | | | |
|---|---|---|---|---|---|---|
| | **Fishery** | **Status Marine Scotland Science and others** | **Measures proposed** | **Information requirements** | **Partners** | **Resources needed** |
| 1.8 | Cockles | Info from surveys of Cockle beds at Barra (1970, 1974, 1993, and 2008)<br>Traigh Leathann, Baleshare, North Ford, Vallay, Traigh Ear, Vallaquie (1993,2000 and 2010)<br><br>Luskentyre, Tong 2000,2010 | Establish Cockle Sub Group to develop sustainable plans for the fishery. Introduction of precautionary MLS of 30 mm. Seek water classification for areas surveyed. Commission new survey of grounds at Barra.Surveys completed for beds in Lewis, Harris and Uist in 2010 | Cockle biomass estimates.<br>Advice on sustainable harvesting levels and methods consistent with sea bird requirements? | SNH,CNES, HIE, FSA, Seafood Scotland, MS-S,MS-C, MS-P | HIE, CNES, SNH funded stock survey |
| 1.9 | Razorfish | Surveys in Broad Bay, Grimsay Loch Carnan (1998) | Obtain guidance on distribution and sustainable harvesting levels and methods | Stock surveys. Fishery and management advice. Good practice from other areas | Seafish, MS-SCI, SNH | EFF, CNES, HIE, SNH |
| 1.10 | Brown shrimp | Not assessed | Identify vessels to participate in a pilot fishery Investigate markets | Identify scale and marketing requirements of this fishery. | MS-S Seafood Scotland, HIE, CNES, LEADER | Funding for pilot Fishery (gear, expertise, etc.) |
| 1.11 | Squid | Not assessed | Seek review of current prohibition on use of small trawl mesh west of Scotland | Identify scale and marketing requirements of this fishery. Previous work by Seafish and Aberdeen University | MS-S, Seafood Scotland, HIE , CNES | Suitable gear for vessels |
| 1.12 | Mackerel | ICES - Fished at $F_{PA}$ but above $F_{MSY.}$ Transition to MSY implies landings of between 592 and | Investigate establishing small-scale mackerel and herring fishery using lines and drift nets | Consider a maximum number of vessels. Potential | Marine Scotland Policy, CNES, | Quota for inshore Sector. Market |

| | | | | | | |
|---|---|---|---|---|---|---|
| 1.13 | Herring in Division Via North | 672K tonnes in 2011. Via North Herring fished below $F_{MSY}$. Management Plan (F0.25) advises landings of 22,481t in 2011 | Investigate means of obtaining additional quota through existing quota management system | marketing channels for local produce | Seafood Scotland, Pelagic Sector | development support |

| **Economic -** Optimise long-term and sustained economic return to communities dependent on inshore fisheries, and to promote quality initiatives. | | | | | |
|---|---|---|---|---|---|
| **Local objective: Provide marketing support to current and developing fisheries** | | | | | |
| **#** | **Fishery** | **Measures proposed** | **Information requirements** | **Partners** | **Resources needed** |
| 2.1 | All | Responsible Fishing Scheme environmental aspects to be included | | Seafish, GTA | Funding for assessment process |
| 2.2 | All | Branding of locally produced seafood | Support to private companies 'own brand' development or joint marketing | CNES, HIE | Market research project |
| **Local objective: Encourage 'catching for the market'** | | | | | |
| **#** | **Fishery** | **Measures proposed** | **Information requirements** | **Partners** | **Resources needed** |
| 2.3 | Nephrops creel | Increase creel caught min landing size to 32 mm carapace length | SISP Project | MS-S, MS-C WIFA, Buyers<br>SFC Langoustine WG | SISP |
| 2.4 | Nephrops Trawl | Increase min tail size to 45 mm in trawl fishery | Impact on fleets, enforceability, | MS,<br>SFC Langoustine working group,<br>Seafish | Link in with national policy developments |
| 2.5 | Scallop | increase MLS to 105 mm | Impact on fleets, enforceability, extension to other IFGs | MS, Scallop working group | |
| 2.6 | Crab | Increase MLS size to 150 mm (brown crab) and 70 mm (velvet crab) | | MS | |
| 2.7 | Lobster | Phased Increase Min. LS to 90 mm<br>Decrease Max.LS to 145 mm & ban landing of crippled females | | MS | |

| **Local objective: Assist the industry in cost reductions** | | | | | |
|---|---|---|---|---|---|
| 2.8 | Fuel | Support fuel efficiency, gear adaptation measures. | Explore all fuel efficiency measures including gear adaptations, bulk purchasing, alternative fuel e.g. hydrogen | MS, CNES, Seafish,. LCC | EFF |

| **Environmental** To maintain and restore the quality of the inshore marine environment for fisheries and for wildlife | | | | | |
|---|---|---|---|---|---|
| **Local objective: Reduce impact of fishing on the marine environment & develop more selective gear** | | | | | |
| **#** | **Fishery** | **Measures proposed** | **Information requirements** | **Partners** | **Resources needed** |
| 3.1 | Nephrop Traw; | Apply for extension of Stornoway Nephrops Trawl fishery MSC Accreditation | Already achieved for North Minch trawl fishery | MS-S, MSC, WIFA, SNH, Industry | Funding for assessment process |
| 3.2 | All | Review existing fishing prohibitions | | MSC, MSS,MSP, SNH | |
| 3.3 | Nephrops Creel | Use mesh sizes, which reduce discards and by-catch and select nephrops at sizes required by the market. | SISP gear trials - quarterly monitoring by observer over a year period | MS-Science, WIFA | SISP |
| 3.4 | Scallop | Promote use of eco – dredge<br>UK Scallop Code of Conduct | Evaluate research on gear design | Marine Scotland, Seafish<br>All stakeholders | Trialling of gear In commercial environment |

| **Social -** to recognise historical fishing practices and traditional ways of life, to manage change, and to interact proactively with other activities in the marine environment | | | | | |
|---|---|---|---|---|---|
| **Local objective: Provide advice, training and facilitate access to available funding for fishermen** | | | | | |
| **#** | **Issue** | **Measures proposed** | **Information requirements** | **Partners** | **Resources needed** |
| 4.1 | Credit | Ensure necessary levels of access to credit for fisheries sector | Impact that credit arrangements are having on the sector. State aid compliant | CNES, Banks, HIE, Marine Scotland, Seafish Economics | CNES, HIE, Banks |
| 4.2 | Fuel | Support fuel efficiency measures, assistance with engine improvements, bulk purchasing | Explore all fuel efficiency measures, fishing practices, engine replacements | CNES,MS, HIE, Seafish Tehnology | EFF, CNES, MS, HIE |
| 4.3 | Gear | Facilitate access to available funding support for new gear for pilot fisheries or gear adaptations for conservation purposes. | New pot design, lining, jigging, eco-friendly gear | MS, CNES, HIE, SNH, Seafish Technology | EFF, MS, HIE, CNES. SNH |
| 4.4 | Training | Marketing and handling practices for current and new fisheries, recognised qualifications for inshore skippers | Access to new markets, local delivery of training to Nationally recognised standards | MS, Seafish, GTA, CNES, HIE, SDS, Seafood Scotland, LCC | EFF, MS, Seafish |
| **Local objective: Encourage new entrants into the fishing industry at a sustainable level** | | | | | |
| **#** | **Issue** | **Measures proposed** | **Information requirements** | **Partners** | **Resources needed** |
| 4.5 | Recruitment | Develop Outer Hebrides Fisheries Support Scheme & Community Quota Scheme | Compliant with State Aid Rules<br>Promotion in schools | MS, CNES, Banks, HIE, WIFA, LCC, Schools | CNES, HIE, EFF |

| | Issue | Action proposed | Partners | Resources needed |
|---|---|---|---|---|
| **Governance –** improved decision making and engagement between fisheries interests, with agencies and with other sectors | | | | |
| **Local objective: Improve decision-making and reduce conflict in the sector and between other marine sectors** | | | | |
| | **Issue** | **Action proposed** | **Partners** | **Resources needed** |
| 5.1 | Decision making | Establish a conflict resolution procedure and determine appropriate actions for those found not fishing according to IFG agreements<br>Non consensus issues referred to SIFAG | ExCom, AG, MS-Compliance, SIFAG | |
| 5.2 | | Review access arrangements in all fisheries | ExCom, AG, SFPA | Distribution network to all users |
| 5.3 | Engagement | Develop process and contacts for effective regular consultation with Marine Scotland and other government departments and agencies | Marine Scotland (and others) | |
| 5.4 | | Develop process for engagement with marine developers, aquaculture, renewables | CNES, ExCom, AG | |
| 5.5 | | IFG membership of Scottish Marine Regions | Nominated IFG member | Time, T&S |
| 5.6 | Monitoring | Review and reporting of progress in applying management measures to achieve objectives. | IFG co-ordinator, MS | Production of Annual report / attendance at national IFG meetings. |
| 5.7 | Information and communication | Develop a website for the IFG with access to useful documentation (plan, constitution, minutes, and background on industry), contacts & potentially marketing info. | IFG co-ordinator, CNES, HIE, , Seafood Scotland, MS | Budget/staff resources from Marine Scotland |

**Table 2 - Summary of fisheries issues, proposed measures, information requirements, partners and required resources**

## 6. MANAGEMENT MEASURES

### 6.1 *NEPHROPS* CREEL *FISHERY*

### ICES Assessment and Advice

6.1.1 *Nephrops* stocks west of Scotland (VIa) are managed under the Common Fisheries Policy (CFP) by the European Commission. Management advice, formulated by the International Council for the Exploration of the Sea (ICES) on the basis of underwater TV surveys estimates of abundance, is for individual functional units whereas the Total Allowable Catches (TACs) are applied to the larger ICES finfish areas. The 2010 TAC for Area VIa, which includes the North Minch, the South Minch and Clyde functional units was 16,057 tonnes (UK share 15,677 tonnes), 15% less than that in 2009. The North and South Minch functional units are most relevant to the Outer Hebrides IFG area.

6.1.2 There are no precautionary reference points for *Nephrops* stocks or any formally agreed management objectives or plans. Under the ICES MSY (maximum sustainable yield) framework, which was adopted in 2010, exploitation rates which generate high long term yield with a low probability of over fishing have been estimated and proposed for each functional unit. It is not possible to estimate $F_{MSY}$ for *Nephrops* directly, therefore ICES use a series of $F_{MSY}$ proxies. The most appropriate proxy for each functional unit is selected on the basis of a number of factors including burrow density, harvest rate, stability of stock size and nature of the fishery. In general, $F_{35\%SpR}$[7] is used as a proxy for $F_{MSY}$.

6.1.3 ICES advice in 2010 indicates that *Nephrops* stocks in both the North and South Minch are stable but at lower levels than observed between 2003 and 2006. Based on the transition approach to MSY, ICES recommended a reduction in harvest ratio to 20.1%, with landings of no greater than 3,100 tonnes in the North Minch and a harvest ratio of 12.9% and landing of less than 4,000 tonnes in the South Minch in 2011. These imply lower landings than have been taken in recent years.

6.1.4 ICES note that abundance in the North and South Minch should be considered a minimum estimate as fishing takes place outside the area covered by the underwater TV survey. Also, that overall effort in terms of creel numbers is not known and measures to regulate the fishery are not in place.

### The Fishery

6.1.5 The *Nephrops* creel fishery developed in the Outer Hebrides IFG area around 25 years ago. Initially, it was a seasonal fishery, mainly between January and April, after which vessels targeted lobster and brown crab. The

[7] ($F_{35\%SpR}$ is the fishing mortality associated with 35% of the spawning stock biomass per recruit when F=0. ie in the unexploited state.)

fishery has since expanded considerably, stimulated by the premium prices paid for whole live prawns.

6.1.6 The value of landings of creel caught *Nephrops* into the Outer Hebrides peaked in 2005 but has since declined, despite significant increases in effort in terms of both vessel numbers and number of creels. The fishery is still however the most important by value in the area. Landings from the OHIFG area of 420 tonnes in 2009 were valued at £3.339 M selling at an average price of £7,950 per tonne.

6.1.7 It is estimated that there are currently up to 80 creel vessels fishing for *Nephrops* using around 100,000 creels in the OHIFG area. Some fish in the area all year round whilst others operate on a seasonal basis. The numbers of creels per vessel have increased dramatically, from around 200 when the fishery first developed to over 4,000 for some vessels. Many vessels have two sets of gear, which are hauled every second or third day. According to fishermen, the sizes of creel caught *Nephrops* have decreased, in the last five years and the catch per unit effort has declined. Many vessels have increased the numbers of creels fished in an attempt to maintain previous catches.

6.1.8 *Nephrops* grounds are at a premium as vessels compete for the most lucrative and productive grounds. In some cases, creel vessels now fish on recognised trawl tows increasing likelihood of interaction with trawlers. Competition for suitable grounds for creeling also means that static vessels shoot gear over one another.

6.1.9 The issue of increasing creel numbers has been raised at the Scottish Fisheries Council (SFC) Langoustine Implementation Group and at its predecessor, SeaFAR. A consultation paper was issued in 2005 proposing the introduction of a *nephrops* permit scheme for under 10 metre and non sector vessels and for creel limits based on overall vessel length. Despite widespread industry support, no action was taken on either and additional vessels and additional creels have since joined the fishery.

6.1.10 There are no regulations relating to minimum mesh sizes in the *Nephrops* creel fishery, with traditional mesh sizes ranging from 32 – 36 mm. There are regulations which prohibit parlours in creels with a mesh size smaller than 60 mm. Fishermen using mesh sizes between 32 and 36 mm, report significant discards (up to 50%) of undersized or small prawns (smaller than those required for the live market), and variable discards of other species that are returned to the sea. Many of the *Nephrops* discarded are eaten on the surface by sea birds. The remainder may not survive return to the seabed. From a stock conservation perspective, it would be better if these were not caught in the first place. The Scottish Industry Science Partnership (SISP) has approved a project to investigate the issues raised in the local fishery and the SISP application form is at **Appendix 4.**

6.1.11 Current minimum landings sizes for *Nephrops* west of Scotland are total length of 70 mm or carapace length of 20 mm. This applies to both the creel and the trawl fishery. The trawl fishery supplies, a tail or fresh whole or frozen market, whereas virtually all creel caught *Nephrops* are sold to the live market, mostly in Spain, which requires animals of 110 mm overall length or 32 mm carapace length or over.

**ISSUES**

6.1.12 The *Nephrops* creel fishery is the most valuable fishery in the Outer Hebrides and supports employment in the most fragile areas of the region. The uncontrolled increase in creel vessels in the under 10 metre sector, coupled with uncontrolled numbers of creels deployed is of serious concern to the future management of this important and valuable fishery. TACs and quota limits on quantities landed apply over the wider stock area, are more relevant to trawlers and are not generally restrictive of landings in the creel fishery. The introduction of measures to monitor and control fishing effort (mortality) in the creel fishery is therefore a priority.

6.1.13 In addition, the current *Nephrops* minimum landing sizes were set before the creel fishery developed and relate to a trawl fishery supplying a mainly *Nephrops* tail, fresh and frozen market. The creel fishery supplies *Nephrops* to live markets that require larger sized *Nephrops*, it is therefore considered that a a different landing size should be set to reflect market demand. In addition, more selective gears, designed to catch the sizes of nephrops required by the live market should be evaluated

6.1.14 Currently,very little information is available to indicate the state of the stocks on creel fishing grounds within the IFG area. The increase in static gear being set on the grounds for lower returns suggests that abundance has declined. A suitable logbook to monitor the catch per unit effort in the *Nephrop* creel fishery is urgently required to assist with the evaluation of effects of the management measures proposed for the fishery.

**OBJECTIVE**

Improved management of the *Nephrops* creel fishery - introduce fishing effort control, evaluate/introduce additional management measures.

**MANAGEMENT MEASURES and ACTIONS PROPOSED**

**6.1.15 Creel limits - maximum number based on vessel overall length**:

- ‹ 8 metre – 600 creels verified crew of 2 limit 800
- 8 – 10 metres - 1,000 creels verified crew of 3 limit 1,200
- 10 – 12 metres – 1,200 creels verified crew of 3 limit 1,500
- › 12 metres – 1,500 creels verified crew of 3+ limit 1,800

***Contribution to SIFAG HLOs***

Biological: creel limits offer the potential to control fishing effort in a locally important and expanding fishery which is currently effectively uncontrolled. It is anticipated that introduction of the limits specified above will reduce fishing effort

Social: limits proposed allow proportionate capacity to fishery related to vessel size and crew number

Environmental: reduced effort will reduce any associated impact on seabed

Economic: potential to increase in price due to lower landings. Reduction in operating costs as CPUE would increase. Ability to manage effort would support accreditation and may bring market benefits

Governance: reduced creel numbers should/will reduce conflict, competition for space

#### 6.1.15 Evaluate effects of creel mesh size increase and escape panels

***Contribution to SIFAG HLOs***

Biological & Environmental: Improved selection will reduce discards, any decreased retention of berried females has the potential to improve spawning potential and increase recruitment

Economic: consistent with catching for the market - may reduce returns from the fishery initially but improved value at a later date

Governance: easily enforced through creel manufacturers

#### 6.1.16 Increase in minimum landing size in the creel fishery

***Contribution to SIFAG HLOs***

Biological & Environmental: has the potential to preserve spawning stock and may improve recruitment assuming discards survive.

Economic: catching for the market improved value at later date

Governance: easy to enforce

#### 6.1.17 Develop fit for purpose logbook to monitor effort and calculate CPUE

***Contribution to SIFAG HLOs***

Biological & Environmental: relevant to improved management and evaluation of measures introduced

Economic: Information would support fishery accreditation, which could bring market benefits

## 6.2 BROWN CRAB FISHERY

### Marine Scotland Science - Assessment and Advice

6.2.1 Marine Scotland science uses length cohort analysis (LCA) to assess brown crab *(or crab and lobster*) stocks around Scotland. Assessments are done tri-annually on a regional basis, and are based on reported landings data and size data (carapace width or length) collected as part of MS-S market sampling programme.

6.2.2 The LCA method uses the commercial catch size composition data (size frequency) along with estimates of growth parameters and natural mortality to estimate stock biomass and fishing mortality at length. Because of differences in growth males and females are stocks are assessed separately. The key assumption of the approach is that the length distribution is representative of a typical cohort over its lifespan. However, this is only true of length frequency data from a single year if the population is in equilibrium and therefore the LCA is usually applied to data averaged over a number of years during which recruitment and exploitation rates have been stable. LCA also assumes uniform growth among all animals.

6.2.3 The results can be used to predict long-term (equilibrium) changes in the stock biomass and yield-per-recruit based on changes in mortality, fishing effort or size regulations. Assuming a direct relationship between fishing mortality and effort, lower levels of fishing effort will result in an increase in stock size and a reduction in landings. A higher level of effort will reduce total stock biomass but landings may also fall, as animals are caught before they may have time to grow to a size that would contribute much weight to the yield (growth overfishing). In between these lies $F_{MAX}$, the fishing mortality rate that maximises yield per recruit.

6.2.4 The changes that the LCA predict are long term (equilibrium). The approach gives an indication of the exploitation of the stock in terms of growth overfishing, but not recruitment overfishing; it does not provide any indication of short term stock dynamics or recruitment over-fishing. It is therefore best to interpret the LCA analyses in conjunction with other information such as catch rate (CPUE) data. This is because if the stock is not in equilibrium, if for example recruitment is decreasing and fewer small individuals are entering the stock, the stock may appear healthy as the size of those individuals being removed increases.

6.2.5 MS-S most recent assessment for brown crab in the Hebrides region, which corresponds quite closely to the OHIFG area, based on data from 2006 – 2008, indicates males and females were fished close to $F_{MAX}$, the fishing mortality that maximises the yield-per recruit. An increase in fishing mortality could potentially reduce the biomass and the yield per recruit in the long term.

6.2.6 The brown crab fishery is not subject to EU TAC regulations or national quotas although there are EU measures in place to restrict the fishing effort (kW days) of all vessels > 15 m (including creel boats) in ICES Sub area VI. In Scotland, vessels landing brown crab are required to have a licence with a shellfish entitlement. Vessels without this entitlement are only allowed to land limited amounts (25 crabs per day). The main regulatory mechanism is a minimum landing size of 140 mm carapace width (CW) to the north of 56 $^{o}$N and 130 mm CW to the south of 56 $^{o}$N (except for the Firth of Forth).

6.2.7 In addition, it is illegal to land female egg-bearing edible crabs, or crabs that have recently moulted (The Sea Fisheries (Shellfish) Act 1967). Landings of crab claws (detached) are restricted to 1 % of total catch when fishing with pots or creels, or 75 kg if they are by-catch from another fishery (Article 18(4) of Council Regulation (EC) No 850/98).

6.2.8 There are no existing management plans, targets limits or reference points or limit reference points for brown crab.

**The Fishery**

6.2.9 The brown crab fishery in the OH IFG area developed in the mid seventies by a fleet of nomadic vivier vessels from the Channel Isles, selling their catch to the live market. Local vessels started to target the fishery in the early eighties supplying both live and processing markets. The biggest problem experienced in the early years was high levels of poor quality black spotted crab.

6.2.10 Since 2005, landings into the Outer Hebrides have ranged from 611 – 988 tonnes. However, vivier vessel catches from the IFG area and landed elsewhere are significant. Currently, up to 12 large vivier crabbers target the more offshore ground of North Rona, Sula Sgeir, Flannans, and St Kilda. These vessels land into Mallaig, Uig, Ullapool, Scrabster and Orkney. A further 60 local vessels, mostly under 10 metres, fish for brown crab along with lobster, landing their catch to either the processed or live market depending on season and meat yield. Frozen fresh bait is usually sourced from the mainland.

6.2.11 Despite several attempts to establish crab processing locally, only limited processing takes place in Uist, with the remainder of landings are sold live to the export market. The brown crab caught at North Rona and Sula Sgeir is processed in Orkney. Brown crab quality tends to vary considerably throughout the year and some processors buy most of their stock over a 3 to 4 month period in the late autumn.

6.2.12 Over the last 5 -10 years, there has been increased effort on the inshore OH IFG grounds, resulting in an oversupply onto the market. In some instances the larger vivier vessels have had to tie up due to lack of demand. Higher fuel and bait costs and static prices over the last five years has resulted in catchers having had to land more crab to remain viable. Buyers are becoming more selective, with some only purchasing crab above 150 mm carapace width. Many are reluctant to purchase or will only pay reduced prices for crippled brown crab.

**ISSUES**

6.2.13 The most recent assessments indicate that brown crab are exploited close to $F_{MAX.}$ There is currently no control on fishing effort or landings. Within the OHIFG area effort has increased and some fishermen have observed declining catch rates suggesting local stocks are becoming depleted. The IFG therefore wants to introduce limits on the number of creels per vessel as a measure to allow for improved management of the fishery.

6.2.14 There is a better market for larger brown crab and there is therefore a good market case to increase the minimum landing size, currently 140 mm to 150mm in the IFG area. This would also potentially benefit the stock.

6.2.15 There is also a requirement for information on local stock dynamics. The IFG therefore proposes to establish a logbook scheme to improve future stock assessment and to allow for the the evaluation of the effects of introducing management measures. Having a means to control effort and improvements to data collection will help the case for MSC accreditation. MSC accreditation for brown crab at pan Scottish level is the favoured position of the SFC Crab and Lobster Sub Group members.

**OBJECTIVE**

Improved management of the brown crab creel fishery - introduce fishing effort control (creel limits), evaluate/introduce additional management measures.

**PROPOSED MANAGEMENT MEASURES**

**6.2.16 to introduce creel limits and limits on numbers of parlour creels based on vessel overall length and crew numbers**

- ‹ 8 metre – 600 creels verified crew of 2 limit 800
- 8 – 10 metres - 1,000 creels verified crew of 3 limit 1,200
- 10 – 12 metres – 1,200 creels verified crew of 3 limit 1,500
- 12 – 15 metres – 1,800 creels
- › 15 metres – 2,000 creels
- maximum 50% parlour creels permitted per boat

**Vessels that fish with both brown crab and *nephrops* creels and have landed more than 10 tonnes of brown crab in any of the previous 5 years in the period 1 Dec – 31 March are permitted to have up to a maximum 75% of each gear type during this seasonal period.**

**During all other periods of the year vessels would be able to fish different types of gear up to the maximum permitted for one type.**

***Contribution to SIFAG HLOs***

Biological: creel limits offer the potential to control fishing effort and by implication fishing mortality in a locally important fishery which is currently effectively uncontrolled. It is antiipated that introduction of the limits specified above will reduce or cap fishing effort.

Social: The limits proposed allow proportionate allocation of gear related to vessel size and crew number

Environmental: Any reduction in the numbers of creels hauled will reduce any associated impact on seabed

Economic: May increase or decrease the value of landings in the short term. Potential economic benefits from increased efficiency if effort reduction/cap increases CPUE in the medium term. Ability to manage effort in the fishery would support accreditation and may bring market benefits.

Governance: reduced creel numbers should/will reduce conflict, competition for space

**6.2.17 Increase brown crab minimum landing size to 150 mm**

***Contribution to SIFGA HLOs***

Biological & Environmental: has the potential to reduce fishing mortality on the stock. May conserve or increase spawning stock biomass and may improve recruitment.

Economic: Catching for the market - may reduce returns from the fishery initially but improve value and efficiency in the medium term

Governance: easily enforced

**6.2.18 Develop fit for purpose logbook to monitor fishing effort and calculate CPUE in the crab (and lobster) creel fishery**

***Contribution to SIFAG HLOs***

Biological & Environmental: will support improved management of the fishery and allow for evaluation of measures introduced

Economic: Better information would support fishery accreditation, which could bring market benefits

## 6.3 LOBSTER FISHERY

### Marine Scotland Science (MS-S) Assessment and Advice

6.3.1 Marine Scotland science uses length cohort analysis (LCA) to assess lobster stocks around Scotland. Assessments are done tri-annually on a regional basis, and are based on reported landings data and size data (carapace width or length) collected as part of MS-S market sampling programme.

6.3.2 The LCA method uses the commercial catch size composition data (size frequency) along with estimates of growth parameters and natural mortality to estimate stock biomass and fishing mortality at length. Because of differences in growth males and females are stocks are assessed separately. The key assumption of the approach is that the length distribution is representative of a typical cohort over its lifespan. However, this is only true of length frequency data from a single year if the population is in equilibrium and therefore the LCA is usually applied to data averaged over a number of years during which recruitment and exploitation rates have been stable. LCA also assumes uniform growth among all animals.

6.3.3 The results can be used to predict long-term (equilibrium) changes in the stock biomass and yield-per-recruit based on changes in mortality, fishing effort or size regulations. Assuming a direct relationship between fishing mortality and effort, lower levels of fishing effort will result in an increase in stock size and a reduction in landings. A higher level of effort will reduce total stock biomass but landings may also fall, as animals are caught before they may have time to grow to a size that would contribute much weight to the yield (growth overfishing). In between these lies $F_{MAX}$, the fishing mortality rate that maximises yield per recruit.

6.3.4 The changes that the LCA predict are long term (equilibrium). The approach gives an indication of the exploitation of the stock in terms of growth overfishing, but not recruitment overfishing; it does not provide any indication of short term stock dynamics or recruitment over-fishing. It is therefore best to interpret the LCA analyses in conjunction with other information such as catch rate (CPUE) data. This is because if the stock is not in equilibrium, if for example recruitment is decreasing and fewer small individuals are entering the stock, the stock may appear healthy as the size of those individuals being removed increases.

6.3.5 The lobster fishery is not subject to EU TAC regulations or national quotas.  In Scotland, vessels landing lobster are required to have a license with a shellfish entitlement. Vessels without this entitlement are only allowed to land limited amounts (5 lobsters per day).

6.3.6 The main regulatory mechanism is a minimum landing size of 87 mm carapace length (CL). This applies to all areas except Shetland where the minimum landing size is 90 mm.

6.3.7 In addition, its illegal to land 'V'-notched lobsters, or animals that have been mutilated in any way. (The Lobsters and Crawfish (Prohibition of Fishing and Landing) (Scotland) Order 1999). Lobsters and Crawfish can only be retained on board or landed whole. (Article 18(3) of Council Regulation (EC) No 850/98).
There is a maximum landing size of 155 mm for female lobsters (Article 9 of The Inshore (Prohibition of Fishing Methods)(Scotland) Order 2004).

6.3.8 There are no existing management plans, targets limits or reference points or limit reference points for lobster. The SFC Crab and Lobster Sub Group have indicated that lobster management at local level should be devolved to IFGs.

**The Fishery**

6.3.9 The lobster fishery in the OHIFG area developed over 60 years ago, initially fishermen used single chamber wooden creels, then progressing to steel creels with further progression to the increased use of parlour creels.

6.3.10 Since 2005, landings into the Outer Hebrides have ranged from 90 - 178 tonnes, . The majority of landings are from local vessels of under 12 metres in length. Prices have remained fairly constant over the last five years. From early autumn, significant volumes of lobsters are stored in onshore live storage facilities before being sold for the Christmas market. A fleet of around 80 local vessels target lobster on the inshore grounds to the west of the Hebrides, mainly from April – October. Larger nomadic vivier vessels target the more offshore grounds all year round and land into Mallaig, Uig, Ullapool, Scrabster and Orkney.

6.3.11 Creel numbers have increased gradually over the years, with pots being hauled every second or third day compared to daily pattern of hauling in the early years of the fishery. Parlour creels tend to retain relatively large numbers of lobster, compared to single chamber creels. The retained lobsters fight and many lose their claws and fetch lower prices when sold. Legislation in Jersey caps the use of parlours at 50% of total permitted creels. Fishermen have reported that catch per unit effort has reduced significantly, in the OH IFG area, over the years resulting in vessels having to increase the number of creels to retain similar catches.

6.3.12 The Scottish Fisheries Council Lobster and Crab Sub Group has given widespread support to introducing creel limits in the lobster fishery. The introduction of parlour creels has increased the efficiency of creels and cause damage to the shellfish when left for several days. Creel limits already operate in other parts of the UK and the Channel Isles, where only a maximum 50% of total creel limits can be parlours. MSC accreditation for lobster fishery at pan Scottish level is the favoured position of SFC Sub Group members.

**ISSUES**

6.3.13 Lobster stocks are exploited at or above $F_{MAX}$ and there is currently no control on effort or landings. Effort has increased and fishermen have observed declining catch rates indicating local stocks are becoming depleted. The IFG therefore wants to introduce limits on the number of creels as this would allow for improved management of the fishery with potentially benefits to stocks and future of the fishery

6.3.14 A logbook scheme to improve future stock assessment (provide information on stock dynamics) and assist in the evaluation of the effects of introducing the management measures also is required. Having a means to control effort and more and better data collection will help the case for MSC accreditation.

6.3.15 Market demand for large and crippled lobsters is poor, resulting in lower prices being paid for premium sizes. Previous increases in minimum landing sizes have benefited stocks and provided increased economic returns to vessels. Further phased increases in minimum landings sizes will benefit the stocks and provide long term economic benefits to the industry.

**OBJECTIVE**

Introduce effort control and improved management in the lobster creel fishery

**PROPOSED MANAGEMENT MEASURES**

**6.3.16 To introduce creel limits and numbers of parlour creels based on vessel overall length**

- Similar limits to brown crab fishery

***Contribution to SIFAG HLOs***

- Similar to brown crab fishery

**6.3.17 Phased increase in minimum landing size 87 – 88 - 90mm for one year**

***Contribution to SIFAG HLOs***

Biological & Environmental: may reduce fishing mortality and improve recruitment

Economic: catching for the market improved value at later date

Governance: easily enforced

### 6.3.18 Reduce maximum landing size of females from 155mm to 145mm and ban landing crippled females

***Contribution to SIFAG HLOs***

Biological & Environmental: may reduce fishing mortality and improve recruitment

Economic: catching for the market

Governance: easily enforced

### 6.3.19 Develop fit for purpose logbook

***Contribution to SIFAG HLOs***

Biological & Environmental: Improved data collection and CPUE/LPUE

## 6.4 VELVET CRAB FISHERY

### Marine Scotland Science (MS-S) Assessment and Advice

6.4.1 Marine Scotland science uses length cohort analysis (LCA) to assess velvet crab stocks around Scotland. Assessments are done tri-annually on a regional basis, and are based on reported landings data and size data (carapace width or length) collected as part of MS-S market sampling programme.

6.4.2 The LCA method uses the commercial catch size composition data (size frequency) along with estimates of growth parameters and natural mortality to estimate stock biomass and fishing mortality at length. Because of differences in growth males and females are stocks are assessed separately. The key assumption of the approach is that the length distribution is representative of a typical cohort over its lifespan. However, this is only true of length frequency data from a single year if the population is in equilibrium and therefore the LCA is usually applied to data averaged over a number of years during which recruitment and exploitation rates have been stable. LCA also assumes uniform growth among all animals.

6.4.3 The results can be used to predict long-term (equilibrium) changes in the stock biomass and yield-per-recruit based on changes in mortality, fishing effort or size regulations. Assuming a direct relationship between fishing mortality and effort, lower levels of fishing effort will result in an increase in stock size and a reduction in landings. A higher level of effort will reduce total stock biomass but landings may also fall, as animals are caught before they may have time to grow to a size that would contribute much weight to the yield (growth overfishing). In between these lies $F_{MAX}$, the fishing mortality rate that maximises yield per recruit.

6.4.4 The changes that the LCA predict are long term (equilibrium). The approach gives an indication of the exploitation of the stock in terms of growth overfishing, but not recruitment overfishing; it does not provide any indication of short term stock dynamics or recruitment over-fishing. It is therefore best to interpret the LCA analyses in conjunction with other information such as catch rate (CPUE) data. This is because if the stock is not in equilibrium, if for example recruitment is decreasing and fewer small individuals are entering the stock, the stock may appear healthy as the size of those individuals being removed increases.

6.4.5 MSS' LCA assessments for velvet crab in the Hebrides region, which corresponds quite closely to the OHIFG area, for the period 2002 to 2005 and 2006 – 2008 indicate that both male and female velvet crab stocks were fished close to $F_{MAX.}$

**The fishery**

6.4.6 The velvet crab fishery was developed 25 years ago, with the main market being in Spain. The Hebrides had the fourth largest Scottish landings by weight between 2002 and 2006 and the fishery is of particular importance to the under 8 metre sector All the velvet crab are sold to vivier lorries on a weekly basis. Prices have remained constant over many years, with the smaller class of velvets tending to fetch around £1.00 per kilo less than the larger velvets.

6.4.7 The fishery is currently managed by a shellfish licence, a minimum size of 65 mm carapace width. The fishery has no restrictions on landings and is pursued by around 40 local vessels, fishing in depths shallower than 20 metres. Vessels use similar gear to target velvets as they do for lobster and brown crab, although on different grounds and creel numbers used have increased steadily over the years to maintain catches at similar levels. Fishing for velvet crab tends to be better in areas of strong currents.

**ISSUES**

6.4.8 Stocks are exploited at around $F_{MAX}$ and there is currently no control on effort or landings. Effort has increased and fishermen have observed declining catch rates as local stocks are becoming depleted. The IFG therefore wants to introduce limits on the number of creels as this would improvement the management of the fishery and would be potentially beneficial to stocks.

6.4.9 A logbook scheme to improve future stock assessment (provide information on stock dynamics) and assist in the evaluation of the effects of introducing the management measures. Having a means to control effort and more and better data collection will help the case for MSC accreditation.

6.4.10 Continued landings of berried velvets could have a negative impact on the future of the fishery. Improved selection procedures are necessary to ensure that selection of catch is undertaken at time of hauling. Increasing the minimum landing size should increase SBB and has the potential to increase recruitment and provide enhanced returns to vessels in the short to medium term.

6.4.11 Due to lack of space for sorting the catch aboard the vessels, fishermen generally leave their selection until market day, resulting in many velvets being rejected on the quayside and dying and being lost to the fishery.

**OBJECTIVE**

Improved management of the creel fishery, introduce effort control and improved management in the velvet crab fishery

**PROPOSED MANAGEMENT MEASURES**

**6.4.12 To introduce creel limits and parlour numbers based on vessel overall length size:**

- Similar numbers to lobster and brown crab

**Contribution to SIFAG HLOs**

Biological: sustainable management of stock due to less effort

Social: equal access to fishery dependent on vessel size

Environmental: reduction in associated impact on seabed

Economic: increase in price due to lower landings

Governance reduce conflict

**6.4.13 Introduce legislation to prohibit landing of berried velvet crab**

**Contribution to SIFAG HLOs**

Biological & Environmental: will improve recruitment (designed to protect SBB and may improve future recruitment)

Economic: improved value at later date

Governance: easily enforced

**6.4.14 Increase in minimum landing size from 65 – 70mm carapace width length**

***Contribution to SIFAG HLOs***

Biological & Environmental: will improve recruitment

Economic: catching for the market improved value at later date

Governance: easily enforced

### 6.4.15 Promote improved grading and selection procedures

***Contribution to SIFAG HLOs***

Biological & Environmental: may improve recruitment

Economic: catching for the market

### 6.4.16 Develop fit for purpose logbook

***Contribution to SIFAG HLOs***

Biological & Environmental: Improved data collection/ stock assessments

## *6.5 NEPHROPS* TRAWL FISHERY

### Marine Scotland Science (MS-S) Assessment and Advice

6.5.1 In addition to creel *Nephrops* fishery,the ICES advice noted concerns about discards of white fish in the fishery. *Nephrops* trawlers are required to use more selective gear as part of the west of Scotland emergency measures. Under the EU Cod Recovery Plan, trawl effort in Division V1a has declined significantly. So far this has mainly affected effort in the larger mesh gears > 100mm and effort in the *Nephrops* fisheries has been relatively stable. Conditions of the Stornoway MSC *Nephrops* trawl fishery stress the need for management at functional unit level and for monitoring by catch and discards. Vessels are restricted to days at sea depending on their previous cod catches.

### The fishery

6.5.2 The trawl fishery for *nephrops* has been in existence for over 50 years. Nephrops were initially taken as a by-catch by white fish trawlers, being tailed and sold for the UK scampi market. As new marketing opportunities for whole prawn developed in the early eighties, many of the trawlers moved to rougher grounds to target larger *nephrops* which commanded higher prices.

6.5.3 Minimum mesh sizes in the Nephrops trawl fishery were increased in May 2009 from 70 mm to 80 mm for single rig trawl with a 3 metre square mesh panel at 120 mm. Those increased mesh sizes were introduced to protect white fish stocks and to reduce discards of juvenile fihs.Mesh size for twin rig vessels reduced in 2008, from 95 mm to 80 mm in the area north of 56ºN. Mesh sizes on the west coast are now similar to those in the North Sea.

6.5.4 Current minimum landing sizes for *Nephrops* in the VIa are total length 70 mm and carapace length 20 mm, with tail sizes at 37 mm, whereas those in for the North Sea are total length 85 mm, carapace length 25 mm, with tail sizes being 46 mm.

6.5.5 A fleet of around 100 trawlers operate in the North and South Minch area. Landings and the size of animals landed have been stable over a number of years. Volumes of *Nephrops* tails landed however have reduced since the increase in mesh size to 80 mm. This could be due to changes in the selection pattern, but could also be reflect a reduction in abundance and or the size of the animals.

6.5.6 The *Nephrops* fishery has proven itself to be sustainable at level of vessel effort. Large *Nephrops* freezer trawlers, previously built for white fish offshore grounds, now operate in the area. Those vessels remain at sea for longer trips and freeze all the catch at sea.

6.5.7 Following a lengthy process Youngs Bluecrest financed the North Minch *nephrops* trawl fishery through successful MSC accreditation. The accreditation has opened up new marketing opportunities for the company in Germany, Swizterland and Belguim and has meant that local vessels have maintained a competitive price structure for whole trawl caught *nephrops.* Youngs Bluecrest pioneered the Youngs Trace system aboard a number of Stornoway *nephrops* trawlers. This new system provides full traceability of the product from the point of capture to the point of sale

**OBJECTIVE**

Propose additional conservation measures for key fisheries

**PROPOSED MANAGEMENT MEASURES**

**6.5.8 To increase the minimum landing size of trawl caught *Nephrops* to total length 85 mm, carapace length 25 mm and tail size 46 mm.**

***Contribution to SIFAG HLOs***

Biological: More smaller *Nephrops* discarded to improve recruitment

Environmental :Reduce discards of non target species due to larger mesh size

Economic: result in higher prices

Governance: consistency with NS - easily enforced

.

## 6.6 SCALLOP FISHERY

### Marine Scotland Science (MS-S) Assessment and Advice

6.6.1 Marine Scotland Science (MS-S) conducts assessments of scallop stocks around Scotland on a regional basis. These use reported landings and market sampling data to derive estimates of spawning stock biomass, fishing mortality and recruitment and annual dredge surveys provide a fishery independent indicator of the state of the stocks.

6.6.2 Marine Scotland Science's North West assessment region corresponds most closely with the Outer Hebrides Inshore Fisheries Group area. The most recent assessment indicated that spawning stock biomass (SSB) has decreased steadily from high values in 1999, a pattern mirrored by landings from the area. Both the assessment and the surveys indicate a decline in recruitment between 1999 and 2003, some improvements in 2004 and 2005 and a decrease thereafter.

6.6.3 Fishing mortality in the North West region has also declined since 2004 and is still low but this has not so far been accompanied by an increase in SSB or recruitment.

6.6.4 There are no agreed target or reference points for scallops and no management plans. A yield per recruit analyses indicate that fishing mortality is currently above $F_{0.1}$ – higher than that consistent with the maximum long term yield.

6.6.5 The reasons for the persistently low stock and recruitment levels, despite the decline in fishing morality, are not known. Under such circumstances, management advice from MSS is for no increase in effort and for introduction of measures to increase the spawning stock biomass. One such measure is to increase the current MLS from 100 mm to 110mm. The survival of discarded scallops is high and therefore most undersized scallops returned to the sea have the potential to grow, to increase the reproductive capacity of the stock and potentially improve future recruitment.

6.6.6 It has also been suggested that mapping of scallop grounds, or collecting CPUE data from the fleet to identify areas of high concentrations of small or undersized scallops would be beneficial to identify areas where the fishery would be most adversely affected by increasing MLS. Logbooks would be useful in providing some of the above information.

### The fishery

6.6.7 The scallop fishery has been developed successfully over a 40 year period. Around 35 scallop dredgers, of which 6 are locally based, are active in the IFG area. Further teams of scallop divers, some locally based and other nomadic vessels operate in the area throughout the year. Mobile vessels operate mainly in the Minches area, whilst dive teams operate in the Minches, Loch Roag and west of Harris areas.

6.6.8 Scallop processing is an important part of the local economy, with processing plants in North Uist and Barra. Kallin Shellfish employ 15 people that process scallops from the six locally based vessels. Barratlantic employ 40 people processing mainly *nephrops* and scallops from around 7 mainland based vessels that fish in the South Minch and as far south as the Clyde. Other nomadic vessels fish the area on a more seasonal basis, mostly in winter and spring, and land to mainland ports for onshore processing in north east Scotland.

6.6.9 The inshore scallop fishery is regulated with scallop entitlement on the licence, a maximum of eight dredges per side, seasonal closures and an EU minimum landing size of 100 mm. Dive teams must operate from a licensed vessel, have a diving qualification and must comply with minimum manning levels. Scallop licence entitlements do not apply to under 10 metre vessels. Seasonal scallop closures for conservation purposes, from Lochmaddy to Barra, have been very successful, with reduced conflict and improved catches to correspond with seasonal marketing demands and are easily enforced.

6.6.10 Scallop prices have remained relatively constant for over 15 years, whilst operating costs, in particular fuel and steel, have risen rapidly during that period. Profitability in the sector has been greatly reduced, resulting in many vessels with scallop entitlement diversifying to the *nephrops* fishery when it became more profitable.

6.6.11 MSC accreditation for scallops at pan Scottish level is the favoured position of Scottish Fisheries Council Scallop Sub Group members

**ISSUES**

6.6.12 Scallops are of significant importance to the local economy providing employment both on vessels and onshore processing. Whilst scallop entitlements introduced a cap on the number of vessels permitted to fish for scallops, significant latent entitlements exist that could increase effort into the fishery if stocks and market economic conditions improve. Very little data is available on CPUE in the scallop fishery therefore designing a fit for purpose logbook would be useful, particularly to evaluate stocks locally. Measures to enhance market prices and controlling fishing mortality are therefore a priority for this fishery.

6.6.13 Seafish through the UK Scallop Working Group have been involved in designing more selective gear to reduce impact on the seabed. Promotion of more eco-dredge use and all scallop dredgers operating in the area participating in the UK Scallop Code of Conduct will reduce impact on the seabed and promote a better image for the fishery.

**OBJECTIVE**

Propose additional conservation measures for key fisheries

**PROPOSED MANAGEMENT MEASURES**

**6.6.12 Increase minimum landing size for scallops to 105 mm with immediate effect then 110 mm within 2 years**

***Contribution to SIFAG HLOs***

Biological & Environmental: aimed at protecting and increase spawning stock biomass

Economic: catching for the market improved value at later date

Governance: easily enforced

**6.6.13 Mapping of scallop grounds**

***Contribution to SIFAG HLOs***

Biological : improve data information on seabed

**6.6.14 Develop fit for purpose logbook**

***Contribution to SIFAG HLOs***

Biological & Environmental: Improved data collection on grounds fished and location of undersized scallops

**6.6.15 Develop more selective lighter gear**

***Contribution to SIFAG HLOs***

Environmental: Reduce impact on seabed

Economic : Reduce fuel costs and improve profitability

**6.6.16 Adopt UK Scallop Good Practice Guide Appendix 8**

***Contribution to SIFAG HLOs***

## 6.7 INSHORE FISHERIES AFFECTED BY COD RECOVERY MEASURES

### 6.7.1 CRAWFISH FISHERY

#### Marine Scotland Science (MS-S) Assessment and Advice

6.7.2 Marine Scotland Science (MS-S) do not assess crawfish stocks in the IFG area. Hence status is unknown. Reported landings are much lower than historical levels, this could be due to crawfish having been included with lobster landings. It is a candidate for protection under Wildlife and Countryside Act Schedule 5 (out to consultation in Scotland) and on SNH's priority PMF list. Based on experience in other areas, measures to protect the stock from over-fishing and a programme of data collection would be advised.

#### The fishery

6.7.3 Tangle netting, with a minimum mesh size of 250mm, for crawfish was developed to the West of the Hebrides in the mid-seventies with trials funded by the White Fish Authority. The main areas targeted were to the West of Barra, Uist and Lewis, with further development of the grounds to the East of Uist and Scalpay

6.7.4 A local fleet of 20 under 10 metre static gear vessels targeted the fishery from April – September. The fishery is directed at crawfish with no white fish by catch a few lobsters are also caught in the tangle nets. Fishing grounds are mostly within the 6 mile limit, in water depths of up to 60 metres. Nets are set over the rough, peaky, hard grounds usually frequented by shellfish.

6.7.5 Vessels were attracted to this seasonal fishery to take effort away the traditional stocks of lobster, *Nephrops*, velvet and brown crab during periods when those stocks command low prices and markets are over-supplied.

6.7.6 All crawfish are sold live and in many cases both fishermen and merchants store the catch to benefit from higher Christmas prices. Mortality rates during storage are low with fishermen and merchants storing them individually using a specially designed netted bag. The main market is in Spain with prices in excess of £40 per kilo being paid at Christmas.

6.7.7 End of year, December 2008, EU agreements in keeping West of Scotland mobile demersal fisheries open resulted in a prohibition in the use of gill and tangle nets, unless tied to the shore with a stake.

#### ISSUES

6.7.8 The directed crawfish fishery using a minimum mesh size of 250 mm has had no impact on white fish stocks and the IFG consider a derogation is urgently required to allow this method of fishing to continue. Skippers are keen to take observers aboard to gain independent approval that the fishery has no impact on white fish stocks.

6.7.9 Local stocks in the IFG area appear to be healthy with many larger animals over 2 kgs being caught. The market prefers crawfish smaller than 2 kgs with lower prices being paid for larger animals. Therefore introducing a maximum landing size and introducing a ban on the landing of berried crawfish would be beneficial to stock recruitment. The fishery would benefit from vessels having logbooks to indicate current effort and CPUE in fishery. Data collection required to progress stock assessment and advice.

**OBJECTIVE**

Propose additional conservation measures for key fisheries.

**PROPOSED MANAGEMENT MEASURES**

**6.7.9 Introduce a maximum landing size of 145 mm carapace length (males and females) and a ban on landing berried females**

***Contribution to SIFAG HLOs***

Biological & Environmental: intended to protect spawning females, potential to maintain improve recuitment

Economic: catching for the market

Governance: easily enforced

**6.7.10 Develop a log book for the fishery**

***Contribution to SIFAG HLOs***

Biological & Environmental: Improved data collection

**6.7.11 Commence an observer programme**

***Contribution to SIFAG HLOs***

Biological & Environmental: Improved data programme

Governance: An open and transparent environment

Social: Provide long term fishery

**6.7.2 SQUID FISHERY**

**Marine Scotland Science (MS-S) Assessment and Advice**

6.7.2.1 MS-S do not assess the West Coast inshore squid fishery. However, Seafish and Aberdeen University have completed a report on the inshore squid fishery in the North Minch. This report is available at **Appendix 5.**

**The fishery**

6.7.2.2 The squid fishery was developed by around six local inshore *nephrop* trawlers around six years ago. Fishing was mainly on a seasonal basis, in the North Minch, from September to November when prawn catches were low.

6.7.2.3 This non quota fishery created new alternative opportunities for local vessels at time when traditional fishing opportunities were limited. All the squid was sold to the domestic market

6.7.2.4 Local squid sizes vary from 4" – 12" , with prices ranging from £15 - £18 per stone, averaging around £90 per box.

6.7.2.5 Seafish Industry Authority staff have used net monitoring equipment to replicate net design at the Flume Tank , in Hull, and have designed the optimum rig for the type of squid net to be used in the inshore waters of the Minches. White fish catches were very low due to squid net being rigged off the seabed, with a cod end mesh size of 32 -34 mm.

6.7.2.6 Following the EU Council meetings in December 2008, it is no longer permitted to target squid, with mesh size of 32 - 34 mm in the inshore waters of the west coast of Scotland. This prohibition is to protect juvenile cod, haddock and whiting from being caught in small meshed gears. Local fishermen indicate that a clean targeted squid fishery could be pursued in inshore waters provided the squid net was professionally rigged to avoid catches of juvenile white fish.

6.7.2.7 Similar squid gear is already used in the inshore waters of the Moray Firth and it would be prudent to investigate the possibility of seeking a derogation which would permit similar gear types to be used in the inshore waters of the Minches. Fishermen are requesting that independent observers are used to verify that a clean targeted squid fishery, that will have no impact on juvenile cod, haddock and whiting, can be pursued in the inshore waters of the Minches.

## PROPOSED MANAGEMENT MEASURES

### 6.7.2.8 Commence an observer programme

***Contribution to SIFAG HLOs***

Biological & Environmental: Improved data programme

Governance: An open and transparent environment

Social: Provide long term seasonal fishery

## 6.8 DEVELOP NEW SUSTAINABLE FISHERIES

### 6.8.1 COCKLES

**Marine Scotland Science (MS-S) Assessment and Advice**

6.8.1.1 A survey of the cockle beds in Lewis, Harris and North Uist, funded by HIE, CNES and SNH was completed in 2010. Copy of survey is at **Appendix 6.**.

A summary of the findings are:

- Shore based surveys of eight cockle grounds on the Uists, Harris and Lewis were carried out between 13.11.09 and 29.2.10.
- All of the grounds had been previously surveyed in 2000 and a number had also been surveyed in 1993.
- A stratified random survey design was used allowing comparison of the results with previous surveys.
- In total 416 sites were sampled. At each site sediment was sampled from an area of 0.1m2 and cockles were removed with a sieve.
- A total of 1064 cockles were counted, aged, measured and weighed.
- Estimates of total biomass for each ground ranged from 132 at Tong tonnes to 709 tonnes at Traigh ear. North Ford and Traigh ear in Uist supported highest cockle biomasses including a high proportion of cockles in 5 and 6+ age classes.
- All grounds contained a broad age range of cockles.
- Ten percent or more of the cockles at North Ford, Vallaquie and Traigh ear were larger than 30 mm (the minimum size permitted in the Outer Hebrides fishery). Cockles larger than 30 mm were estimated to make up less than 10% of the total stocks on Baleshare, Traigh Leathann, Luskentyre, Tong and Vallay. No cockles over 30 mm were found in Vallay samples.
- The cockles sampled took a minimum of three years and more generally six or seven years to reach 30 mm.
- Current survey results are broadly similar to those from surveys in 1993 and 2000.

- The recent survey provides a useful overview of cockle distribution and abundance. Future surveys should examine exploited cockle grounds in detail to provide more precise information on target stocks.

**The fishery**

6.8.1.2 Cockles were harvested by mechanical methods in Barra, North Uist, Harris and Lewis until a prohibition was introduced on mechanical harvesting by a Statutory Instrument through the Inshore Fishing (Scotland) Act .

6.8.1.3 Hand racking is undertaken in Barra and Harris, with gatherers supplying catch for the live market. Concern was expressed in Harris that stocks could become over-exploited as there was no minimum size in place to protect the fishery.

6.8.1.4 Following a period of local consultation. a pre-cautionary minimum landing size of 30mm was introduced, under a Statutory Instrument (SI), for cockles in the Outer Hebrides. This was to prevent over-fishing until appropriate measures for the long term management of the fishery could be considered.

6.8.1.5 Biomass estimates (in tonnes) for 25% of the cockle stock available at each of the possible minimum landings sizes for 25 – 30mm:

| MLS | 25 | 26 | 27 | 28 | 29 | 30 |
|---|---|---|---|---|---|---|
| Traigh Leathann | 33 | 33 | 29 | 24 | 13 | 13 |
| Baleshare | 41 | 35 | 30 | 30 | 13 | 12 |
| North Ford | 133 | 125 | 116 | 108 | 93 | 73 |
| Vallay | 20 | 13 | 13 | 7 | 5 | 2 |
| Traigh Ear | 153 | 133 | 110 | 90 | 66 | 52 |
| Vallaquie | 50 | 49 | 41 | 40 | 30 | 24 |
| Luskentyre | 48 | 42 | 37 | 29 | 23 | 17 |
| Tong | 35 | 35 | 33 | 28 | 26 | 26 |

**ISSUES**

6.8.1.6 The OH IFG Cockle Sub Group, consisting of MS-S, MS-C, SNH, CNES, Seafish, RSPB and LCC, will recommend to the Executive Committee the way forward to manage the fishery, in a sustainable manner taking into consideration, market requirements, site designation status, seasonal closures, minimum landing sizes, licensing, quotas, days fished and site specific extraction methods.

6.8.1.7 Depending on the final agreed minimum landing size there could be a potential to harvest from between 200 – 500 tonnes. This could generate a fishery that could be valued up to £400,000.

6.8.1.8 The Executive Committee and the Advisory Group of the OH IFG consider that the IFG should be the Management Group that should be

delegated the powers to licence and manage the cockle fishery on behalf of all stakeholders.
.

**OBJECTIVE**

Assist the industry in developing new fisheries on a sustainable basis

**PROPOSED MANAGEMENT MEASURES**

**6.8.1.9 Licence the fishery in a sustainable manner**

**Contributes to SIFAG HLOs**

Biological, Environmental & Governance: Involvement of all stakeholders

Economic: Generate additional income in communities

Social: Provide new employment opportunities

**6.8.2 RAZORFISH**

**Marine Scotland Science (MS-S) Assessment and Advice**

6.8.2.1 Survey worked completed in Broad Bay, Grimsay and Loch Carnan in 1998. Copy of survey can be seen at **Appendix 7.**

**The fishery**

6.8.2.2 There are limited commercial diving fisheries for razorfish at locations throughout the Western Isles. Stock surveys were completed in 1999 using a water jet dredge system and it was recommended that further studies should be undertaken on distribution of stocks and to investigate sustainable harvesting levels and methods. Advances have been made in dredge design that reduce impact on the seabed and commercial razorfish extraction occurs at other locations throughout the UK.

**ISSUES**

6.8.2.3 The Executive Committee of the Outer Hebrides IFG has approved a recommendation that a Razorfish Sub Group, consisting of MS-S, MS-C, SNH, CNES, Seafish, HIE, RSPB and LCC, should be formed to progress the potential for developing a commercial razorfish fishery in the area.

6.8.2.4 There is a good market for razorfish and it would be beneficial to the OH IFG if a small scale well controlled licensed fishery could be developed. However, wide range consultation with a wide range of stakeholders would have to be convened to gain knowledge of good practices in other areas, where razorfish stocks are fished sustainably.

6.8.2.5 The Executive Committee and the Advisory Group of the OH IFG consider that the IFG should be the Management Group that should be delegated the powers to licence and manage a sustainable local razorfish fishery on behalf of all stakeholders.

**OBJECTIVE**

Assist the industry in developing new fisheries on a sustainable basis

**PROPOSED MANAGEMENT MEASURES**

**6.8.2.6 Investigate the possibility of developing a small scale local razorfish fishery**

**Contributes to SIFAG HLOs**

Biological, Environmental & Governance: Involvement of all stakeholders

Economic : Generate additional income in communities

Social: Provide new employment opportunities

**6.8.3 BROWN SHRIMP**

**Marine Scotland Science (MS-S) Assessment and Advice**

6.8.3.1 Marine Scotland Science (MS-S) have not assessed this stock

**The fishery**

6.8.3.2 Fishermen report very small catches of brown shrimp in their velvet crab pots when fishing in very shallow waters. Catches seem to be higher during the late autumn and winter months. There is a strong market demand for brown shrimp with prices of up to £20 per kilo being paid.

**ISSUES**

6.8.3.3 The opportunity exists to develop a small scale brown shrimp fishery for the benefit of under 8 metre vessels that fish in shallow waters. Local shellfish buyers are aware of potential marketing outlets for brown shrimp and would sell the product direct to the live market in Spain.

6.8.3.4 A small scale pilot project to develop this fishery could be costed and applications made to a range of funding agencies. The project would look at distribution, sizes, markets, discards and mortality rates.

**OBJECTIVE**

Assist the industry in developing new fisheries on a sustainable basis

**PROPOSED MANAGEMENT MEASURES**

**6.8.3.5 Investigate the possibility of developing a small scale local brown shrimp fishery**

**Contributes to SIFAG HLOs**

Biological, Environmental & Governance: Involvement of all stakeholders

Economic : Generate additional income in communities

Social: Provide new employment opportunities

## 6.8.4 SMALL SCALE MACKEREL FISHERY

6.8.4.1 A number of local under 10 metre vessels have shown an interest in developing a small scale local inshore mackerel fishery, using lines. They already have a small monthly quota allocation of up to 2 tonnes depending on season. The fishery would be close inshore and could be developed without any conflict with any other fisheries.

6.8.4.2 Vessels could set feelers to establish that the quality of any mackerel on the grounds was of good quality, before commencing a targeted fishery in any area.

6.8.4.3 Local markets could cater for small volumes of line caught mackerel , with options of smoking, salting on selling fresh to local outlets.

**OBJECTIVE**

Assist the industry in developing new fisheries on a sustainable basis

**PROPOSED MANAGEMENT MEASURES**

**6.8.3.5 Investigate the possibility of developing a small scale local inshore hand line mackerel fishery**

**Contributes to SIFAG HLOs**

Biological, Environmental & Governance: Selective fishing methods, no discards, easy to monitor on small vessels

Economic : Generate additional income in communities

Social: Provide new employment opportunities

## 6.9 AMENDMENTS TO INSHORE FISHING (SCOTLAND) ACT 1984

6.9.1 A number of prohibitions have been introduced in waters around the Outer Hebrides through the Inshore Fishing (Scotland) Act 1984. The last review was undertaken in 2002 and it is now considered that it would be beneficial to remove measures which are no longer relevant. Furthermore, additional measures are necessary to take account of changes in fishing patterns that have occurred within the Outer Hebrides since the last review.

**Amendments to area within which prohibitions applies:**

### 6.9.2 Stuley Island to Barra Head and Gurney Point

Any method of fishing for sandeels to be amended from 1 March to 31 October in each year to 1 June to 31 August in each year.

This is to reflect the period during which sandeel licences have been issued

### 6.9.3 Sound of Harris

Mobile gear prohibition to be removed

This prohibition was introduced in error and this area is already covered with seasonal scallop dredging.

### 6.9.4 Bragar to Dell

Prohibition of fishing with creels to be amended from 1 July – 30 September to 1 January to 31 March in each year and 1 November to 31 December in each year

The size of vessels fishing in this area has changed and brown crab processing in the area has ceased since the previous measure was introduced. The new prohibition period would coincide with all the other creel prohibition periods throughout the Outer Hebrides area.

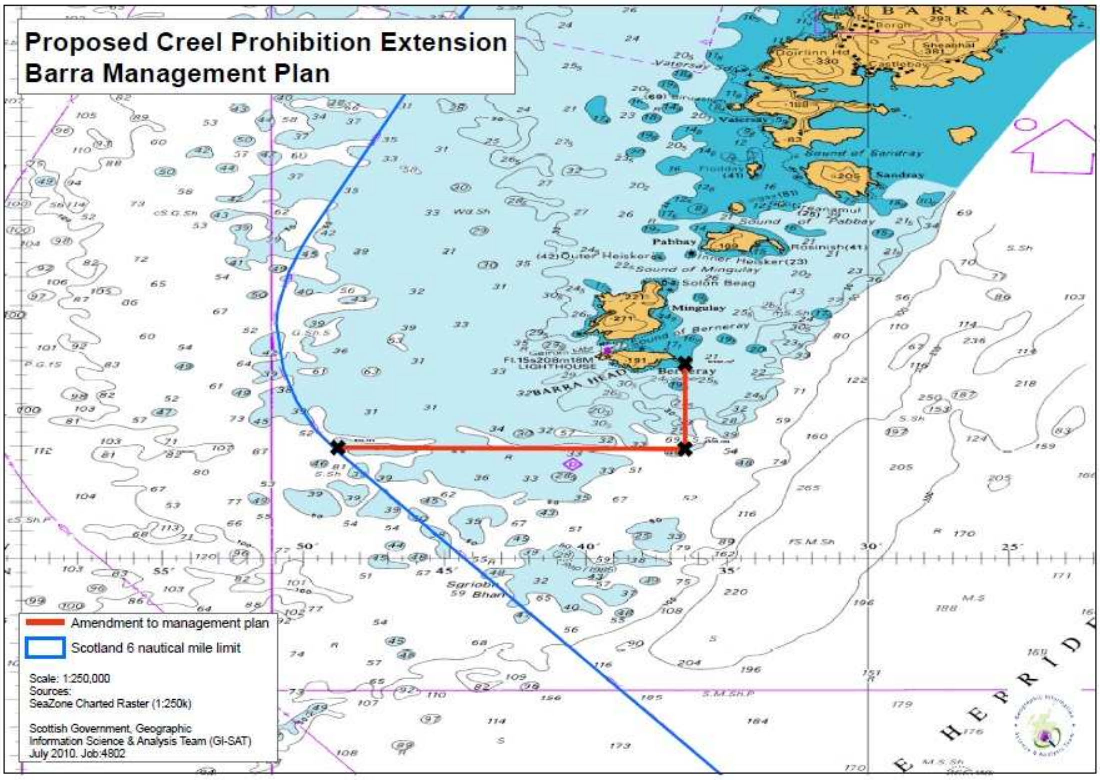
### 6.9.5 Lochmaddy to Stuley Island

Seasonal prohibition periods to include all methods for catching scallops

The current seasonal prohibitions only apply to scallop dredging and to aid conservation this should be extended to cover all methods of fishing.

### 6.9.6 Northern Barra, South Uist, Benbecula, North Uist and Harris

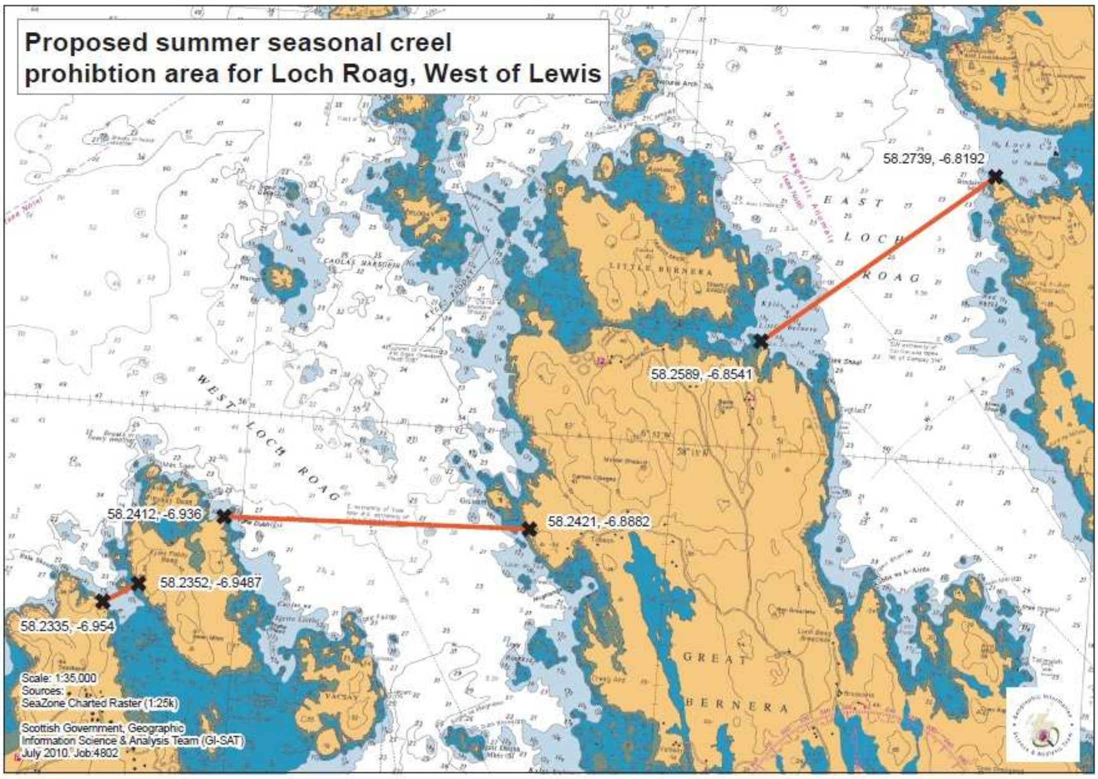
Prohibition of fishing with creels 1 January to 31 March in each year and 1 November to 31 December in each year to be extended South following the 6 mile limit contour to join a line running South from Sgeir Mhore Berneray 56º46.90 N 7º 36.48 W running south for 3 miles to a position 56 43.87N 7 36.48W then west to intersect the UK 6 mile limit at 56º 43.92´N, 7º48.78W.




The extension of the creel prohibition area would include all the areas fished by the local static gear fleet and would prevent over-fishing in the small area that is not currently covered by the creel prohibition**.**

### 6.9.7 Loch Roag

New prohibition of fishing for sea fish with creels from 1 May – 31 July in each year:




**OBJECTIVE**

Improve decision making and reduce conflict in the sector and between other marine sectors

**PROPOSED MANAGEMENT MEASURES**

1. Review arrangements in all fisheries

**Contributes to SIFAG HLOs**

Biological : Environmental: Reduce effort in areas and improve recruitment

Economic : Fishing area to meet market requirements

Governance: Easy to enforce

## 6.10 FUEL EFFICIENCY

6.10.1 The Outer Hebrides fishing fleet has suffered from paying much higher fuel costs over many years, resulting in the fleet being less profitable than those operating in other areas of Scotland.

6.10.2 Fuel tanks have been installed by CNES at most of the main fishing ports in the area, however, fuel prices continue to be significantly higher than at piers owned by Highland Council.

6.10.3 Discussions have been held with Lews Castle College, (LCC) to investigate the potential for alternative sources of cheaper fuel that would be appropriate for use on inshore vessels. Following those discussions, LCC have been successful in having been awarded EFF funding to investigate the use of hydrogen aboard inshore vessels. It is expected that savings of up to 15% in fuel costs once the hydrogen system has been installed aboard fishing vessels.

6.10.4 The hydrogen project will be over a 3 year period during which commercial trials will be undertaken aboard an inshore trawler to ensure that that this new technology will be appropriate for use aboard inshore vessels.

6.10.5 The IFG and the wider Scottish fishing industry will be updated on a regular basis with an update on the various stages of the project. LCC research staff will be available to travel to around Scotland to demonstrate the benefits that can be achieved from the project.

### OBJECTIVE

Assist the industry in cost reductions

### PROPOSED MANAGEMENT MEASURES

**6.10.5 Investigate the possibility of using hydrogen as a fuel source aboard fishing vessels**

**Contributes to SIFAG HLOs**

Environmental: Reduce $CO_2$ emissions

Economic : Reduce costs and increase profits

Social: Provide new research employment opportunities

## 6.11 FLEET RENEWAL AND RECRUITMENT

6.11.1 There has been a gradual downsizing of the Outer Hebrides fleet, following decommissioning schemes and reduced profit margins in the over 10 metre sector of the fleet. Currently, nearly 80% of the fleet is under 10 metres in length.

6.11.2 The onshore shellfish processing sector depend on supplies from the over 10 metre sector for all of their raw material. Therefore, it's of paramount importance to the local economy that funding is available to enable young fishermen to become shareholders in over 10 metre vessels.

6.11.3 The average age of the various sectors for over 10 metre vessels range from 25 – 38 years old and is in urgent need of significant investment to renew that sector of the fleet. Similarly, the average age of the skippers of the over 10 metre sector is 45 years old.

6.11.4 CNES has been very supportive to the fishing industry providing a loan guarantee scheme of £1M, in partnership with the Royal Bank of Scotland.
The Fisheries Loan Scheme was very successful with only £12,000 of guarantee being called in during the 10 year duration of the Scheme. However, this arrangement has had to be renewed with the State Aids Unit and it's becoming increasing more difficult to devise a Sate Aid compliant scheme that can offer any assistance for the purchase of fishing vessels.

6.11.5 CNES invested £700,00 in the purchase of West of Scotland *Nephrops* quota, with this quota held by the Scottish Fishermen's Organisation and the Orkney Fish Producers Organisation and leased to fishermen at commercial rates. This has enabled new entrants to lease *Nephrops* quota rather than incurring the additional capital costs of buying quota, along with a vessel and licence.

6.11.6 Access to fisheries training to National Standards is available throughout the Outer Hebrides through a network of qualified trainers. However, skippers of the larger vessels are finding recruitment of qualified deckhands extremely difficult and are dependent on EU Nationals, following visa restrictions being imposed on Filipino fishermen.

6.11.7 Currently, in excess of 150 fishermen have completed their Inshore Skippers Ticket for under 15 metre vessels, through Government funded courses. Those new qualifications are fully transferable to both the aquaculture and marine tourism sectors, with the addition of an ENG1 medical certificate. Many of those skippers are now keen to move into vessel ownership, with the main barrier being lack of finance due to Banks being reluctant to support the fishing industry.

6.11.8 Conditions could be attached to any approved new entrant scheme to ensure that vessels adopted selective gear, completed specific logbooks to enhance data collection and targeted stocks that were considered to be sustainable.

**OBJECTIVE**

**Encourage new entrants into the fishing industry at a sustainable level**

**PROPOSED MANAGEMENT MEASURES**

**6.11.8 Investigate setting up a State Aid Compliant Scheme for the purchase of vessels for suitably qualified fishermen**

**Contributes to SIFAG HLOs**

Economic : Create additional employment, protect processing sector employment

Social: Sustain population in fragile communities

## 7. RESEARCH AND MONITORING REQUIREMENTS

### 7.1 BASLINE ASSESSMENT SUMMARY

7.1.1 Marine Scotland Science currently undertake surveys and regional stock assessments for *Nephrops*, scallops, lobster, brown crab and velvet crab. They operate a nephops discard programme, recorded sizes of landed and discarded nephrops in the trawl fishery, and collect length frequency data from shellfish landings.

7.1.2 Observer trips are undertaken aboard *nephrops* trawlers by Glasgow University as part of the North Minch *Nephrops* MSC Accreditation Scheme. Results from those trips are shared with industry and Marine Scotland Science. Further observer trips are undertaken aboard *Nephrops* trawlers as part of West of Scotland cod recovery measures. By-catch and discard details are recorded as part of those observer programmes.

7.1.3 Vessel monitoring systems currently aboard all over 15 metre vessels and Youngs Trace Systems aboard all *Nephrops* trawlers landing to Youngs Bluecrest provide information on location of trawled *Nephrops.*

7.1.4 Additional data on quantities landed are provided by by inshore skippers who complete log sheets, (Nep 1 and Shell 1 forms) and submit sheets to the local fishery office as required under national legislation

### 7.2 SCIENCE PLAN

#### 7.2.1 SISP Project

7.2.1.1 The current SISP project at **Appendix 4** should provide the IFG with the required information to introduce improved management measures for the *Nephrops* creel fishery:

- creel minimum mesh size to catch for market
- evaluate benefit of escape panels
- increase minimum landing size
- seasonal ban on landing berried *Nephrops*
- reduce discards in the fishery

### 7.3 Develop logbooks

7.3.1 There is currently very little data on catch rates in creel fisheries in the IFG area. Assessments of crab and lobster stocks in particular would be improved if there was information on stock dynamics and or recruitment. The evaluation of the effects of introduction of additional management measures in the IFG area will require such information. It is therefore proposed that Marine

Scotland and Industry develop a logbook scheme to gather CPUE data, this to be completed by selected but representative vessels providing good coverage of the IFG fishing ground / geographic area.

7.3.2 The information collected will provide information on effort, by-catch, discards, hours fished and area distribution of the fisheries. Furthermore, information provided will illustrate benefits of eg increasing minimum landing sizes.

### 7.4 Develop New Sustainable Fisheries

7.4.1 It is anticipated that regular cockle stock surveys to be undertaken once a licensed cockle fishery is established.

7.4.2 Conduct further studies on razorfish as recommended by the Marine Laboratory in their earlier report on the effects of water jet dredging in some Western Isles populations.
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### 7.5 Observer Programme

7.5.1 An independent scientific observer to be sourced to observe by-catches in an inshore squid fishery.

7.5.2 An independent scientific observer to be sourced to observe by-catches in the crawfish tangle net fishery to the West of the Hebrides.

### 7.6 Water Classification

7.6.1 Water classification must be completed for all new areas where cockles and razorfish are harvested. Both CNES and Food Standards Agency (FSA) will have to be involved in sampling procedures to determine the classifications of sites prior to the product being sold directly to the market.

## 8. IMPLEMENTATION OF PLAN

8.1 There will be several stages involved in the consideration and implementation of the objectives set out in the IFG Management Plans.

8.2 SIFAG will consider whether the management plans are consistent with the high level objectives and whether proposals in them have been assessed for legislative requirements. Marine Scotland will assess the impact of the proposals. It is expected that a Strategic Environmental Assessment (SEA)be required on at least some objectives and this will be carried out by the SEA Gateway team in Marine Scotland). These Assessments will run simultaneously and on receipt of their conclusions the plans will be sent to Scottish Ministers.

8.3 Once the plans have been approved by Scottish Ministers, then the agreed appropriate managed measures will be underpinned by legislation. Marine Scotland will be responsible for implementing national legislation where necessary to deliver the objectives which may include Regulating or Several Orders, mechanisms under the Inshore Fishing (Scotland) Act 1984 or other legislation such as the Sea Fish (Conservation) Act 1967.

| *Objective:* | | | |
|---|---|---|---|
| **Improve management of creel fisheries additional conservation measures** | | | |
| *Management Measures* | *Timing* | *Responsibility (lead & others)* | *Monitoring (key indicators)* |
| ▪ Limit creel numbers in all creel fisheries | 2011 onwards | IFG, MS-Sci, MS-Comp, SFC Sub Groups | Tags, logbooks for CPUE checks |
| ▪ Evaluate effects of creel mesh size and escape panel on catch composition | 2010 - 2011 | IFG, SISP,MS-Sci, Industry | Logbooks, data on discards, sizes and berried sizes |
| ▪ Increase minimum landing sizes for lobster, brown and velvet crab | 2012 onwards | IFG, MS- Sci, SFC Sub Groups | Logbooks, CPUE, F and value of landings |
| ▪ Reduce maximum landing size for lobster, ban on landing berried female lobsters | 2012 onwards | IFG, MS-Sci | Logbooks, CPUE increase in recruitment , improved catch rate of smaller lobsters |
| ▪ Encourage improved grading | 2012 | IFG, Seafood | Checks on |

| | | | |
|---|---|---|---|
| practices for velvets | onwards | Scotland | discards and undersized at vivier lorries |
| *Data;* | | | |
| Existing: No existing data available on creel numbers and no measures in place to limit number of vessels in IFG area | | | |
| Required: Develop creel tagging system, develop logbook system, statutory consultation process on new measures | 2012 onwards | IFG, MS-Policy, MS-Sci, MS-Comp. | |
| *Relationship with national measures (existing or proposed)* | | | |
| Linking in with the relevant Sub Groups of the Scottish Fisheries Council, measures could be introduced through existing legislation | | | |
| *Additional funding/resources identified* | | | |
| SISP funding approved for evaluating effects of creel mesh size and escape panel on catch composition. EFF funding required for logbooks. Cost implications for a creel tagging system | | | |

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|---|---|---|---|
| *Objective:* | | | |
| **Additional conservation measures for key fisheries** | | | |
| *Management Measures* | *Timing* | *Responsibility (lead & others)* | *Monitoring (key indicators)* |
| ▪ Increase MLS for trawl caught *nephrops* | 2012 . | IFG, MS, SFC Sub Group | Monitor sizes |
| ▪ Increase scallops MLS to 105mm | 2012 | IFG,MS-Sci, SFC Sub Group | Monitor size of SSB |
| ▪ Prohibit landing of berried females and introduce a maximum landing size for crawfish | 2012 | IFG, MS-Sci, MS-Comp, Buyers | Logbook for monitoring numbers returned to fishery |
| *Data* | | | |
| Existing: Size data available from some processors, in case of trawled *nephrops,* MSS market and discard sampling | 2012 onwards | IFG, *Nephrops* buyers | |
| Required: Similar data from other *nephrops* processors. Additional data on meat weight sizes from scallop buyers, MS sampling landings | 2012 onwards | IFG, *Nephrops* and Scallop processors | |
| *Relationship with national measures (existing or proposed)* | | | |
| West of Scotland minimum mesh sizes in the *nephrops* trawl fishery are similar to the North Sea and similar MLS should be adopted. Increasing scallops sizes to 110mm | | | |

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| would have too much economic impact on scallop vessels, with a phased increase being the most logical step for the West Coast. |
| *Additional funding/resources identified* |
| No additional resources required other than cost of consultation with industry prior to introducing such measures. |

| *Objective:* | | | |
|---|---|---|---|
| **Assist industry in developing new sustainable fisheries** | | | |
| *Management Measures* | | | |
| ▪ Cockle Sub Group develop a management plan for a sustainable fishery | 2012 | IFG Cockle Sub Group | Agree harvesting areas, exploitation rates, number of licences |
| ▪ Obtain guidance on developing sustainable harvesting methods for razorfish | 2012 | IFG Razorfish Sub Group | Stock surveys and best practices from other areas |
| ▪ Pilot trial to develop a small scale brown shrimp fishery | 2012 | IFG, MS, Seafood Scotland, SNH | Monitor catches and markets |
| ▪ Investigate potential in developing a localised squid fishery | 2012 | IFG, MS | Monitor catches and markets, observer programme |
| ▪ Investigate the possibility of developing small-scale handline and drift net herring and mackerel fishery | 2012 | IFG, MS, Pelagic sector | Landings from fishery, economic return and develop local market |
| *Data* | | | |
| Existing: Information from surveys of Cockle beds at Barra (1970, 1974, 1993, and 2008)<br>Traigh Leathann, Baleshare, North Ford, Vallay, Traigh Ear, Vallaquie (1993,2000 and 2010)<br>Luskentyre, Tong 2000,2010<br><br>Razorfish Surveys in Broad Bay, Grimsay Loch Carnan (1998)<br><br>Information on squid from Aberdeen University and Seafish | | | |

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|---|---|---|---|
| ICES Advice available for herring and mackerel | | | |
| · Required:<br>· Develop new approach to managing localised fisheries e.g. cockles, raorfish<br>· New survey for Barra cockle beds<br>· Further studies on Razorfish gear development to improve selectivity and reduce damage to catch and by-catch and reduce impact on seabed<br>· Observers to determine cod by-catch in squid fishery<br>· Identify local markets for locally caught mackerel from small inshore vessels | 2012 onwards | IFG, MS | |
| *Relationship with national measures (existing or proposed)* | | | |
| Scottish licensing review for new approach to licensing local fisheries incorporating the IFGs Executive and Advisory Groups as the Managing Body to manage particular local fisheries. Current observers used for cod recovery measures to be used in squid fishery for investigating cod by-catch in west Coast fishery. | | | |
| *Additional funding/resources identified* | | | |
| Developing new fisheries could be eligible for funding from EFF, CNES, HIE, LEADER, SNH | | | |

| | *Timing* | *Responsibility (lead & others)* | *Monitoring (key indicators)* |
|---|---|---|---|
| *Objective:* | | | |
| **Provide marketing support to current and developing fisheries** | | | |
| *Management Measures* | | | |
| ▪ MSC *Nephrop* trawl fishery accreditation. | 2012 onwards | IFG, Youngs Bluecrest | Continued Accreditation |
| ▪ Consider pan Scotland level MSC accreditation for scallop and brown crab | 2012 onwards | IFG, MS,SFC Crab/scallop sub groups | Improved data collection |
| ▪ Responsible Fishing Scheme | 2012 | IFG, GTA, Seafish | Monitor vessel numbers |
| *Data* | | | |
| Existing: Youngs Bluecrest for North | | IFG, MS, | |

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|---|---|---|---|
| Minch *Nephrop* trawl fishery<br>Crab and scallop sub groups forward plans<br>Develop existing base of vessels for joining RFS | | Seafish, GTA | |
| Required:<br>Coordination of existing workstreams | | IFG | |
| *Relationship with national measures (existing or proposed)* | | | |
| Promotion of MSC for key fisheries and Seafish and SNH to develop RFS to consider more environmental criteria. | | | |
| *Additional funding/resources identified* | | | |
| Continuation of Seafish funding for RFS and EFF for promotion and marketing | | | |

| | *Timing* | *Responsibility (lead & others)* | *Monitoring (key indicators)* |
|---|---|---|---|
| *Objective:* | | | |
| **Encourage 'catching for the market'** | | | |
| *Management Measures* | | | |
| ▪ Increase minimum landing sizes for trawl and creel caught nephrops, scallops, brown and velvet crab<br>▪ Introduce maximum landing size for crawfish and reduce MaxLS for lobster<br>▪ Ban landing of crippled female lobsters<br>▪ Ban landing of berried female crawfish | 2012 | IFG, MS, Industry | Prices per kg and value of landings |
| *Data* | | | |
| Existing: Existing legislation in place for enforcement of minimum landing sizes | | | |
| Required: Amendments to existing legislation | 2012 | MS | |
| *Relationship with national measures (existing or proposed)* | | | |
| Develop issues raised at SFC Sub Group meetings | | | |
| *Additional funding/resources identified* | | | |
| *None* | | | |

| | *Timing* | *Responsibility* | *Monitoring* |
|---|---|---|---|

| | | | |
|---|---|---|---|
| | | *(lead & others)* | *(key indicators)* |
| *Objective:* | | | |
| **Assist industry in cost reductions** | | | |
| *Management Measures* | | | |
| ▪ Support fuel efficiency<br><br>▪ Gear adaptation methods | 2011 onwards<br><br>2012 | LCC,IFG,CNES MS, Seafish<br><br>IFG, MS, Industry | Progress report with LCC<br><br>Monitor discards fuel useage |
| *Data* | | | |
| Existing: Lews Castle College research on use of hydrogen approved 3 year EFF funding<br>Seafish studies on more cost effective and fuel efficient gear | | | |
| Required: | | | |
| *Relationship with national measures (existing or proposed)* | | | |
| Improve profitability of the fishing fleet | | | |
| *Additional funding/resources identified* | | | |
| EFF application submitted to Marine Scotland | | | |

| | *Timing* | *Responsibility (lead & others)* | *Monitoring (key indicators)* |
|---|---|---|---|
| *Objective:* | | | |
| **Reduce impact of fishing on the marine environment & develop more selective gear** | | | |
| *Management Measures* | | | |
| • Develop environmental aspects of the Seafish Responsible Fishing Scheme<br>• Review existing fishing prohibitions<br>• Reduce by-catch and marine organisation and small *nephrops* with larger mesh size in *nephrops* creels<br>• Promote use of scallop eco-dredge<br>• UK Scallop Good Practice Guide | 2012<br><br>2012<br><br>2012<br><br>2012<br><br>2012 | Seafish, SNH, GTA<br><br>MS, IFG<br><br>MS-Sci, IFG, Industry and Creel manufacturers<br><br>MS, IFG, SNH and Industry | Reduce discards<br><br>Local coordination of benefits<br>Additional data collection by vessels<br>Monitor catch rates, seabed impact and fuel consumption |

| *Data* | | | |
|---|---|---|---|
| Existing: Seafish RFS criteria, SISP project has commenced, Seafish report available on eco- scallop dredge, Code of Conduct in draft form | | | |
| Required: Progress with Seafish to develop environmental aspects of RFS. More research on use of eco-dredge and finalisation of Scallop Code of Conduct. | | | |
| *Relationship with national measures (existing or proposed)* | | | |
| Seafish Scallop Working Group to continue work on scallop dredge design and Code of Conduct for all sectors o the scallop sector | | | |
| *Additional funding/resources identified* | | | |
| Seafish with UK Scallop Working Group | | | |

| | *Timing* | *Responsibility (lead & others)* | *Monitoring (key indicators)* |
|---|---|---|---|
| *Objective:* | | | |
| ***Provide advice, training and facilities to available funding for fishermen*** | | | |
| *Management Measures* | | | |
| • Access to Sate Aid compliant credit facilities | 2011 | CNES, IFG, Banks | Monitor number of applicants and successful applications |
| • Fuel efficiency measures | 2011 | Seafish, CNES,Business Gateway LCC | |
| • Facilitate access to funding for new gear for pilot fisheries or adapt gear for conservation purposes | 2012 | IFG, MS | Monitor profitability of vessels |
| • Promote skipper training and training for marketing and improved handling practices | 2012 | GTA, IFG, Industry | Monitor numbers |
| *Data* | | | |
| Existing: CNES have details on range of business support schemes. Nationally recognised training schemes in place for catching sector. | | | |
| Required: Determine State Aid Compliant assistance. Develop selective gear for new fisheries | | | |

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|---|---|---|---|
| | | | |
| *Relationship with national measures (existing or proposed)* | | | |
| Scottish Seafood Training Partnership developing career pathways for all sectors of the fishing industry | | | |
| *Additional funding/resources identified* | | | |
| CNES already operate a loan guarantee with the Royal Bank of Scotland for business support | | | |

| | *Timing* | *Responsibility (lead & others)* | *Monitoring (key indicators)* |
|---|---|---|---|
| *Objective:* | | | |
| **Encourage new entrants into the industry at a sustainable level** | | | |
| *Management Measures* | | | |
| • Enhance Fisheries Support Scheme<br>• Promote Community Quota Scheme<br>• Promote Maritime Skills for Work | 2011 onwards | IFG,GTA,LCC, CNES, Seafish, SSTP, MS, Schools | Monitor number of applicants |
| *Data* | | | |
| Existing:<br>Business Gateway involved in Business Support. *Nephrops* Quota Scheme in operation. Maritime Skills for Work launched in Scotland. | | | |
| Required:<br>Assistance with developing state aid compliant assistance for vessel purchase. Access to promote fisheries within schools | | | |
| *Relationship with national measures (existing or proposed)* | | | |
| Marine Scotland keen to assist new entrants into the fishing industry | | | |
| *Additional funding/resources identified* | | | |
| CNES guarantee of £1M available plus £700,000 for Community Quota | | | |

| | *Timing* | *Responsibility (lead & others)* | *Monitoring (key indicators)* |
|---|---|---|---|
| *Objective:* | | | |
| ***Improve decision making and reduce conflict in the sector between other marine sectors*** | | | |
| *Management Measures* | | | |

| | | | |
|---|---|---|---|
| • Review access arrangements to improve cooperation amongst different fisheries sectors<br>• Engage with marine developers, aquaculture, marine renewables<br>• IFG Membership of Scottish Marine Regions<br>• Develop website | 2011<br><br>2011<br><br>2012<br><br>2012 | IFG, Industry, MS-C<br><br>IFG, CNES Planning<br><br>MS<br><br>IFG,MS | Monitor numbers of gear conflict<br><br>Transparent feedback from meeting |
| *Data* | | | |
| Existing:<br>Outer Hebrides Regional Initiative Project Board for Marine Renewables | | | |
| Required:<br>Develop links with Marine Planning, undertake mapping of areas of high economic importance to fisheries | | | |
| *Relationship with national measures (existing or proposed)* | | | |
| Marine Scotland Science mapping programme established for pilot areas | | | |
| *Additional funding/resources identified* | | | |
| Marine Scotland and Renewables Sector | | | |

**APPENDICES**

**APPENDIX 1**

OUTER HEBRIDES INSHORE FISHERIES GROUP CONSTITUTION

1. NAME

1.1. The name of the Group shall be the Outer Hebrides Inshore Fisheries Group ("the IFG").

2. OBJECTS

2.1. The IFG will have the following objects: --

2.1.1. to prepare, deliver, maintain and review management plans for the sustainable exploitation, management and regulation of sea fisheries within the IFG area, which is defined in the Schedule hereto and which hereinafter is called “the Area”;

2.1.2. to initiate and develop proposals which will serve in the implementation of the Management Plan and;

2.1.3. to assist Scottish Ministers in their task of creating a Scottish sea fishing industry that is sustainable and profitable and supports strong local communities, managed effectively as an integral part of coherent policies for the marine environment.

3. POWERS

3.1. In furtherance of the objects, the IFG may:-

3.1.1. employ or retain and pay any person or persons to supervise, organise and carry on the work of the IFG;

3.1.2. engage and pay fees to professional and technical advisers/consultants to advise or assist in the work of the IFG;

3.1.3. bring together in conference and work in liaison with representatives of voluntary associations or organisations, government departments, local and other statutory authorities and individuals;

3.1.4. take out membership of such associations or organisations as are considered to be in the interests of and compatible with the objects of the IFG;

3.1.5. promote and carry out or assist in promoting and carrying out research, surveys and investigations and, where considered appropriate, publish the results;

3.1.6. arrange and provide for or join in arranging and providing for the holding of exhibitions, meetings, lectures, classes, seminars and training courses;

3.1.7. subject to such consents as may be required by law, borrow or raise money, apply for and receive grants and accept gifts on such terms and on such security as shall be deemed to be necessary for the attainment of the objects;

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3.1.8. invest the money of the IFG not immediately required for the attainment of the objects in or upon such investments, securities or property is maybe thought fit, subject nonetheless to such conditions (if any) as may for the time being be imposed on required by law; and,

3.1.9. do all such other lawful things as are necessary for the attainment of the objects.

4. MEMBERSHIP

4.1. Membership of the IFG shall be open to:

4.1.1. Fishermen's Associations, as the term is commonly understood in Scotland, having in its membership the owners of 10 or more Scottish or UK Fishing vessels registered under the terms of the Merchant Shipping Act 1995 and holding a licence granted by the Scottish or UK Ministers and any one of which vessels fishes commercially in the Area ("Association member").

4.1.2. Owners, skippers and crew of a Scottish or UK fishing vessel registered under the terms of the Merchant Shipping Act 1995 and holding a licence granted by the Scottish or UK Ministers and which fishes commercially in the Area, but which vessel is not contained within the membership list of a Fishermen's Association in membership of the IFG ("Individual member").

4.1.3. Other persons or combination of persons representing a legitimate commercial fishing interest operating in the Area who, or which, are not eligible in terms of subclauses 4.1.1 and 4.1.2 as shall be admitted by the Executive Committee having regard to guidance from the National Coordinator and/or the Scottish Government.

4.1.4. Notwithstanding the terms of clause 4.1.1 hereof, an Executive Committee may admit in to membership, subject to such terms, as to it seem appropriate, a Fishermen's Association which does not meet the criterion of the minimum number of members.

4.2. Applications for membership shall be lodged with the Coordinator or with an office of the Scottish Fisheries Protection Agency (SFPA) situated within the Area.

4.3. The Coordinator shall have the right to demand of any applicant for membership such evidence as shall seem appropriate to the Coordinator to prove eligibility. The decision of the Coordinator, in the event of a refusal, may be appealed to the National Coordinator.

4.4. The Coordinator shall keep a register of the IFG Members and shall so far as practicable keep the same up to date. In addition he/she is required, formally, to review the eligibility of all members on a triennial basis and in doing so may require from any member such evidence as shall satisfy the Coordinator that a right to membership still exists. On completion of his/her review the Coordinator may terminate the membership of any member who or which fails to meet a criterion of membership. A decision of the Coordinator to terminate membership may be appealed to the National Coordinator.

4.5. The admission to, or the continuation in, membership of the IFG by any Association or Individual member may be objected to by any other member provided that the objection is restricted to a complaint that any one or more of the criteria for admission to membership was not, or is not being, met.

4.6. The objection shall be made in writing to the Coordinator, who shall so soon as practicable institute the procedure set out in sub-clause 4.4 hereof.

4.7. The membership of such persons or combination of persons as shall have been granted in terms of clause 4.1.3 hereof, may be terminated, if the Executive Committee so decides, acting reasonably and in accordance with guidance from the National Coordinator and/or the Scottish Government.

5. EXECUTIVE COMMITTEE

5.1. The IFG shall have an Executive Committee ("the Committee").

5.2. The membership of the Executive Committee shall comprise a representative nominated by each of the following Associations:

Anglo- Scottish Fishermen's Association

Clyde Fishermen’s Association

Orkney Fisheries Association

Mallaig & North West Fishermen’s Association

Scallop Association

Scottish Pelagic Fishermen’s Association Ltd

Scottish White Fish Producers Association Ltd

Western Isles Fishermen’s Association

5.3 an individual selected from amongst the Individual members (“the Independent Member”).

5.4 The individual shall be selected following the procedures outlined at sub-clause 5.7.1.

5.5 The term of appointment of the Independent Member shall be three years.

5.6 A Member of the Committee shall cease to be a Member of the Committee if he/she or the Association member he/she represents ceases to satisfy the eligibility criterion for IFG membership, or he/she being the representative of an Association member loses the nomination of that member.

5.7 Any vacancy in the Committee shall be filled so soon as reasonably practicable, in accordance with the procedures set out herein but in the interim the Committee is empowered to fill the vacancy by co-option.

5.8 The Independent Member shall be selected following an election.

5.8.1 The election shall be amongst those Individual members who have been nominated by least 10 other Individual members none of whom shall be connected to the same vessel. Thereafter, a postal ballot shall be arranged amongst Individual members according to the guidance that the Scottish Government may issue from time to time.

6 EXECUTIVE COMMITTEE POWERS

6.1 The Committee is vested with full powers to conduct the affairs of the IFG and to carry out its objects. The Committee shall control the funds of the IFG, be responsible for engaging and dismissing its employees or consultants and for securing the observance of this Constitution.

6.2 The Committee may delegate any of its powers either to officials, individual members or to committees of members set up for specific purposes. Such committees need not consist solely of members of the Committee

7 MEETINGS OF THE EXECUTIVE COMMITTEE

**Notice of Meetings**

7.1 Meetings of the Committee shall be held as the Committee shall agree or as the Chair shall direct.

7.2 Notwithstanding the terms of sub-clause 7.1 no less than one half of the Executive Committee may also, by written notice served on the Chair, require that a meeting of the Committee be convened

7.3 Unless all the members of the Committee agree otherwise, no less than 14 days written notice shall be given of any meeting of the Committee.

7.4 The calling notice shall specify the time and place of the meeting and, subject to the terms of sub-clause 7.10 hereof, the agenda shall specify the general nature of the matters to be discussed.

7.5 The non-receipt of notice of a meeting by any person entitled to receive notice shall not invalidate the proceedings of that meeting.

**Proxies and General**

7.6 Any Member of the Committee shall be entitled to grant any other member of the Committee or where an Association representative, another member of the Association or, where the Independent member another Individual member, a proxy entitling that other member to attend a meeting of the Committee on his behalf. The holder of the proxy is required to deposit the proxy with the Secretary of the meeting prior to the commencement of business and the Chair shall be bound to intimate granting of the proxy at the commencement of business.

7.7 The Chair shall have the power upon his/her own motion or at the request of any member of the Committee to admit any other person to attend and speak at a meeting of the Committee, if in the opinion of the Chair that person can contribute to the discussions of the Committee.

7.8 The Chair shall have the power, at his/her absolute discretion, upon his/her own motion or at the request of any member of the

Committee to allow any other person to attend, but not speak at a meeting of the Committee.

**Quorum**

7.9 The quorum for a meeting of the Committee shall be 40% of its membership.

**Decision Making**

7.10 Matters on which a decision of the Committee is required must be clearly indicated on the agenda with the reasons for the proposal being set out clearly.

7.11 The Committee shall strive to reach agreement on any matter before it.

7.12 Where an agreement can not readily be reached, the Chair, supported by the Coordinator, will endeavour to resolve the matter.

7.13 In the event that the procedure in sub-clause 7.12 does not result in agreement being reached, the Chair shall refer the matter via the Coordinator to SIFAG. SIFAG shall consider the matter and express an opinion, which may include a recommendation to put the matter to alternative dispute resolution, for further consideration.

8 EXECUTIVE COMMITTEE CHAIR AND DEPUTY CHAIR

**Chair**

8.2 The Committee shall, as soon as convenient following the constitution of the IFG and as is appropriate thereafter, appoint a Chair to hold office for three years.

8.3 The Chair shall be a person who appears to have no such financial or commercial interests as are likely to affect him or her in the discharge of his or her function as a chairman independent of the sea fish industry.

8.4 The Chair shall be appointed by the Committee, after proper public advertisement, and interview, upon such terms and conditions, including emolument, as shall be determined, from time to time by the Committee, following guidance from Scottish Ministers.

8.5 The Chair is required to declare any interest in the matters being discussed at the meetings of the Committee.

8.6 In the event of the Chair’s resignation, or for any other reason causing him or her to become unable to perform the duties of chair, the Committee shall have power to require the resignation of the Chair and shall thereafter appoint a substitute in accordance with the procedure set out in sub clause 8.3 hereof.

**Deputy Chair**

8.7 The Committee shall elect, annually, from amongst their number, a Deputy Chair. No person may hold the office of Deputy Chair for more than two consecutive years.

8.8 In the event of the Deputy Chair resigning or ceasing to be a member of the Committee, the Committee shall have power to elect a replacement to serve for the remainder of the term, this period of office not counting for the purpose of the requirement in the previous sub-clause.

9 FINANCE

9.2 The Committee shall appoint a Treasurer to keep proper accounts of the finances of the IFG.

9.3 All monies raised by or on behalf of the IFG shall be applied to further the objects of the IFG and for no other purpose, including payment of reasonable and proper remuneration to any employee of the IFG and fees to professional and technical advisers.

9.4 The accounts shall be independently approved at least once per year by the reporting accountants to the IFG.

9.5 An account or accounts shall be opened in the name of the IFG with a reputable financial institution, having its head office in the United Kingdom, as the Committee shall from time to time decide. The Committee shall authorise in writing such person or persons as it shall decide, to sign financial instruments on behalf of the IFG

9.6 The Committee shall have the power to authorise the payment of such sum as it considers appropriate, from time to time, to the Chairman in reimbursement of incidental expenses, including posts and telephones, incurred by him on the business of the IFG.

9.7 Reasonable expenses properly incurred by members of the IFG, or members of its Committee, or by any other person, in representing the IFG shall be reimbursed. The IFG at the AGM shall fix the rate of reimbursement, including a daily allowance fee for non-vouched expenses. The Committee shall have the power between the AGMs, in an emergency, to authorise additional payments.

10. IFG COORDINATOR

10.1. The IFG shall have an Inshore Fisheries Coordinator ("the Coordinator") who shall be responsible for assisting the IFG in the conduct of its business.

10.2. The Coordinator shall also be the Secretary of the Committee, and any subcommittees thereof and the Treasurer of the IFG.

11. IFG ADVISORY GROUP

11.1. The IFG shall be advised and assisted by an Advisory Group ("the Group").

11.2. The Group shall advise the Committee in the drawing of the Management Plan and any other proposal and/or initiative as may be appropriate with the aim of ensuring that the Committee takes into account relevant technical expertise, the relevant wider national and international policy context and the views of key stakeholders.

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11.3. The calling notice and the agenda of the Committee shall be served upon the members of the Group and when appropriate and relevant a request for the attendance of one or more members of the Group shall accompany the same. For the avoidance of doubt, the attendance of any member of the Group at a meeting of the Committee shall not be counted towards the quorum of the meeting.

11.4. The Group shall comprise representatives from the following:

Marine Scotland Science;

Marine Scotland Compliance

Scottish Natural Heritage;

Scottish Environment Protection Agency;

Comhairle Nan Eilean Siar

Highlands and islands Enterprise

Seafish;

Seafood-Scotland;

University of the Highlands and Islands;

Visit Scotland Outer Hebrides

RSPB;

Aquaculture Sector;

Shellfish Processing Sector;

Crown Estate

Marine Renewables Sector

11.5. Membership of the Group may include also such other persons or bodies as to the Committee seem relevant or having regard to guidance as may be issued from time to time by the Scottish Government.

11.6. The Committee shall consult the Group, or relevant members of the Group, in relation to any material decision that it proposes to take and to take into account the responses received to the consultation.

12. GENERAL MEETINGS

12.1. An Annual General Meeting ("AGM") of the IFG shall be held no later than three months after the end of its financial year at such place as the Committee shall determine. The Secretary shall give at least 21 days notice of the meeting in such manner as the Committee shall prescribe, but subject to the requirements of sub-clause 12.3 hereof. At such AGM the business shall include the consideration of the annual report of the work done by under the auspices of the Committee, including, specifically, a report of the implementation of the management plan, the approval of the independently verified accounts for the preceding year and the transaction of such other matters as may from time to time be necessary.

12.2. The non-receipt of notice of a meeting by, any person entitled to receive notice shall not invalidate the proceedings at that meeting.

12.3. Notice of the AGM shall not only be given to members of the IFG but to all members of the Group and so far as is possible to the public at large. The Committee shall endeavour to hold the AGM, in succeeding years in different locations adjacent to the Area and shall following the conclusion of the formal business arrange for a presentation, which will be of interest to the wider public, of its work or any subject concerned with its objects.

12.4. The Chair, with or without the consent of the Committee may, or at the request of the Committee shall, call a general meeting of the IFG. The Secretary shall give at least 21 days clear notice of the meeting setting out in sufficient detail the business of the meeting. For the avoidance of doubt the notice need only be served on members of the IFG.

**Voting and Proxies**

12.5. Only Members of the IFG shall be entitled to vote at General Meetings. Voting shall be on the basis of one vote per vessel, which habitually fishes commercially in the Area, or in the case of persons admitted to membership under clause 4.1.3, one vote per person or a combination of persons, as the case may be.

12.6. For the avoidance of doubt, an authorised representative of a Fishermen's Association may cast the total number of votes which otherwise the qualifying members of that Association, not present or represented at the meeting, could cast individually.

12.7. Prior to the commencement of business those intending to vote shall submit to the Coordinator their case for entitlement to vote and, where appropriate, the number of votes which they intend to cast.

12.8. The Coordinator shall inform the meeting of the applications received. The Chair shall consider objections made and answers thereto. The Chair's decision as to eligibility shall be final.

12.9. A member entitled to attend and vote at a General Meeting is entitled to appoint a Proxy to attend and vote instead of him or her. A proxy need not be a member of the IFG. On request, the Coordinator shall be bound to provide to any applicant a Form of Proxy.

12.10. To be effective, the instrument appointing a Proxy, and any Power of Attorney or other authority under which it is executed (or duly certified copy of any such power or authority) must be deposited with the Coordinator not less than 48 hours before the time for holding the General Meeting or at any adjournment thereof.

13. ALTERATIONS TO THE CONSTITUTION

13.1. The Constitution may only be amended at a General Meeting of the IFG called for that purpose.

13.2. The proposal shall require the endorsement of the Committee or failing that endorsement, the endorsement of SIFAG. It shall, in any event, require the prior endorsement of SIFAG and that of Scottish Ministers.

13.3. A proposal to amend the Constitution shall be carried if 75% of the votes cast are cast in favour of the proposal.

14. DISSOLUTION

14.1. If the Committee decides, at any time, that on the grounds of expense or otherwise it is necessary or advisable to dissolve the IFG, it shall call a general meeting of the IFG, of which meeting not less than 60 days notice (stating the terms of the resolution to be proposed thereat) shall be given.

14.2. The said notice shall also be served, for information, upon members of the Group and Scottish Ministers.

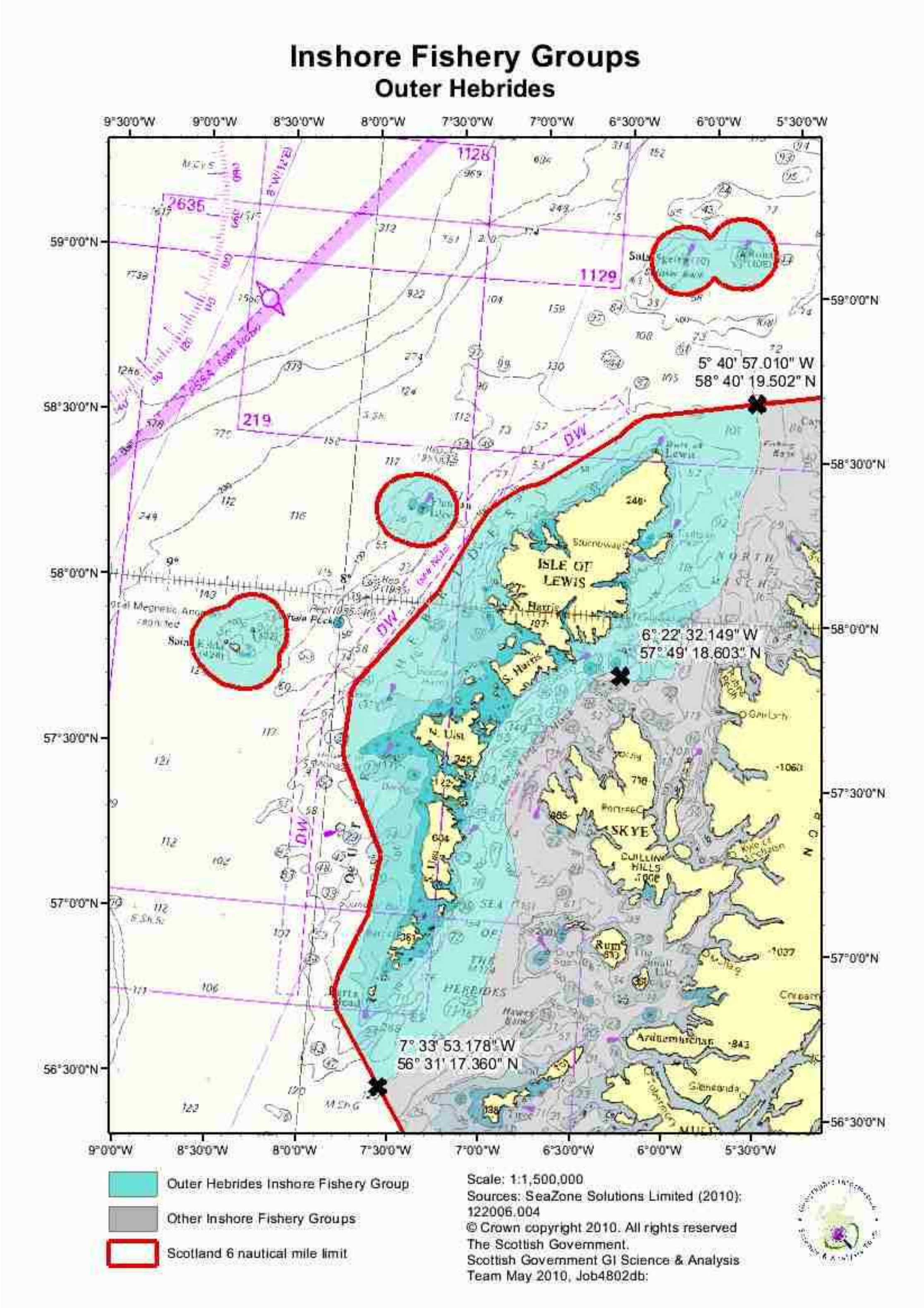
14.3. In the event that the notice is not withdrawn and if the decision is approved by 75% of the votes cast at such general meeting, the Committee shall have the power, under the direction of SIFAG, to dispose of any assets held by or on behalf of the IFG and thereafter to dissolve the IFG.

## SCHEDULE

Definition of the Area:

The sea area between the Outer Hebrides and the mainland is divided into three main areas, the North Minch, the Little Minch and the Sea of the Hebrides. In the North Minch, the Outer Hebrides Inshore Fisheries Group forms a boundary with the neighbouring North West Inshore Fisheries Group between Kinlochbervie and the Northern tip of Skye. A further boundary with the Small Isles and Mull Inshore Fisheries Group lies between the Northern tip of Skye and an area South of Barra Head. The boundaries with neighbouring Inshore Fisheries Group are similar to the sea areas covered by the Marine Regions within the Marine Bill.

The boundary to the West of the Hebrides is contained within an area out to 6 nautical miles offshore from baselines between the Butt of Lewis and Barra Head. A 6 nautical mile radius around St Kilda, the Flannan Isles, North Rona and Sula Sgeir is also included within the boundaries of the Inshore Fisheries Group.


Inshore Fishery Groups
Outer Hebrides
5° 40' 57.010" W
58° 40' 19.502" N
6° 22' 32.149" W
57° 49' 18.603" N
7° 33' 53.178" W
56° 31' 17.360" N
ISLE OF LEWIS
SKYE
Outer Hebrides Inshore Fishery Group
Other Inshore Fishery Groups
Scotland 6 nautical mile limit
Scale: 1:1,500,000
Sources: SeaZone Solutions Limited (2010): 122006.004
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The Scottish Government.
Scottish Government GI Science & Analysis Team May 2010, Job4802db:

## GUIDANCE ON THE CONSTITUTION

### NAME

This clause is self-explanatory. The IFG name should reflect the geographical coverage of the IFG which for ease of reference could also be abbreviated.

### OBJECTIVES

The objectives of the IFG as indicated here should be the core objectives of any IFG. They are based on discussions that we have had with inshore fishing interests, including the Scottish Inshore Fisheries Advisory Group. However, an IFG may decide to adopt further objectives or undertake other activities to further or complement these core objectives depending on its particular requirements and local circumstances.

The main objective of the IFG will be that of producing and driving the implementation of the **Management Plan** which will realise in practice the Strategic Framework high level objectives within the IFG area. However, it will be important for an IFG whilst developing the plan to take into account the policy and legislation context which has led to the setting up of the IFGs and the introduction of a new approach to inshore fisheries management, such as

- the need to adapt inshore fisheries management to the changes to and demands on Scottish inshore fisheries;
- the need to strike a fair balance amongst biological, environmental, economic and social priorities ;
- the need to recognise the diversity of roles and responsibility of stakeholders in the inshore sector;
- the need to give fishermen a strong voice with the aim of achieving improved governance in the inshore sector; and
- the relevant legislation and policies at national and international level; and
- the social and economic needs of the local communities that depend on the fisheries in the IFG area.

In furtherance of the above objectives, an IFG will be able to exercise a number of powers which will enable an IFG to undertake certain activities, e.g. employ staff, pay professional fees for services received, take up membership of other associations or organisations etc. In any event, the exercise of these powers could not undermine the IFG's objectives and contravene other provisions of the Constitution.

To ensure the realisation of the IFG's objectives, all individuals involved in the IFG should be encouraged to pursue the best interests of the whole inshore commercial fishing sector in the IFG. They should also work together towards the collective interest of the fisheries in their area from which everyone will benefit in respect of all matters which are to be discussed at meetings and conduct themselves with transparency and in a fair and equitable manner and be seen to do so.

## IFG MEMBERSHIP

An important principle of the IFGs will be that all individuals with an active commercial interest in the inshore fisheries in the IFG's area will be eligible for membership of the IFG.  This will include:

- **Fishermen's Associations** which have at least 10 registered vessels in their membership and operating commercial in the IFG area; and

- **Individuals from the Independent Sector** (non-affiliated to any Fishermen's Association or Trade Organisation), i.e. owners, skippers and crew of a registered vessel operating commercially in the IFG.

The effect of this is that owners, skippers and crew of an eligible vessel will be required to register their interest in an IFG in writing - either with the Local Coordinator or an office of the SFPA - to become members.

Depending of the local circumstances of an IFG, others commercial fishing interests in the area – for example hand-gatherers, cockle pickers, divers etc. – may also become members of the IFG.  When coming to a view on such matters, the Executive Committee should draw on guidance from the IFG National Coordinator and/or SIFAG.   Further, the Executive Committee will have discretion to admit to the IFG membership Fishing Associations which do not meet the minimum criteria for membership, i.e. vessel number.

The establishment of the IFG will be publicised in the local and/or national media so that eligible prospective members wishing to join the IFG may register their interest.

The IFG Local Coordinator will maintain a register of IFG members and keep members up-to-date with IFG activities.

Any IFG member will be able to object to the membership and/or continuation of another IFG member, if it is believed that they do not meet the eligibility criteria for IFG membership. Objections should be made in writing to the IFG Local Coordinator in the first instance who will investigate the grounds on which the objection has been made and advise of their decision as soon as is possible. The decision of the Local Coordinator may be appealed to the National Coordinator whose decision will be final.

## IFG EXECUTIVE COMMITTEE

An IFG will need an Executive Committee to implement the requirements of the Constitution and ensure that the IFG's work fits, proposals and plans fit with overarching and national strategic objectives for inshore fisheries.  It is important that the IFG includes as many as possible of the fishermen operating in the area and the Executive Committee's membership should reflect the IFG's inclusive and diverse nature.

The Executive Committee needs to have links back to the membership of the IFG. The simplest way of achieving this is through the involvement of **Fishermen's Associations (FAs)** whose members operate commercially in the IFG area. The Associations will appoint their representatives to the Executive Committee. They will have clear accountability back to their membership who are, in turn, members of the IFG.

It is important also that IFG members from the **independent sector**, i.e. those fishermen who are not affiliated to any Fishermen or Trade Association, have an opportunity to participate in the Executive Committee. The Scottish Government recognises that these individuals can not have the same kind of representative accountability to other independent fishermen as the FA representatives do to their membership. The Scottish Government believes that the independent sector's participation in the Executive Committee can be done best by appointing (via an election process outlined below) a single "spokesperson", i.e. a nominee, from the independent sector to speak for, on as collective a basis as is possible, the independent sector's interest on the IFG Executive Committee.

The membership of the Executive Committee will comprise of **one representative of each sector**, i.e. one representative from each of the relevant Fishermen's Associations within the IFG area and one representative from independent sector (non-affiliated fishermen).

The **method of appointing a representative from the independent sector** to the Executive Committee will be **election.** This process will give independent fishermen the opportunity to be involved in the IFG and its Executive Committee in an open, transparent and fair way.

The **electoral process** will essentially consist of **a postal ballot**. The IFG Coordinator will place a public notice in the relevant media, inviting people to register an interest in the emerging IFG and asking:

(i) to indicate whether they are or are not members of a FA; and

(ii) whether they wish to be considered as a prospective candidate for election to the IFG's Executive Committee.

The resulting list will in effect form an 'electoral roll' of the IFG's independent sector fishermen, as well as identifying those who are eligible to stand for election. Independent fishermen who have registered an interest in the IFG may put themselves forward as candidates for the Executive Committee with the support of **at least 10 independent fishermen** none of whom should be associated to the same vessel. Subsequently, a postal ballot will be arranged to elect a representative to the Executive Committee.

The electoral process outlined above will also apply to the appointment of those identified under the terms of paragraph 4.1.3 to the Executive Committee, i.e. hand-gathers etc.

The term of the appointment of representatives from either Fishermen's Associations or the independent sector or others identified under the terms of paragraph 4.1.3 to the Executive Committee will be three years.

As stated earlier, the Executive Committee members drawn from the independent fishermen in the IFG area will not have the same direct accountability to a body of membership as the FA representatives. However, they should apply their best efforts to put across the general view of the independent fishermen with an interest in the area and, in keeping with all members of the IFG's Executive Committee, to promote the interests of the IFG as a whole.

In addition, it would be open always to any independent fishermen to put their views directly to the IFG at a members' meeting or to approach the IFG's Chair or co-ordinator to ask them to present their views to the Executive Committee.

Irrespective of whether an Executive Committee member represents a FA or the independent sector, it is important that all Committee members act in the best interests of all those eligible for membership of the IFG and in the wider interests of the fisheries in the IFG area.

**EXECUTIVE COMMITTEE POWERS**

The Committee will have powers to control IFG funds, employ and dismiss employees in observance of the Constitution and under the terms of paragraph 3.1.

**MEETINGS OF THE EXECUTIVE COMMITTEE**

**General:** these meetings are the means whereby the members of the Executive Committee conduct the IFG's business. Meetings will be aimed mainly at considering issues relating to the development and implementation of the Management Plan, but they will also provide a forum for discussing a wide range of subjects, for example issues affecting the IFG's fisheries and initiatives; interaction or conflict between IFG and/or fishing and other marine activities; representations from stakeholders; preliminary consideration of proposals on new initiatives prior to seeking the views of the Advisory Group, IFG members and other stakeholders.

**Collective interest, dialogue and consensus**: it is important that the Executive Committee works towards the collective interest of the fisheries from which everyone in the area will benefit. The Executive Committee should work in a spirit of openness and trust, making decisions and progressing initiatives through dialogue, compromise and consensus. Everyone's views should be valued and taken into account.

**Proxies and Quorum:** if any member of the Executive Committee cannot attend a meeting, he/she is entitled to nominate a proxy to attend meeting under the terms of 7.6 provided that the proxy is submitted to the Secretary of the meeting, i.e. the Local Coordinator, prior to the meeting. The Chair has discretion to admit any other person at the meeting of the Executive Committee, e.g. guest speakers, observers etc. The quorum for the meetings, i.e. the minimum number of members required to be present at the meeting before it can validly proceed with its business, is 40% of the Executive Committee members.

An IFG could agree a different quorum depending on local circumstances. However - to avoid stasis - we recommend that the thresholds of the quorum necessary to hold a meeting and the majority needed for a decision should be kept as low as possible.

IFGs should state what the quorum will be in their constitution or rules of procedure from the outset so that it is clear to all those involved. The quorum should only be amended through the procedures for revision of the Constitution at paragraph 13.

**Decision making**: in reaching a decision the Members of the Committee should take account of the full range of relevant factors, including contrary views and concerns of those eligible for membership of the IFG and other stakeholders in the fisheries in the IFG.

It will be important that FA representatives on the Executive Committee should attend with a sufficient mandate from their members to enable them to discuss, agree and progress issues within reasonable timescales at the meetings.

Decisions should be made by **consensus-building** and the Executive Committee should strive to reach agreement on any matter being considered.

This measure aims to incentivise dialogue, compromise and agreement, rather than a reliance on voting and the settling differences by numerical weight rather than strength of argument.

**Conflict Resolution**: there may be times when these arrangements may not result in a satisfactory and productive outcome. It is therefore important to have a process to resolve conflict in the IFG.

In the first instance, IFGs should endeavour to mediate and resolve any issue and/or conflict within the IFG. The Chair of the IFG should act as mediator between the parties involved, supported in this task by the IFG coordinator. The Chair may seek advice and support from other relevant locally or nationally available resources, such as community mediation centres, non-interested parties in the area and professional mediators.

Once all the options to resolve the conflict within the IFG have been exhausted, the Chair may refer the matter via the IFG coordinator to SIFAG. SIFAG will consider any issues referred to it and express an opinion about the matter to the IFG for further consideration; this, for example, could include a proposal that the matter be referred to mediation.

In exceptional circumstances, issues may be referred to the Scottish Government for consideration or decision.

## EXECUTIVE COMMITTEE CHAIR AND DEPUTY CHAIR

The Chair of the Executive Committee should be independent in the discharge of his/her duties and have no commercial connection with a financial interest in the fishing sector within the IFG area. It is however desirable that the Chair should have some knowledge of the fishing industry and wider fishing policy context. Individuals currently serving on the Executive Committee will be ineligible for appointment.

The Chair has both a leadership and an interpersonal role. He/she will lead the IFG towards its primary goal of better governance in the inshore sector. He/she will lead and manage the Committee's business, providing clear direction and focus on the aims and objectives of the IFG, promoting constructive debate and effective decision-making at meetings, ensuring that the necessary expertise and the wider policy context and other relevant interests are taken into account in the decision-making process.

The Chair will be responsible for ensuring that meetings are properly structured, run smoothly and follow the agreed agenda. The Chair will oversee the production of the Committee's annual report on the IFG's activities.

The Chair will fulfil an interpersonal role by developing a productive relationship between and amongst the Members, acting as an 'honest broker' and mediator when problems and conflicts arise. The Chair will have to declare any interest in the matters being discussed

The Chair is expected to adhere to high personal and professional standards, and to develop and maintain the good reputation of the IFG. It is expected that the Chair's conduct should be in line with the standards set out by the Standards Commission for Scotland.

The Chair will be recruited through an open recruitment process by the Executive Committee. The position should be advertised locally and/or nationally as appropriate and Members of the Executive Committee - with the support of the IFG Local Coordinator - will drive the recruitment process. Terms and conditions of appointment, including any emolument, will be determined by the Executive Committee taking into account guidance from Scottish Ministers.

The IFG Chair will be appointed for a three year period. A person may be appointed Chair for any number of consecutive periods.

The Executive Committee will have the power to appoint a new Chair in the event of the Chair's resignation or Chairs becoming unable to fulfil his/her duties.

To ensure that IFG business is dealt with effectively in the temporary absence of the Chair, e.g. illness, other engagements etc, the Executive Committee will have to elect a Deputy Chair amongst themselves on an annual basis. The

Deputy Chair will hold office for one year and cannot be re-elected for more than two consecutive years.

The Executive Committee will elect a new Deputy Chair in the event of the Deputy Chair resigning or ceasing to be a member of the Executive Committee.

**FINANCES**

This clause is self-explanatory. The finance arrangements will ensure that the IFG finances are properly managed and accounted for. It is essential that the IFG accounts are approved by an independent professional accountant.

**IFG COORDINATOR**

Co-ordinators will assist IFGs in conducting their business, including by providing technical advice.

The Coordinator will work closely with the Executive Committee Chair, Executive Committee members and the wider membership of the IFG.

The Coordinator will fulfil three main roles within the IFG:

- providing administrative support;
- providing intelligence and information; and
- interfacing with other bodies and institutions.

The IFG Coordinator will be part of a larger team of Coordinators, servicing other IFGs and reporting to the **IFG National Coordinator**. The IFG National Coordinator will help IFGs with all aspects of their formation, including: establishing membership, based on agreed eligibility criteria; identifying the potential members of the Executive Committee; and supporting the nomination or election process to identify the independent sector's representatives to the Executive Committee.

Additionally, the Scottish Government and its Agencies will provide assistance, and in some circumstances specific guidance, to the IFGs as appropriate.

**IFG ADVISORY GROUP**

We consider it is important that the Executive Committee is able to draw on scientific and technical advice in developing the Management Plan. They may also find it helpful to have ready access to the views of key stakeholders and those who will implement some of the measures in the Management Plan.

The Executive Committee should therefore have an Advisory Group of relevant experts and key stakeholders. The Executive Committee should consult and liaise with the Advisory Group as appropriate to ensure that input from the relevant experts and interests is sought before finalising a decision on the Management Plan or other matter.

The Executive Committee should invite Members of the Advisory Group to its meetings as and when appropriate giving reasonable notice but its members shall neither form part of the quorum, nor be entitled to vote

The Executive Committee will have duty to invite representatives from the following organisations:

- Marine Scotland Science;
- Marine Scotland Compliance
- Scottish Natural Heritage;
- Scottish Environment Protection Agency
- Highlands and Islands Enterprise;
- Seafish;
- Seafood Scotland;
- Environmental NGOs which are in membership of Scottish Environment LINK, or from time to time as it may be appropriate, another environmental NGO which the Executive Committee will consider to be appropriate

The Executive Committee may also invite - according to the local circumstances and as it appears reasonable to SIFAG - representatives from other bodies and locally relevant stakeholders to its meetings.

Consultation with the Group will ensure that the IFG develop robust proposals for legislation that enjoy credibility and are well supported by the whole fishing sector in the IFG's area and by other interested parties.

**MEETINGS OF THE IFG MEMBERS AND IFG PUBLIC MEETINGS**

**General:** Annual General Meetings ("AGM") are meetings where the Executive Committee will bring the IFG members together who will be able to share perspectives and concerns, hear other points of view, identify issues and agree resolutions for action.

It is a forum where the Executive Committee will share information and exchange ideas on the management of the IFG fisheries, and in particular the Management Plan. These meetings could also be a useful forum to discuss any other issues that may affect the IFG fisheries and ways of working in partnership with other stakeholders and developing relationships.

It will be beneficial for an IFG to also provide an opportunity for all stakeholders to hear about the activities of the IFG and meet the Executive Committee. To this end AGMs will have to be held in public and move locations within the IFGs' geographical area. Attendance will be open to all IFG members as defined earlier as well as the Advisory Group members and other relevant stakeholders, including interested members of the public. They will also be able to attend and speak at the meetings and pose question to the Executive Committee albeit they will not have any voting rights.

The IFG Coordinator will make the necessary arrangements for the meeting including advertising it as appropriate.

In the interests of openness and transparency, the AGM should consider:

- **an annual report, including a progress report on the implementation of the Management Plan;**
- **the approval of the independently verified accounts;** and
- **any other matter as it may be relevant**

Indeed, the Executive Committee may wish to agree an IFG communication plan with the aim of keeping the IFG members and the wider stakeholder community informed of their activities.  The IFG coordinator will assist in the development and implementation of the plan and the setting up an IFG website, newsletter, stakeholder database etc.

**Voting and Proxies:** only members of the IFG will be entitled to vote. In the case of Fishermen’s Associations or nominees from the independent sector, voting will be on the basis of **one vote per vessel**. To ensure that at the AGM business is dealt with smoothly and efficiently, an authorised representative of a Fishermen’s Association may cast the total number of votes which the members of that Association, not present or represented at the meeting, could cast individually. In the case of people admitted to the IFG membership under paragraph 4.1.3, voting will be on **one vote per person**. IFG members entitled to vote at the AGM, if unable to attend the meeting, can appoint a proxy to vote on his/her behalf. A proxy form can be obtained from the Local Coordinator and has to be submitted to the Coordinator 48 hours prior to the meeting.

## ALTERATION OF THE IFG CONSTITUTION AND IFG DISSOLUTION

Again these clauses are self-explanatory. Procedures covering the revision of the IFG Constitution and dissolution of the IFG must be settled given their significance and their possible wider implications for the IFGs and inshore fisheries policy in general.  We consider the wording given here must be therefore considered to be the minimum basic requirement in respect of dissolution.

It is expected that IFGs’ operational arrangements will be tested on the ground so that their procedures can be refined and improved as IFGs work progresses. To this end, it is envisaged that IFG coordinators will, from time to time, report to SIFAG on IFG operation and any other issue that may affect a particular IFG.

**APPENDIX 2**

**ACCESS CODE RODEL & HARRIS PRAWN AREA**

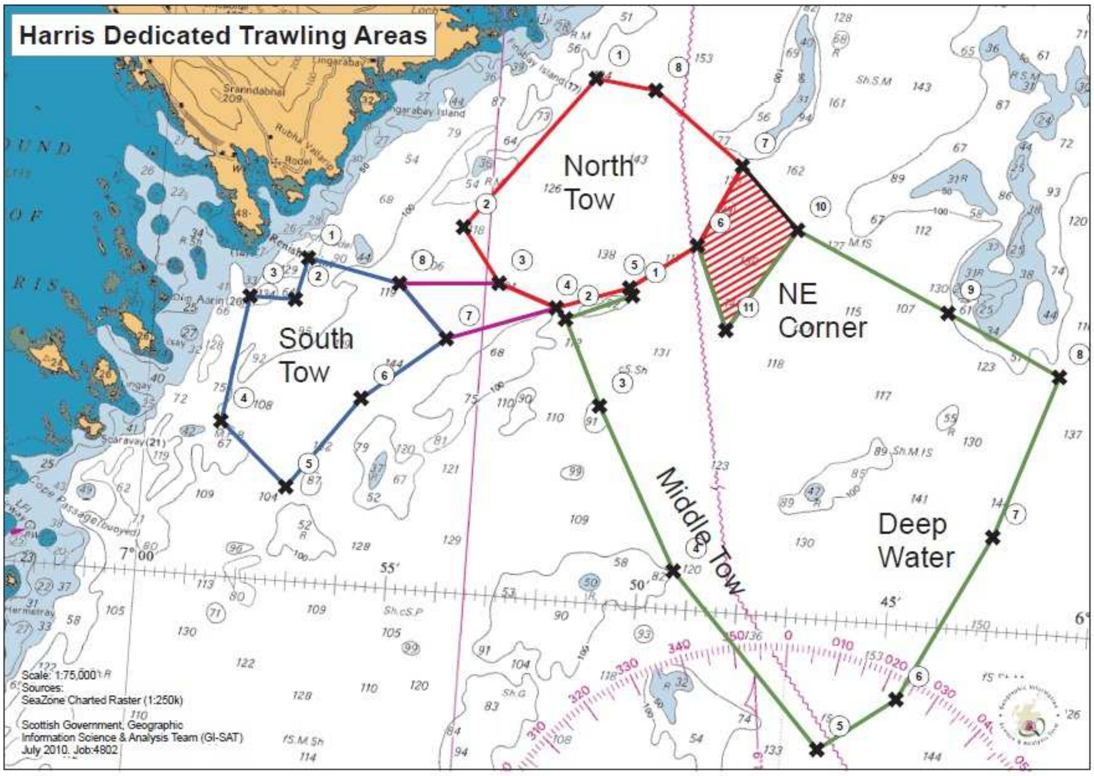
- Static gear will be marked by buoys, the minimum size of which will be 40" circumference.
- The registration and number of the vessel will be clearly marked on each buoy.
- **<u>Mobile vessels must make contact with one of the listed vessels to ascertain the position of static gear prior to operating inside of the zones.</u>**
- Static gear MUST NOT be set within the recognised tow area.
- The VHF contact channel for the area will be channel 11
- Mobile vessels must not commence fishing operations during the hours of darkness unless they have ascertained during the hours of daylight that the area fished is clear of static gear.
- Any static gear not being fished should be reported to the Fishery Office, so that arrangements can be made for it to be lifted.
- Vessels which accidently tangle with gear are asked to notify local vessels, Fishery Office or WIFA with the readings of where gear has been dropped so that it can be recovered by the owner and to prevent further damage to other gear.
- The following telephone contact numbers cover Harris area:

Mobile vessels:

| | | |
|---|---|---|
| LEAD US | Roddy Morrison | 07990513352 |
| TRUE VINE | Finlay E MacLeod | 07747773831 |
| COCQUET HERALD | John MacDonald | 07879331780 |
| Static Vessels: | | |
| KORONA | Murdo Ferguson | 07748612441 |
| MY GIRLS | Neil MacAulay | 07775987500 |

In the case of any problems contact can be made with:

| | | |
|---|---|---|
| Donald Morrison | Senior Fishery Officer | 01851703291 |
| Duncan MacInnes | IFG Coordinator | 01851702385 |


Harris Dedicated Trawling Areas
North Tow
South Tow
NE Corner
Middle Tow
Deep Water
Scale: 1:75,000
Sources:
SeaZone Charted Raster (1:250k)
Scottish Government, Geographic Information Science & Analysis Team (GI-SAT)
July 2010, Job:4802

## READINGS FOR TRAWL TOWS AT RODEL

| NORTH TOW | | MIDDLE TOW | |
|---|---|---|---|
| 1. 45.58N | 51.53W | 1. 43.30N | 50.50W |
| 2. 43.90N | 53.96W | 2. 43.00N | 51.80W |
| 3. 43.33N | 53.17W | 3. 42.10N | 51.00W |
| 4. 43.11N | 52.00W | 4. 40.40N | 49.30W |
| 5. 43.38N | 50.57W | 5. 38.61N | 46.20W |
| 6. 43.88N | 49.28W | | |
| 7. 44.76N | 48.50W | | |
| 8. 45.50N | 50.33W | | |
| **SOUTH TOW** | | **DEEP WATER TOW** | |
| 1. 43.45N | 57.00W | 6. 39.20N | 44.70W |
| 2. 43.00N | 57.20W | 7. 41.00N | 43.00W |
| 3. 43.00N | 58.10W | 8. 42.75N | 41.90W |
| 4. 41.65N | 58.50W | 9. 43.35N | 44.20W |
| 5. 41.00N | 57.12W | 10.44.12N | 47.31W |
| 6. 42.00N | 55.75W | 11.43.00N | 48.60W |
| 7. 42.70N | 54.14W | | |
| 8. 43.25N | 55.15W | | |

**NOTES:**

1. **SHADED AREA AROUND OUSTIDE NORTH TOW IS TOWED BY VISITING TRAWLERS.**

2. **AREA BETWEEN NORTH TOW AND SOUTH TOW TO BE KEPT CLEAR TO CONNECT THE TWO TOWS.**

**APPENDIX 3**

**CHICKEN HEAD TO CELLAR HEAD AREA**

**1 NOVEMBER – 31 MARCH**

**IN DEPTHS BELOW 100 METRES**

- Static gear will be marked by buoys, the minimum size of which will be 40" circumference.

- The registration and number of the vessel will be clearly marked on each buoy.

- Mobile vessels must make contact with one of the listed vessels to ascertain the position of static gear prior to fishing shallower than 100 metres

- The VHF contact channel for the area will be channel 11

- Mobile vessels must not commence fishing operations during the hours of darkness unless they have ascertained during the hours of daylight that the area fished is clear of static gear.

- Any static gear not being fished should be reported to the Fishery Office, so that arrangements can be made for it to be lifted.

- Vessels which accidentally tangle with gear are asked to notify any of the named vessels, Fishery Office or IFG Coordinator, with the readings of where gear has been dropped so that it can be recovered by the owner and to prevent further damage to other gear.

- The following telephone contact numbers cover the area:

  Mobile vessels:

| | | |
|---|---|---|
| SIARACH | Calum MacLeod | 07814447081 |
| SHEIGRA | Peter MacDonald | 07818035481 |
| COMRADE | Iain Murray | 07880553968 |
| WAVE CREST | Calum MacDonald | 07879497308 |

Static Vessels:

| | | |
|---|---|---|
| CARLSBAY | Douglas Craigie | 07747481692 |
| DELTA DAWN | Jamie MacDonald | 07796614801 |
| RABBIE B | Iain MacDonald | 07796488550 |

In the case of any problems contact can be made with:

| | | |
|---|---|---|
| Donald Morrison | Senior Fishery Officer | 01851703291 |
| Duncan MacInnes | IFG Coordinator | 01851702385 |

**APPENDIX 4**

*Outline Proposal for a Research Project under the*

*Scottish Industry / Science Partnership (SISP) Scheme*

***Please complete this form giving as much detail as possible. A Liaison Officer can be appointed at an early stage to help you with your proposal if you feel this would be beneficial. Contact the Scottish Industry / Science Partnership (SISP) Secretariat to arrange this.***

***Note: Text boxes should automatically expand as details are added. Paper versions of this form may be obtained from the SISP Secretariat – see section 7 for contact details.***

**1. Summary – Proposer(s) Details**

| | |
|---|---|
| **Industry**<br>Name and address of all industry individuals, institution(s) or organisation(s) involved in the proposal.<br><br>Note:<br>1. For organisations or institutions, please name a contact person.<br>2. Please include phone and email details. | Duncan MacInnes<br>Outer Hebrides Inshore Fisheries Group<br>Craigard<br>Newvalley<br>LEWIS HS2 0DW<br>d_macinnes@scotlandifg.co.uk<br>01851 701230<br>07748332595<br><br>Dr Anne McLay<br>Inshore Fisheries Group Leader<br>Marine Scotland – Science<br>Marine Laboratory<br>PO Box 101<br>375 Victoria Road<br>ABERDEEN AB11 9DB<br>01224 295463<br>mclaya@marlab.ac.uk |
| **Project Title** | The effects of mesh size on catch composition in the *Nephrops* creel fishery |

**2. Summary - Project details**

| | | | |
|---|---|---|---|
| How long do you estimate the project will take? | I year (plus time for data analysis) | When do you propose the project should start? | April 2010 |

| | |
|---|---|
| How much do you estimate the project will cost? (think about consumables, vessel costs, travel costs, etc) | £13,800 - see breakdown provided |

COST FOR PRAWN MESH SIZE PROPOSAL

| | £ |
|---|---|
| *Vessel costs for 20 days @£150/per day | 3,000 |
| Science observer time 30 days at £150/per day | 4,500 |
| Observer T&S for 2 visits to Aberdeen | 1,000 |
| Personal Protective Equipment | 300 |
| Science observer 20 days local / mileage travel | 1,000 |
| 80 Escape panels | 100 |
| Digital calipers & sampling equipment | 500 |
| 40 prawn creels with 44mm mesh @£25.00 each | 1,000 |
| | 11,400 |
| **MSS Science observer T&S and SGAL | 1,000 |
| Contingency repairs etc | 1,400 |
| TOTAL | 13,800 |

*Costs estimated for vessel to supply prawn creels with 32mm, 36mm and 40mm mesh sizes, recompensed for loss of fishing time etc.
** May not be required

Note. MSS staff time not costed

**3. What do you plan to do?**

Describe briefly (e.g. 200 words) the problem which is to be tackled by the project

The project addresses the problem of the undesirably high proportion of small *Nephrops* caught in the creel fishery. It seeks to identify a more appropriate mesh size for *Nephrops* creels to retain those animals required by and of most value to the live market and to reduce the discards of both *Nephrops* and other species.

The *Nephrops* creel fishery in the Western Isles, and in other areas on the west coast of Scotland, has increased significantly over the last 20 years. The value of creel landings from the Western Isles to the year ending October 2009 was £3M, equal to the value of landings from the trawl fishery. *Nephrops* creel landings from the area account for approximately 20% by value of the Scottish total.

Currently, the mesh size most commonly used in the creel fishery is 32 mm. Fishermen report significant discards (up to 50%) of undersized or small prawns, smaller than those required for the live market, and variable discards of other species that are returned to the sea. Many of the *Nephrops* discarded are eaten on the surface by sea birds. The remainder may not survive return to the seabed. From a stock conservation perspective, it would be better if these were not caught in the first place.

Current minimum landings sizes for *Nephrops* west of Scotland are total length of 70 mm or carapace length of 20 mm These apply equally to the creel and to the trawl fishery which supplies / a tail or fresh whole or frozen market. However, virtually, all creel caught *Nephrops* are sold to the live market, mostly in Spain, which requires animals of 110 mm overall length or 32 mm carapace length or over.

It is proposed to carry out fishing trials to evaluate the effects increasing the mesh size used in the *Nephrops* creel fishery to improve the selection pattern and to enable fishermen to ‘catch for the market’.

Outline the scientific basis for this work

Recent ICES assessments show a decline in *Nephrops* abundance in the North Minch functional unit and stable but lower abundance in the South Minch. The latest ICES advice was for a significant reduction in fishing mortality and a 50% reduction in TAC for VIa as a whole. It is important therefore that measures which have the potential to reduce fishing mortality, whilst maintaining a sustainable fishery are investigated.

Despite the increase in the creel fishery, Marine Scotland Science currently undertake only limited observer monitoring of the *Nephrops* creel fishery. There have been no systematic studies on the effects of mesh size on catch composition and there is no scientific basis on which to advise on an optimal mesh size for the fishery in the Western Isles. Monitoring of the Marine Stewardship Council accredited fishery in Loch Torridon, where fishers use creels with 38 mm mesh fitted with escape panels has shown that these measures lead to selection of larger prawns, very few animals of <30 mm carapace length are retained in these creels. This and other studies (eg Adey, 2007) have also shown significant seasonal variation in catch composition and catch rates of males, females and berried females which are related to the biology of the animal.

Increasing creel mesh size from the current 32 mm used in the Western Isles has the potential to allow a higher proportion of smaller *Nephrops* to escape from creels either when the creels are in situ on the sea bed or when they are hauled and significantly reduce discards of *Nephrops* and other species, which are also caught in creels.

It is estimated there are currently up to 80 vessels using around 100,000 prawns creels in the Western Isles fishery, and up to 500,00 *Nephrops* creels deployed on the west coast as a whole, all contributing to significant discards and associated mortality of small prawns. The improved selection pattern in the creel fishery (assuming no increase in total creel effort or change in the trawl fishery exploiting the same stock) should result in a greater proportion of mature individuals in the stock and as a consequence, in an increase in the expected long-term average spawning biomass. Although the relationship between spawning biomass and recruitment is uncertain in *Nephrops* stocks, an increased biomass should reduce the likelihood of the stock suffering reduced reproductive capacity.

The proposed study will evaluate the effects of creel mesh size on *Nephrops* catch composition and provide information required for the improved management of the creel fishery in the future.

List the main objective(s) of the project

To investigate the effects of creel mesh size and escape panels on catch composition in the *Nephrops* creel fishery in the Western Isles

To identify the most appropriate mesh size to retain *Nephrops* of a size required for the live market.

To evaluate the effects of creel mesh size and escape panels on landings and discards of *Nephrops* and other non target species

To provide data on seasonal variation in catch rates of berried females (which could also inform future management of the fishery)

Give details of how you think the work should be done

.

It is proposed that a scientific observer, working on board a static gear vessel will record *Nephrops* catch composition in creels of covered with 32, 36, 40 and 44 mm mesh and 32 and 36 mm mesh creels fitted with escape panels. Creels would be randomly arranged on 2 strings of up 120 creels in total and deployed over fishing grounds in the Sound of Harris and North Uist area. Those grounds where one of the first in Scotland where the *Nephrops* creel fishery was developed in 1982.

The observer will make measurements of the carapace length of all *Nephrops* captured in each creel. These will be recorded along with information on sex and female maturation status (berried or non-berried) and details of other species caught in the creels. Test strings would be deployed on four separate occasions over a 12 month period, ideally once in each quarter. This is considered to be the minimum necessary to evaluate the effect of mesh size or escape panels on catch composition against the background of seasonal variation observed elsewhere.

The effects of mesh size and escape gaps on catch composition will be assessed using statistical models including mesh size, creel, string and seasonal effects. These and other data on catch rates and landings will be analysed and reported at the end of the project.

A fishing vessel, appropriately recompensed, would be expected to supply 120 creels - equal numbers with mesh size of 32, 36 and 40 mm. Forty creels with 44 mm mesh size would be purchased for the project, and a further 80 creels, 40 with 32 and 40 with 36 mm mesh fitted with escape panels will be required.

**4. Why do you think this project is important?**

Briefly summarise the main benefits of the project, including the intended use of results

The *Nephrops* creel fishery is becoming increasing valuable to the Western Isles economy and it is vital that research is undertaken to protect the fishery and the stocks on which it is based. Creel caught *Nephrops* are currently selling at about £8,000 per tonne and increasing the mesh size has the potential to protect stocks for local communities where alternative employment opportunities are virtually non existent.

The main benefits of the project will be information to improve management of the creel fishery, at both the IFG and Government level. It should be possible to determine the effects of increasing mesh size on selection and identify an optimum size which enables fishers in the Western Isles to maximise returns by fishing for the market. Adopting larger meshes would reduce *Nephrops* discards and potentially fishing mortality which would be beneficial to the stock.

Results will also provide the OH IFG with information about the proportion of berried females in the catch at different times of year, and allow them to consider whether seasonal prohibitions on landings of berried females should be adopted as part of their management plan.

Comparing the effectiveness of escape panels and increases in mesh size could offer fishermen transitional alternatives to improve stock management. Fitting escape panels being considerably cheaper in the short term than recovering creel with new larger meshes.

Creel manufacturers supplying *Nephrops* creels to Swedish and Norwegian fishermen have indicated that fishermen there require a minimum mesh size of 40 mm for those creel fisheries. Furthermore, creel manufacturers are fully supportive of increasing the mesh size as they could cover creels quicker and that should reduce manufacturing costs.

Give reasons why Scottish Partnership support should be given to this project

The *Nephrops* creel fishery has been expanding rapidly over the last 25 years with no restrictions other than a category A or B licence and a minimum landing size that does not reflect the sizes required by the live market. The Scottish Partnership should support a project which seeks to maximise value of the catch whilst reducing fishing mortality and discards.

Increasing the mesh size in the prawn creel fishery has the potential to substantially reduce discards of small prawns and other species and improve the fishery in the future. Most of the previous research on mesh size in the *Nephrops* fishery has been targeted at the trawl fishery and it is important to also obtain information to inform management of the expanding creel fishery.

The prawn creel fishery is of huge social and economic importance to the Western Isles and many other coastal communities on the west of Scotland with very few alternative employment opportunities. The average price of creel caught prawns is in the region of £8,000 per tonne and the project represents very good value for money in terms of future benefits to communities adjacent to inshore localised prawn stocks.

How will the results advance the aims of the Partnership?

The work will build on current cooperation between MS Science and the recently formed Outer Hebrides Inshore Fisheries Group.

It will provide science to inform management measures proposed by the OH IFG measures which are aimed at stock conservation and improved sustainability of a valuable inshore shellfish with long term benefits to the local stocks and the communities which fish them.

**5. Outline Input of Participants**

What is required of participants in this project? Describe their possible input to the project (e.g. skills, knowledge or contribution in kind to the project).

Please note: All proposals have a Liaison Officer within Marine Scotland Science and you may find it helpful when completing this form to discuss your idea with them. Please contact the SISP Secretariat for contact details of this Liaison Officer.

Marine Scotland Science (MSS) would tender for an appropriately qualified scientific observer to collect data aboard a *Nephrops* static gear vessel. The observer would visit the Marine Laboratory to be appraised of the requirements for the project, experimental design and to receive training in measurements and recording of catch. The observer will liaise with the Outer Hebrides Inshore Fisheries Group to determine the most suitable periods to go to sea, to reflect fishing patterns and seasonal variations in catch rates.

The observer will conduct work all at sea. An observer from Marine Scotland Science might also accompany them initially, if thought necessary. The observer would maintain close contact with MSS throughout the course of the project and provide MSS with data in the electronic format. MSS would be responsible for data analysis.

The OH IFG will advise on seasonal patterns of fishing activity and the most suitable grounds in the Sound of Harris and North Uist area on which to conduct the study.

MSS would work with the observer and the Industry partner to disseminate results and produce the final report.

**1.**

**6. Declaration**

Declaration:

I confirm that I have read this application and that Marine Scotland Science may show this application to third parties for the purposes of assessing its scientific merits. If the idea contained in this proposal is selected for funding, it may go to competitive tender.

Industry Contact 1

Name and initials: Duncan MacInnes

Organisation/Address: Outer Hebrides Inshore Fisheries Group
Craigard, Newvalley, Isle of Lewis HS2 0DW

Signature:

Date: 5 February 2010

[Repeat for all main industry contacts involved]

If you do not have a science contact yet then leave next section blank.

Science Contact 1

Name and initials: Anne McLay

Organisation/Address: Marine Scotland – Science, Marine Laboratory, PO Box 101, 375 Victoria Road, ABERDEEN AB11 9DB

Signature:

Date: 5 February 2010

[Repeat for all main science contacts involved]

**7. Submission**

Please submit the completed proposal form to;

The Scottish Industry / Science Partnership Secretariat
c/o Joyce Petrie
Marine Scotland Science
Marine Laboratory
PO Box 101
375 Victoria Road
Aberdeen
AB11 9DB

Email: partnership@marlab.ac.uk
Fax: 01224 295511

**APPENDIX 5**

School of Biological Sciences
University of Aberdeen

# Squid Fishing Trials in Coastal Waters West of Scotland

For the Western Isles Fishermen's Association

Title: Squid fishing trials in coastal waters west of Scotland.

Client: This document was prepared for and commissioned by the Western Isles Fishermen's Association.

2.

Project Manager: Graham Pierce, University of Aberdeen

Prepared by: L. Hastie, G. Pierce, P. Luque

Date of Issue: 10th of March 2007

# 3. Contents

4.

# 1. Introduction

Cephalopods (essentially squid, cuttlefish and octopods) are arguably the most promising future global fishery resource because of their abundance and rapid stock renewal, related to the short life cycle (Guerra, 1996). Despite these advantages, it is estimated that the world catch of cephalopods represents only 10% of stocks detected (Guerra, 1996). Cephalopods are short-lived molluscs, characterised by rapid growth rates, and are important predators and prey in oceanic and neritic environments. They can range in length from 1.5 cm in pygmy (bobtail) squid (Sepiolidae) to 20 m in giant squid (Architheutidae). Cephalopods exhibit the highest degree of development in invertebrate nervous systems, expressed through complex behaviour patterns such as the ability to learn and the display of complex colour changes. In contrast to other molluscs, most cephalopods lack an external shell, are highly mobile as adults, and occupy similar ecological niches to predatory fish.

Squid are active predators at all stages of their life-cycle and generally regarded as opportunistic, taking a wide variety of prey. Cannibalism has been frequently recorded. Cephalopods also sustain a number of marine top predators such as fish, birds and marine mammals, especially whales (Santos *et al.*, 2001). Many species are powerful swimmers and undertake long feeding and spawning migrations, thus influencing prey and predator communities strongly on a seasonal and regional basis. Squid often interact with commercial fisheries of finfish. Evidence exists that fishing pressure has changed ecological conditions and shifts in community structures have occurred, with cephalopod stocks slowly replacing predatory fish stocks (Caddy & Rodhouse, 1998). The commercial significance of squid and other cephalopods to world fisheries is of relatively recent, but growing, importance (Boyle & Pierce, 1994).

Squid play an important role in the northeast Atlantic ecosystem and are becoming an increasingly important fisheries resource (Collins *et al*., 1995). There is a little information on abundance and fine scale distributions of squid species in the literature. Collins *et al*., (1995) used demersal trawl survey data in the Irish Sea to investigate the distribution and demography of *Loligo forbesi* and also reported catches of other cephalopod species. Pierce *et al*. (1998) used Scottish demersal trawl survey data to describe the spatial distribution and density of *L. forbesi* in the North Sea, Rockall, west of Scotland, west and south west of Ireland.

This preliminary report describes the results of experimental squid fishing trials in coastal waters west of Scotland, commissioned by Highlands and Islands Enterprise. It focuses on the main species of fishery importance, the loliginid squid *Loligo forbesi.* Brief accounts of other commonly occurring squid species in waters west of Scotland are also provided.

**24.**

## 25. 2. Important squid species in the north east Atlantic

### 25.1

### 25.2 2.1. Loligo forbesi (Veined squid)

*Loligo forbesi* (Steenstrup, 1856) is a neritic long-fin squid species occurring in coastal waters and continental shelf seas from 20° N (NW Africa) to 60° N (SW Norway) in the eastern Atlantic, including the North Sea and the Mediterranean Sea (Roper *et al.* 1984). It is the most frequently caught squid species, and forms the basis of a significant by-catch fishery in UK waters (Pierce *et al.* 1994), with annual landings as high as 3500 t (Collins *et al.* 1997). At certain times *L. forbesi* is actually targeted, notably on Rockall Bank in summer (Pierce *et al*., 1994) and in the Moray Firth in autumn (Young *et al*., 2006). In 2005, small-scale directed squid fisheries started in several other localities, including off Skye. *Loligo forbesi* is an annual, semelparous species (i.e. it breeds once then dies, Holme, 1974) showing extended breeding seasons with, depending on the area, one, two or several pulses of recruitment. *Loligo forbesi* in Scottish waters spawns mainly from December to February although breeding animals are also recorded in May. Two main periods of recruitment are found in April and July-November, with small numbers of recruits present throughout most of the year (Boyle & Pierce, 1994).

Animals mature over a range of sizes with males generally growing bigger than females. The two recruitment periods identified for Scottish waters produce distinctive sized-based cohorts (Collins *et al.*, 1999). Mature squid are recorded throughout Scottish waters in winter and eggs of *L. forbesi* have been recorded in trawls off Shetland (Lum-Kong *et al.*, 1992) and are regularly found on creel lines along the Scottish coastline. Although spawning grounds have not yet been documented it has been indicated from the analysis of spatial patterns in fishery data that *L. forbesi* move from the West Coast of Scotland into the North Sea to spawn (Waluda and Pierce, 1998). Although they are short-lived species, fecundity in loliginid squids is surprisingly low, with female *L. forbesi* apparently producing only a few thousand eggs in their lifetime (Boyle *et al.*, 1995).

The main Scottish (by-catch) fishery for *L. forbesi* occurs in coastal waters and usually exhibits a marked seasonal peak around October-November, corresponding to the occurrence of pre-breeding squid (Howard, 1979; Young *et al*., 2006). Analysis of fishery data collected between 1980 and 1990 indicated that *L. forbesi* was widely distributed on the continental shelf and also occurred on offshore banks – notably Rockall (Pierce *et al.*, 1994). Data from trawling surveys by R/V Scotia support a wide distribution and also highlight the patchy nature of its distribution. Pierce *et al*., (1998) presented data from demersal trawl surveys along the west coast of Scotland during November (1990-1994), which showed that highest catches of *L. forbesi* occurred north of Ireland near the Stanton Bank area (~3,200/hr in one haul). Good catches also occurred north and west of the Hebrides and in Donegal Bay, whereas catches south and west of Ireland were relatively poor. Recent analysis of long-term trends in abundance points to the possible influence of oceanographic conditions on squid abundance (Pierce & Boyle, 2003).

### ***25.3*** *2.2.* Alloteuthis subulata *(European common squid)*

*Alloteuthis subulata* (Lamarck, 1798) is a long-fin squid species often taken in hauls alongside *L. forbesi*. It is considered to be a demersal species, mainly occurring in shallow coastal waters of 20-120 m depth (Roper *et al*., 1984), although it has been taken at depths down to 500 m (Guerra, 1982). *Alloteuthis subulata* is a very small squid (typically <15 cm ML) and there is no market for this species in the UK at present. Consequently, it is normally discarded from trawls if caught. However, large catches of *A. subluta* could be marketed overseas as food ('baby squid') or in the UK as bait for the recreational sea fishing industry (small, 'hook-sized' squid, currently imported frozen, are sought after by anglers and considered to be premium bait). Due to its small size and slim body form, it is likely that most individuals are not retained in commercial trawling gear. There are no landings data for waters west of Scotland, although some information on abundance is available from trawl surveys. It is often the most common cephalopod encountered during surveys of shallow, coastal waters (Collins *et al*., 1995).

The only recent studies on the reproductive biology of this species in UK waters were by Rodhouse *et al.* (1988) and Nyegaard (2001) based on samples collected in the English Channel and Irish Sea, respectively. These studies showed that mature animals occur during spring and summer, and juveniles dominate the population in the autumn. Nyegaard (2001) found that the spring and autumn distribution of *A. subulata* in the Irish Sea was related to physical factors and local hydrographical features. *Alloteuthis subulata* appear to prefer warm, saline water. Peak abundance was found in association with the warmest part of the Irish Sea in both March and October. Similar observations have been made for both *Loligo forbesi* and *A. subulata* in the North Sea (Waluda & Pierce, 1998).

### *25.4 2.3.* Todaropsis eblanae *(Lesser flying squid)*

*Todaropsis eblanae* (Ball, 1841) is a bentho-pelagic short-fin squid species found in the Mediterranean, throughout the Eastern Atlantic from 36°S (South Africa) to the Shetland Islands, and in shelf waters of the South Pacific (Arkhipkin & Laptikhovsky, 2000). It is associated with sandy to muddy bottoms within a temperature range from 9 to 18º C in depths ranging from 20 m to 700 m (but confined to depths less than 200 m in the North Sea) (Guerra, 1992). *T. eblanae* exhibits a so-called “intermittent spawning pattern” (Boletzky, 1975) or “intermittent terminal spawning pattern”. Partial ovulation allows for the presence of oocytes at various stages of development and thus continuous production of ova once spawning has commenced (Rocha *et al*., 1996).

At present, *T. eblanae* is not exploited commercially by the UK fleets and consequently there is little information on this species in waters west of Scotland. However, reports from adjacent waters indicate that it can at times be widespread and abundant in the NE Atlantic. Lordan *et al*. (2001) studied the distribution and abundance of cephalopod species caught during demersal trawls surveys west of Ireland and in the Celtic Sea. The most numerous species in catches was *L. forbesi* followed by *T. eblanae,* which was concentrated close to the shelf break in most years. However, in 1994 there were also large catches off the south coast of Ireland. It is also reported to be super-abundant in the North Sea in some years, a phenomenon possibly linked to hydrographical anomalies such as high-salinity influxes of Atlantic seawater (Hastie *et al*., 1994).

# 26. 3. Methods

## 3.1. Fishing trials

Squid fishing trials were carried out in the shallow waters of the Minch using a local fishing vessel, *Comrade SY 337* (length 16.5 m, power 374 hp), based in Stornoway. Three local grounds were fished: waters off Stornoway (N 58$^{o}$10' W 06$^{o}$20'), Shiant East Bank (N 58$^{o}$01' W 06$^{o}$11') and off Kebock Head (N 58$^{o}$07' W06$^{o}$15'). Two types of demersal trawling gear were used, as traditionally employed by Scottish fishermen to target prawns and squid, respectively. The prawn gear had a coarse (60 mm) mesh bag and was set to run directly over the seabed. The squid gear had a fine (40 mm) mesh bag and was set slightly higher in order to run in the water column just above the seabed.

## 3.2. Catch compositions

Squid and fish caught during the tows were identified, counted and measured on board. Squid mantle lengths (ML, to nearest 0.5 cm) were recorded on field data sheets (Table A1, Appendix). Based on the length-frequency data obtained, catch weights were estimated using published species length-weight relationships for squid (Pierce *et al*., 1994) and finfish (Coull *et al*., 1989).

## 4. Results

### 4.1. General

A total of eight tows (= four each using the prawn and squid gears) were carried out on 8–11th November 2005. Tables 1–2 provide brief catch summaries for the hauls using prawn and squid gears, respectively. Full details of all hauls, including exact locations, fishing times and catch breakdowns are provided in Tables A2–A3 in the Appendix.

At the time of writing the present report, data from other trips and other boats, where we were unable to place an observer on board, had not been received. Some additional work has recently been carried out by SEAFISH – the Comrade SY 337 has been fitted with SCANMAR and other instrumentation to monitor gear performance. Unfortunately, owing to a present lack of squid on the grounds, no data are yet available (M. Montgomery, *pers. comm.*).

### 4.2. Performance of prawn gear

No data were collected for haul 1 using the prawn gear since no observer was available onboard. From the remaining three hauls, a total squid catch of 380 individuals, weighing 44.21 kg was achieved. Three species were caught, the long-fin *L. forbesi* (*n* = 325, wt = 37.41 kg), short-fin *T. eblanae* (*n* = 54, wt = 6.8 kg) and a small, unidentified sepiolid species (*n* = 1, wt <0.01 kg). Of the catch, *L. forbesi* comprised 86% by number and 85% by weight, whilst *T. eblanae* comprised 14% by number and 15% by weight (Table 1). A total of 127 fish (11 species, wt = 103.65 kg) were by-caught using the prawn gear. The overall proportion of squid caught was ~30% by weight and a squid:fish weight ratio of 1:2.34 was recorded.

**Table 1. Squid and fish caught using prawn gear.**

| Date | Haul | LF No. | LF Wt.(kg) | TE No. | TE Wt.(kg) | SE No. | Wt.(kg) | SQUID No. | SQUID Wt.(kg) | FISH No. | FISH Spp. | FISH Wt.(kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 08.11 | 1 | *nd* | *nd* | *nd* | *nd* | *nd* | *nd* | *nd* | *nd* | *nd* | *nd* | *nd* |
| 09.11 | 1 | 173 | 24.48 | 50 | 6.43 | 0 | 0 | 223 | 30.91 | 34 | 6 | 4.69 |
| 10.11 | 2 | 33 | 4.64 | 4 | 0.37 | 1 | <0.01 | 38 | 5.01 | 52 | 8 | 22.92 |
| 10.11 | 4 | 119 | 8.29 | 0 | 0 | 0 | 0 | 119 | 8.29 | 41 | 9 | 76.04 |
| Overall | | 325 | 37.41 | 54 | 6.80 | 1 | <0.01 | 380 | 44.21 | 127 | 11 | 103.65 |

LF = *Loligo forbesi*, TE = *Todaropsis eblanane*, SE = Unidentified sepiolid.
Full details provided in Tables A1-A2 (Appendix). *nd* = no data available.

## 4.3. Performance of squid gear

Four hauls using the squid gear yielded a total squid catch of 414 individuals, weighing 31.34 kg. Two species were caught, *L. forbesi* (n = 411, wt = 31.34 kg) and an unidentified sepiolid species (n = 3, wt <0.01 kg). Of the catch, *L. forbesi* comprised 99% by number and >99% by weight (Table 2). A total of 87 fish (14 species, wt = 183.50 kg) were by-caught using the squid gear. The overall proportion of squid caught was ~15% by weight and a squid:fish weight ratio of 1:5.81 was recorded.

**Table 2. Squid and fish caught using squid gear.**

| Date | Haul | LF No. | LF Wt.(kg) | TE No. | TE Wt.(kg) | SE No. | Wt.(kg) | SQUID No. | SQUID Wt.(kg) | FISH No. | FISH Spp. | FISH Wt.(kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 08.11 | 2 | 96 | 5.89 | 0 | 0 | 3 | <0.01 | 99 | 5.89 | 24 | 3 | 8.52 |
| 09.11 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 7 | 6.00 |
| 10.11 | 1 | 24 | 3.87 | 5 | 0.23 | 0 | 0 | 29 | 4.10 | 37 | 9 | 167.06 |
| 10.11 | 3 | 291 | 21.58 | 0 | 0 | 0 | 0 | 291 | 21.58 | 21 | 6 | 1.91 |
| Overall | | 411 | 31.34 | 0 | 0 | 3 | <0.01 | 419 | 31.57 | 87 | 14 | 183.50 |

LF = *Loligo forbesi*, TE = *Todaropsis eblanane*, SE = Unidentified sepiolid,
Full details provided in Tables A1-A2 (Appendix).

## 4.4. Squid catches

Although comparable numbers of long-fin squid (and similar size ranges) were caught using both gears, there were significant differences in the predominant sizes observed. As figure 1 demonstrates, relatively large numbers of smaller squids (*L. forbesi*, ML <13 cm) were caught using the squid gear. Both histograms indicated apparent bimodal or possibly multi-modal size distributions. This was also observed in a small sample of measured short-fin squid (*T. eblanae*) that exhibited two size modes, at 10 cm ML and 13 cm ML (Fig. 2).

Figure 1. Length-frequency histograms of long-fin squid (*L. forbesi*) caught using prawn and squid gears (sample sizes in parentheses).

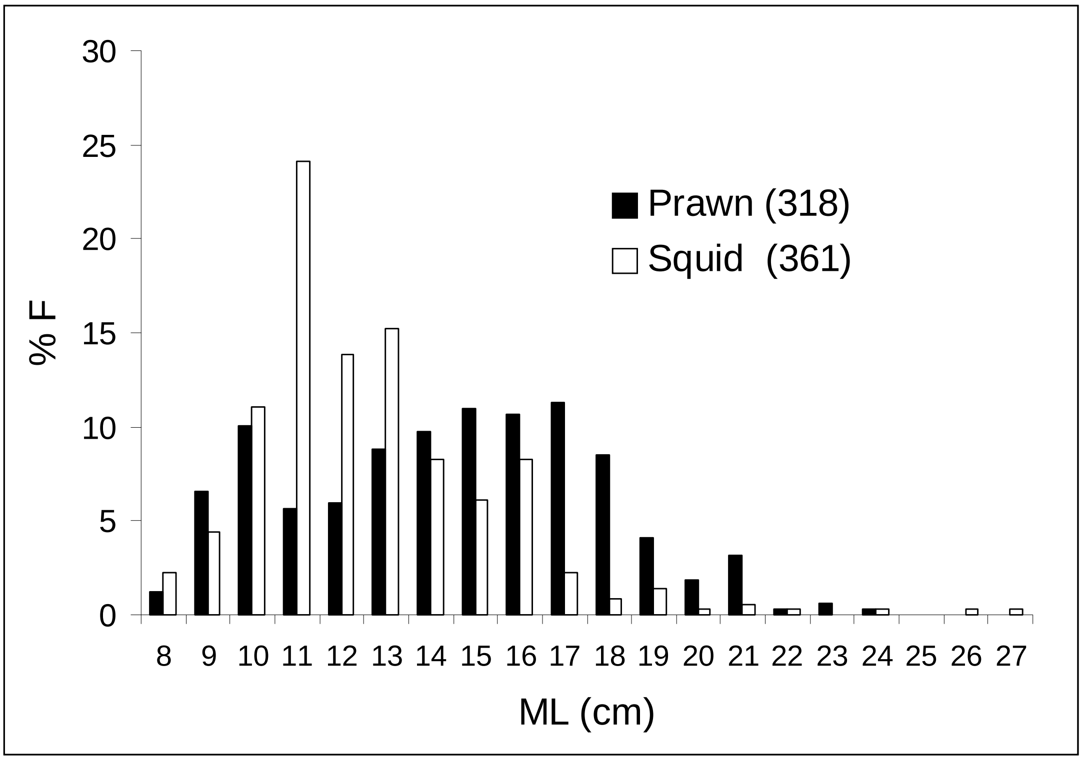
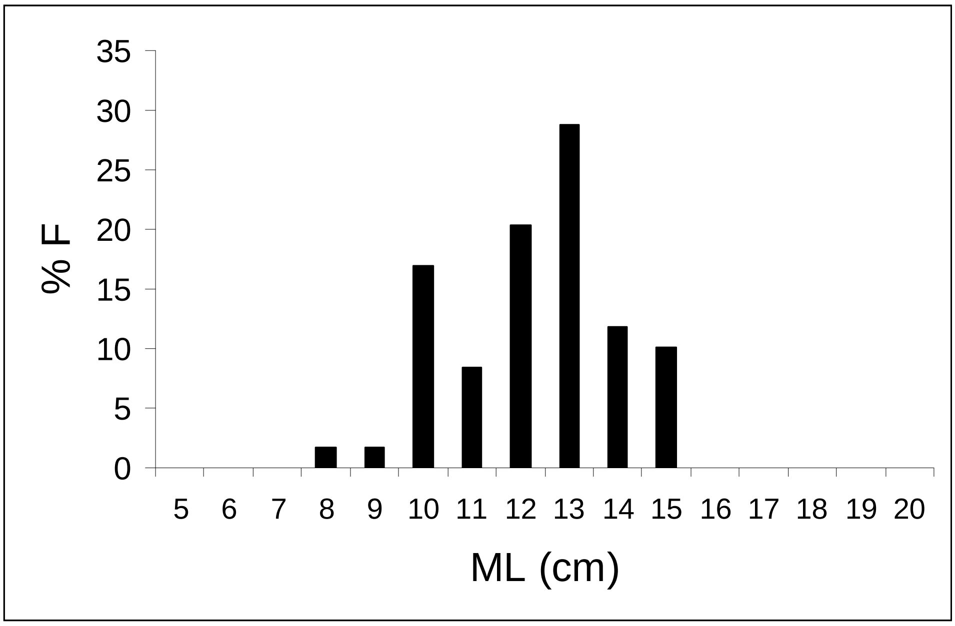



Figure 2. Length frequency histogram of short-fin squid (*T. eblanae*) caught (both gears, sample size: $n$ = 59).



### 4.5. Finfish by-catches

Overall numbers and estimated weights of fish by-catches are provided in Table 3. Totals of 15 species and eight species were by-caught using the prawn and squid gears, respectively. Horse mackerel were the most common caught species by number using both gears (*n* = 38 and 215, respectively). The biggest catches by estimated weight were angler-fish (16.86 kg) using the prawn gear and cod (90.78 kg) using the squid gear. However, these were based on a few large, heavy individual fish that were caught. Significant numbers of marketable haddock, hake and whiting and small herring were also caught, using both gears. Bottom-living species, including eels, rays and flatfish were only caught using the prawn gear (Table 3).

Table 3. Fish species by-caught using prawn and squid gears.

| Species | | Prawn gear | | Squid gear | |
|---|---|---|---|---|---|
| | | Quantity | Weight (kg) | Quantity | Weight (kg) |
| Angler-fish | *Lophius piscatorius* | 6 | 1.12 | 2 | 90.78 |
| Cod | *Gadus morhua* | 2 | 16.86 | 3 | 28.84 |
| Conger eel | *Conger conger* | 2 | *nd* | | |
| Cuckoo ray | *Raja naevus* | 5 | *nd* | | |
| Dab | *Limanda limanda* | 11 | 0.97 | | |
| Grey gurnard | *Eutriglia gurnardus* | 14 | 0.83 | | |
| Haddock | *Melanogrammus aeglefinus* | 31 | 3.58 | | |
| Hake | *Merluccius merluccius* | 11 | 2.15 | 4 | 3.21 |
| Herring | *Clupea harengus* | 20 | 1.17 | *nd* | *nd* |
| Horse mackerel | *Trachurus trachurus* | 38 | 6.20 | 215 | 32.39 |
| John Dory | *Zeus faber* | | | 8 | *nd* |
| Lesser spotted dogfish | *Scyliorhinus canicula* | 1 | *nd* | 2 | *nd* |
| Ling | *Molva molva* | 1 | *nd* | | |
| Plaice | *Pleuronectes platessa* | 13 | 5.65 | | |
| Spurdog | *Squalus acanthias* | 1 | *nd* | 2 | *nd* |
| Whiting | *Merlangius marlangius* | 15 | 1.55 | 90 | 12.23 |

Weights estimated using length-weight keys (Coull *et al*., 1989). *nd* = no data available (not measured).

## 8. Discussion

These preliminary results demonstrate that substantial numbers of marketable squid can be caught by small, inshore fishing vessels operating in shallow coastal waters west of Scotland. With further investigation and refinements of fishing gear, it may be possible to increase catches of squid significantly. The two gears used during this survey, adapted in different ways either for prawn trawling or for small squid have been traditionally used for a few weeks every year by Scottish east coast fishermen targeting squid in a late summer fishery that operates annually in the Moray Firth (Young *et al*., 2006).

Larger numbers of small squid caught using the squid gear compared with the prawn gear was expected, since a smaller mesh size is utilised with the former (40 mm in squid gear as opposed to 60 mm in prawn gear). Very little has been done on the selectivity of commercial nets for squid. Preliminary studies based on research vessel data indicate that squid are selected by trawl cod-ends in a similar fashion to fish (Hastie, 1996).

**27.**

The squid size distributions in figures 1–2 were based on small sample sizes, due to the limited nature of this pilot study – more data are required. Thus the apparent profiles may not accurately reflect the real population structures in waters west of Scotland. However, the presence of several size modes, indicating pulses of recruitment have previously been observed for *L. forbesi* in Scottish waters (Pierce *et al*., 1994; Collins *et al*., 1997).

It is interesting that more fish species were by-caught using the prawn gear than the squid gear. The former was set to hug the seabed whereas the latter was set to run 1-2 m above the seabed. This may explain why a number of bottom-living species (eels, rays, flatfish) were only caught using the prawn gear. According to east coast fishermen operating in the Moray Firth, the use of small mesh squid bags (set to run above and not on the seabed) provides far cleaner (less by-catch) hauls of squid and these are of much better quality than those caught using prawn gears.

The results in this short study indicate that, in coastal waters off the west of Scotland, substantial numbers of squid can be caught using both gear types. The fish by-catch included a number of marketable species that may also be utilized. However, many of these species are subject to numerous management restrictions (including quotas, gear restrictions and minimum landing sizes). Therefore the most appropriate type of gear utilized to target squid will depend on a number of factors relating to the market and current legislation. Research on stock assessments, gear improvements, discarding levels and the selectivity of gears currently used to catch squid is urgently required. A squid fishing project, recently initiated by SEAFISH may help to address some of these concerns.

## 8. Acknowledgements

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**28.**

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***29.1***

## Appendix

| **TABLE A1. Squid data sheet.** | | | | |
|---|---|---|---|---|
| Boat: | Observer: | Gear: | Time: | Tidal cycle: |
| Date: | Longitud: | Latitude : | Fishing area: | |
| Depth: | Ground type: | Temp: | Sea state: | Turbidity: |
| Haul No: | Time start shooting: | Hauling out: | Haul duration: | |
| % Sample: | Total catch weight p/haul : | | | |

| No. squid | Species | ML | Sex | Stage | No. squid | Species | ML | Sex | Stage | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | 1 | | | | | |
| 2 | | | | | 2 | | | | | |
| 3 | | | | | 3 | | | | | |
| 4 | | | | | 4 | | | | | |
| 5 | | | | | 5 | | | | | |
| 6 | | | | | 6 | | | | | |
| 7 | | | | | 7 | | | | | |
| 8 | | | | | 8 | | | | | |
| 9 | | | | | 9 | | | | | |
| 0 | | | | | 0 | | | | | |
| 1 | | | | | 1 | | | | | |
| 2 | | | | | 2 | | | | | |
| 3 | | | | | 3 | | | | | |
| 4 | | | | | 4 | | | | | |
| 5 | | | | | 5 | | | | | |
| 6 | | | | | 6 | | | | | |
| 7 | | | | | 7 | | | | | |
| 8 | | | | | 8 | | | | | |
| 9 | | | | | 9 | | | | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | | | | 0 | | | | | |

**ABLE A2. Summary of squid catches.**

| | GEAR | GROUND TYPE | HAUL No | FISHING AREA | TIME SHOOTING | LATITUD | LONGITUD | TIME HAULING NET | LATITUD | LONGITUD | TIDAL CYCLE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1/2005 | 1 | 1 | 2 | OFF STORNOWAY | 15:13 | N 58º 09.789' | W006º 19.635' | 16:53 | N 58º 08.216' | W006º 18.440' | |
| 1/2005 | 1 | 1 | 2 | OFF STORNOWAY | 15:13 | N 58º 09.789' | W006º 19.635' | 16:53 | N 58º 08.216' | W006º 18.440' | |
| 1/2005 | 2 | 1 | 1 | SHIANT EAST BANK | 7:06 | N 58º 00.781' | W006º 11.277' | 10:30 | N 57º 54.890' | W006º16.508' | low to hig |
| 1/2005 | 2 | 1 | 1 | SHIANT EAST BANK | 7:06 | N 58º 00.781' | W006º 11.277' | 10:30 | N 57º 54.890' | W006º16.508' | high |
| 1/2005 | 1 | 1 | 2 | SHIANT-STORNOWAY | 11:00 | N 57º 54.873' | W006º16.914' | 15:38 | N 58º 03.737' | W006º 17.032 | low mid |
| 1/2005 | 1 | 1 | 1 | KEBOCK HD | 07:30 | N 58º 06.832' | W006º 14.630' | 10:15 | N 58º 04.575' | W006º 18.346 | low |
| 1/2005 | 1 | 1 | 1 | KEBOCK HD | 07:30 | N 58º 06.832' | W006º 14.630' | 10:15 | N 58º 04.575' | W006º 18.346 | low |
| 1/2005 | 2 | 1 | 2 | KEBOCK HD | 10:48 | N 58º 04.285' | W006º 18.619' | 13:00 | N 58º 05.412' | W006º 14.848 | low to hig |
| 1/2005 | 2 | 1 | 2 | KEBOCK HD | 10:48 | N 58º 04.285' | W006º 18.619' | 13:00 | N 58º 05.412' | W006º 14.848 | low to hig |
| 1/2005 | 2 | 1 | 2 | KEBOCK HD | 10:48 | N 58º 04.285' | W006º 18.619' | 13:00 | N 58º 05.412' | W006º 14.848 | low to hig |
| 1/2005 | 1 | 1 | 3 | KEBOCK HD | 13:45 | N 58º 07.061' | W006º 17.777' | 16:15 | N 58º 09.656' | W006º 15.105' | high to lo |
| 1/2005 | 2 | 1 | 4 | KEBOCK HD | 17:00 | N 58º 09.159' | W006º 14.069' | 19:15 | N 58º 09.450' | W006º 19.8 | high to lo |

**ABLE A3 Summary of finfish by-catches.**

| | GEAR | GROUND TYPE | HAUL No | FISHING AREA | TIME SHOOTING | LATITUD | LONGITUD | TIME HAULING NET | LATITUD | LONGITUD | SPECIES |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 05 | 1 | 1 | 2 | OFF STORNOWAY | 15:13 | N 58º 09.789' | W006º 19.635' | 16:53 | N 58º 08.216' | W006º 18.440' | *Melanogrammus a* |
| 05 | 1 | 1 | 2 | OFF STORNOWAY | 15:13 | N 58º 09.789' | W006º 19.635' | 16:53 | N 58º 08.216' | W006º 18.440' | *Merluccius merluc* |
| 05 | 1 | 1 | 2 | OFF STORNOWAY | 15:13 | N 58º 09.789' | W006º 19.635' | 16:53 | N 58º 08.216' | W006º 18.440' | *Zeus faber* |
| 005 | 1 | 1 | 1 | SHIANT EAST BANK | 07:06 | N 58º 00.781' | W006º 11.277' | 10:30 | N 57º 54.890' | W006º16.508' | *Horse mackerel* |
| 005 | 1 | 1 | 1 | SHIANT EAST BANK | 07:06 | N 58º 00.781' | W006º 11.277' | 10:30 | N 57º 54.890' | W006º16.508' | *Conger conger* |
| 005 | 1 | 1 | 1 | SHIANT EAST BANK | 07:06 | N 58º 00.781' | W006º 11.277' | 10:30 | N 57º 54.890' | W006º16.508' | *Merluccius merluc* |
| 005 | 1 | 1 | 1 | SHIANT EAST BANK | 07:06 | N 58º 00.781' | W006º 11.277' | 10:30 | N 57º 54.890' | W006º16.508' | *Lophius piscatoriu* |
| 005 | 1 | 1 | 1 | SHIANT EAST BANK | 07:06 | N 58º 00.781' | W006º 11.277' | 10:30 | N 57º 54.890' | W006º16.508' | *Clupea harengus* |
| 005 | 1 | 1 | 1 | SHIANT EAST BANK | 07:06 | N 58º 00.781' | W006º 11.277' | 10:30 | N 57º 54.890' | W006º16.508' | *Merlangius merlar* |
| 005 | 2 | 1 | 2 | SHIANT EAST BANK | 11:00 | N 58º 54.873' | W006º 16.914' | 15:38 | N 58º 03.737' | W006º 17.032' | *Merluccius merluc* |
| 005 | 2 | 1 | 2 | SHIANT EAST BANK | 11:00 | N 58º 54.873' | W006º 16.914' | 15:38 | N 58º 03.737' | W006º 17.032' | *Melanogrammus a* |
| 005 | 2 | 1 | 2 | SHIANT EAST BANK | 11:00 | N 58º 54.873' | W006º 16.914' | 15:38 | N 58º 03.737' | W006º 17.032' | *Limanda limanda* |
| 005 | 2 | 1 | 2 | SHIANT EAST BANK | 11:00 | N 58º 54.873' | W006º 16.914' | 15:38 | N 58º 03.737' | W006º 17.032' | *Pleuronectes plate* |
| 005 | 2 | 1 | 2 | SHIANT EAST BANK | 11:00 | N 58º 54.873' | W006º 16.914' | 15:38 | N 58º 03.737' | W006º 17.032' | *Eutrigla gurnardus* |
| 005 | 2 | 1 | 2 | SHIANT EAST BANK | 11:00 | N 58º 54.873' | W006º 16.914' | 15:38 | N 58º 03.737' | W006º 17.032' | *Merlangius merlar* |
| 005 | 2 | 1 | 2 | SHIANT EAST BANK | 11:00 | N 58º 54.873' | W006º 16.914' | 15:38 | N 58º 03.737' | W006º 17.032' | *Cuplea harengus* |
| 005 | 1 | 1 | 1 | KEBOCK HD | 07:30 | N 58º 06.832' | W006º 14.630' | 10:15 | N 58º 04.575' | W006º 18.346 | *Merluccius merluc* |
| 005 | 1 | 1 | 1 | KEBOCK HD | 07:30 | N 58º 06.832' | W006º 14.630' | 10:15 | N 58º 04.575' | W006º 18.346 | *Lophius piscatorio* |
| 005 | 1 | 1 | 1 | KEBOCK HD | 07:30 | N 58º 06.832' | W006º 14.630' | 10:15 | N 58º 04.575' | W006º 18.346 | *Conger conger* |
| 005 | 1 | 1 | 1 | KEBOCK HD | 07:30 | N 58º 06.832' | W006º 14.630' | 10:15 | N 58º 04.575' | W006º 18.346 | *Gadus morhua* |
| 005 | 1 | 1 | 1 | KEBOCK HD | 07:30 | N 58º 06.832' | W006º 14.630' | 10:15 | N 58º 04.575' | W006º 18.346 | *Scyliorhinus canic* |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 005 | 1 | 1 | 1 | KEBOCK HD | 07:30 | N 58º 06.832' | W006º 14.630' | 10:15 | N 58º 04.575' | W006º 18.346 | *Squalus acanthias* |
| 005 | 1 | 1 | 1 | KEBOCK HD | 07:30 | N 58º 06.832' | W006º 14.630' | 10:15 | N 58º 04.575' | W006º 18.346 | *Horse mackerel* |
| 005 | 1 | 1 | 1 | KEBOCK HD | 07:30 | N 58º 06.832' | W006º 14.630' | 10:15 | N 58º 04.575' | W006º 18.346 | *Merlangius merlan* |
| 005 | 1 | 1 | 1 | KEBOCK HD | 07:30 | N 58º 06.832' | W006º 14.630' | 10:15 | N 58º 04.575' | W006º 18.346 | *Melanogrammus a* |
| 005 | 2 | 1 | 2 | KEBOCK HD | 10:48 | N 58º 04.285' | W006º 18.619' | 13:00 | N 58º 05.412' | W006º 14.848 | *Gadus morhua* |

**E A3 (continued).**

| | GEAR | GROUND TYPE | HAUL No | FISHING AREA | TIME SHOOTING | LATITUD | LONGITUD | TIME HAULING NET | LATITUD | LONGITUD | SPECIES |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 005 | 2 | 1 | 2 | KEBOCK HD | 10:48 | N 58º 04.285' | W006º 18.619' | 13:00 | N 58º 05.412' | W006º 14.848 | *Limanda limanda* |
| 005 | 2 | 1 | 2 | KEBOCK HD | 10:48 | N 58º 04.285' | W006º 18.619' | 13:00 | N 58º 05.412' | W006º 14.848 | *Scyliorhinus canic* |
| 005 | 2 | 1 | 2 | KEBOCK HD | 10:48 | N 58º 04.285' | W006º 18.619' | 13:00 | N 58º 05.412' | W006º 14.848 | *Squalus acanthias* |
| 005 | 2 | 1 | 2 | KEBOCK HD | 10:48 | N 58º 04.285' | W006º 18.619' | 13:00 | N 58º 05.412' | W006º 14.848 | *Horse mackerel* |
| 005 | 2 | 1 | 2 | KEBOCK HD | 10:48 | N 58º 04.285' | W006º 18.619' | 13:00 | N 58º 05.412' | W006º 14.848 | *Melanogrammus a* |
| 005 | 2 | 1 | 2 | KEBOCK HD | 10:48 | N 58º 04.285' | W006º 18.619' | 13:00 | N 58º 05.412' | W006º 14.848 | *Merlangius merlan* |
| 005 | 2 | 1 | 2 | KEBOCK HD | 10:48 | N 58º 04.285' | W006º 18.619' | 13:00 | N 58º 05.412' | W006º 14.848 | *Raja naevus* |
| 005 | 1 | 1 | 3 | KEBOCK HD | 13:45 | N 58º 07.061' | W006º 17.777' | 16:15 | N 58º 09.656' | W006º 15.105' | *Clupea harengus* |
| 005 | 1 | 1 | 3 | KEBOCK HD | 13:45 | N 58º 07.061' | W006º 17.777' | 16:15 | N 58º 09.656' | W006º 15.105' | *Horse mackerel* |
| 005 | 1 | 1 | 3 | KEBOCK HD | 13:45 | N 58º 07.061' | W006º 17.777' | 16:15 | N 58º 09.656' | W006º 15.105' | *Merlangius merlan* |
| 005 | 1 | 1 | 3 | KEBOCK HD | 13:45 | N 58º 07.061' | W006º 17.777' | 16:15 | N 58º 09.656' | W006º 15.105' | *Gadus morhua* |
| 005 | 1 | 1 | 3 | KEBOCK HD | 13:45 | N 58º 07.061' | W006º 17.777' | 16:15 | N 58º 09.656' | W006º 15.105' | *Scyliorhinus canic* |
| 005 | 1 | 1 | 3 | KEBOCK HD | 13:45 | N 58º 07.061' | W006º 17.777' | 16:15 | N 58º 09.656' | W006º 15.105' | *Squalus acanthias* |
| 005 | 2 | 1 | 4 | KEBOCK HD | 17:00 | N 58º 09.159' | W006º 14.069' | 19:15 | N 58º 09.450' | W006º 19.8 | *Horse mackerel* |
| 005 | 2 | 1 | 4 | KEBOCK HD | 17:00 | N 58º 09.159' | W006º 14.069' | 19:15 | N 58º 09.450' | W006º 19.8 | *Conger conger* |
| 005 | 2 | 1 | 4 | KEBOCK HD | 17:00 | N 58º 09.159' | W006º 14.069' | 19:15 | N 58º 09.450' | W006º 19.8 | *Melanogrammus a* |
| 005 | 2 | 1 | 4 | KEBOCK HD | 17:00 | N 58º 09.159' | W006º 14.069' | 19:15 | N 58º 09.450' | W006º 19.8 | *Merlangius merlan* |
| 005 | 2 | 1 | 4 | KEBOCK HD | 17:00 | N 58º 09.159' | W006º 14.069' | 19:15 | N 58º 09.450' | W006º 19.8 | *Scyliorhinus canic* |
| 005 | 2 | 1 | 4 | KEBOCK HD | 17:00 | N 58º 09.159' | W006º 14.069' | 19:15 | N 58º 09.450' | W006º 19.8 | *Squalus acanthias* |
| 005 | 2 | 1 | 4 | KEBOCK HD | 17:00 | N 58º 09.159' | W006º 14.069' | 19:15 | N 58º 09.450' | W006º 19.8 | *Eutrigla gurnardus* |
| 005 | 2 | 1 | 4 | KEBOCK HD | 17:00 | N 58º 09.159' | W006º 14.069' | 19:15 | N 58º 09.450' | W006º 19.8 | *Pleuronectes plate* |
| 005 | 2 | 1 | 4 | KEBOCK HD | 17:00 | N 58º 09.159' | W006º 14.069' | 19:15 | N 58º 09.450' | W006º 19.8 | *Molva molva* |

APPENDIX 6

# Survey of the cockle grounds of the Outer Hebrides 2009-2010

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April 2010 Outer Hebrides cockle survey 2009 - 2010 1

## SUMMARY

- Shore based surveys of eight cockle grounds on the Uists, Harris and Lewis were carried out between 13.11.09 and 29.2.10.
- All of the grounds had been previously surveyed in 2000 and a number had also been surveyed in 1993.
- A stratified random survey design was used allowing comparison of the results with previous surveys.
- In total 416 sites were sampled. At each site sediment was sampled from an area of $0.1m^2$ and cockles were removed with a sieve.
- A total of 1064 cockles were counted, aged, measured and weighed.
- Estimates of total biomass for each ground ranged from 193 at Tong tonnes to 738 tonnes at Traig ear. North Ford and Traig ear in Uist supported highest cockle biomasses including a high proportion of cockles in 5 and 6+ age classes.
- All grounds contained a broad age range of cockles.
- Ten percent or more of the cockles at North Ford, Vallaquie and Traig ear were larger than 30 mm (the minimum size permitted in the Outer Hebrides fishery). Cockles larger than 30 mm were estimated to make up less than 10% of the total stocks on Baleshare, Traigh Leathann, Luskentyre, Tong and Vallay.
- The cockles sampled took a minimum of three years and more generally six or seven years to reach 30 mm.
- Current survey results are broadly similar to those from surveys in 1993 and 2000; they indicate that cockle stocks are stable with regular annual recruitment.
- This survey provides a useful overview of cockle distribution and abundance. Future surveys should examine exploited cockle grounds in detail to provide more precise information on target stocks.

# INTRODUCTION

Cockles, *Cerastoderma edule* (L.), occur on beaches across Scotland. On the Outer Hebrides they historically support a small fishery and have been harvested by hand gathering and tractor dredge. They are also important in the near shore ecosystem for example as prey for fish and prolific shore birds. Currently small amounts of cockles are taken for personal consumption by locals and tourists and stocks on Traigh Mhor, Barra and Luskentyre, Harris are exploited commercially. In 2009 concern about the possible over exploitation of cockles on these beaches lead to the introduction of a statutory minimum size of 30 mm: it is now prohibited to fish for smaller cockles around the Outer Hebrides[1].

1 The inshore fishing (prohibition of fishing for cockles)(Western Isles)(Scotland)Order 2009.

To ensure that cockles are not over exploited managers require accurate data on cockle abundance and the age structure of populations. Cockle grounds of the Outer Hebrides were surveyed by Fisheries Research Services in 1993 and 2000 (Chapman *et al.* 1993 and Howell *et al.* 2001). This survey was commissioned by the Outer Hebrides Inshore Fisheries Group to update previous work, providing information for sustainable management of the cockle resource in North Uist, Harris and Lewis. The work was sponsored by Scottish Natural Heritage, Comhairle nan Eilean Siar and Highlands and Islands Enterprise, technical and scientific support and advice was provided by Marine Science Scotland. Specific objectives were:

- To survey eight cockle grounds in North Uist, Harris and Lewis, namely: Traigh Leathann, Baleshare, North Ford, Vallay, Grenitote – Traigh Ear, Grenitote – Vallaquie, Luskentyre and Tong (Figure 1).
- To obtain information the distribution, abundance, size and age composition of cockles.
- To derive age, length and weight relationships.
- To produce estimates of cockle stock biomass and prepare a report describing the state of the cockle resources on the main beaches of North Uist, Harris and Lewis.

# METHODS

## SAMPLING STRATEGY

The single stratified random survey design described by Howell *et al.* (2001) was used. This design gives an idea of the variation across cockle grounds thus enables us to gauge the precision of abundance and biomass estimates. Beaches were mapped using Google Earth and a grid was overlaid on each map to create sampling strata (Figure 2). So that our results were comparable with previous work the sizes of strata were similar to those used in 2000 surveys. Stratum size was the same across beaches but varied between beaches. Within each stratum two sites were sampled (except where the second site was inaccessible or on unsuitable substrate). Sites were located at random within each stratum and their co-ordinates were uploaded to a GPS navigator (Garmin eTrex H).

## SAMPLING

Sampling was carried out between 13.11.09 and 29.2.10 during periods of spring tides. Quad bikes were used for most beaches in Uist while those in Lewis and Harris were sampled by foot. Each sample site was located with GPS and a quadrat was used to measure an area of 0.1 $m^2$. Sediment was removed from inside of quadrats to a depth of around 0.1 m, and then passed through a 5mm sieve to remove cockles.

**Cockle sampling kit, including sieves and quadrat** Outer Hebrides cockle survey 2009 - 2010 4

Cockles were bagged and later counted, aged, weighed and measured. Ageing was by eye; - counting growth bands once cockles had been scrubbed clean with a scouring pad. Length measurements were made along the longest axis of the cockle using digital callipers.

**Lengths are measured along the cockle's longest axis.**

## DATA ANALYSIS

The mean abundance and biomass of cockles in a range of categories (six age classes, total and 2 + age groups) was calculated for each stratum or single values were used where only one sample had been taken. These values were raised to the area of the stratum and stratum variance of the mean was calculated. Where strata contained void areas (e.g. dry land and deep water) valid areas were estimated from maps. Stratum values were summed to give estimates of total abundance and biomass for each ground. In contrast to earlier surveys sample (actual) weights of cockles rather than estimated weights were used in biomass calculations. To measure the precision of our estimates standard errors of the difference (SE) for each beach were also calculated from stratum variances of the mean[2]. Note that standard errors of the mean for each beach were based only on strata from which two replicate samples had been collected. Assuming a t statistic of 2, SE can be doubled to give the confidence interval for the sample. Because total variances and standard errors of the difference increase with sample size they should not be compared between beaches or years where differences may be related to differences in sample sizes.

[2] SE of the difference equals the square root of the sum of the squared strata standard errors. Fowler *et al* (1998).

To illustrate the age and length composition of cockle stocks and the proportion of cockles that would have recruited into a fishery (i.e. cockles wider than 30 mm) length- and age-frequency graphs were prepared for each beach. Age-length relationships were also graphed to determine the age at which cockles would recruit into the fishery.

Measurements from all undamaged cockles were used to derive weight-length relationships. As in previous surveys mean weight at length was used in these calculations to reduce the potential bias caused by relatively large numbers of small cockles. An unweighted least squares regression was used to fit the relationship between mean weight and length. All analysis was carried out using Microsoft Excel. 

## RESULTS

A total of 416 stations were sampled across eight beaches as described in Table 1. A number of planned sample sites were inaccessible because of deep river channels or found to be in dry dune areas, in these cases strata were sampled only once. The north eastern area of North ford was particularly difficult to sample due to the number of river channels. Just under half of all the sites sampled contained cockles. In total 1064 cockles were caught. All undamaged cockles were measured, weighed, and aged (a small number of cockles could not be aged and were included in an unclassified age class).

## COCKLE DISTRIBUTIONS

Cockle distributions (presence/absence) are shown in Figures 2a-h, predictably cockles were found in sheltered areas with fairly stable sediment and not mobile, coarse sand such as that to the seaward side of spits. Note that river channels frequently change their course and those shown on satellite photographs were sometimes different at the time of sampling (this was particularly true for Luskentyre). Cockle beds at Vallay, North Ford and Traigh Leathann coved the largest areas (up to 3 $Km^2$) while the smallest ground, at Tong, was less than 1 $Km^2$ (Table 1).

The size and location of cockle grounds was similar to that recorded in 1994 and 2000 with a slight increase in the size of the ground at Luskentyre and a small decrease in the size of the ground at Traig ear. Cockle distributions were typically patchy leading to wide variation in abundance estimates both within and between strata.

## ABUNDANCE AND BIOMASS

The abundance and biomass of cockles on each ground are listed in Table 2 and illustrated by Figure 3. While large numbers of 0 and 1 year old cockles drive patterns in total cockle abundance trends in total biomass are coupled to the abundance of older, heavier cockles. Biomass estimates were highest for North Ford and Traig Ear and these sites supported a high proportion of older cockles. However data for Traig Ear was skewed by a single dense patch of older cockles in one site at the head of the bay, thus the estimate for this beach has high confidence intervals (Table 2, total biomass of cockles at Traig ear is 738 tonnes +/- 328 tonnes cf. 643 tonnes +/- 70 tonnes at North Ford). Other biomass estimates ranged from 193 +/- 26 tonnes at Tong to 319 +/- 32 tonnes at Luskentyre. Average cockle densities are given in Table 3: Vallay and Traigh Leathann supported the lowest densities of cockles, highest cockle densities were found at Tong, Vallaquie and Traigh ear.

A broad range of age classes was found across all of the beaches (Figure 3). Populations at Baleshare, Vallay, Luskentyre and Tong included relatively high numbers of 0 and 1 year old cockles. Figure 4 shows length–frequency distributions, highlighting proportions of cockles over 30 mm (i.e. those that would have recruited to the fishery). North Ford, Vallaquie and Traig ear supported the highest proportions of large cockles (10 % or more of the cockles on these beaches measured over 30 mm). Tong, and to a lesser extent Luskentyre, were dominated by smaller sizes reflecting the high abundance of 0 and 1 year old cockles on these beaches. 

The results of this survey are compared with previous results in Figure 5 and Table 4. The results are broadly similar across years, particularly given the associated sampling variances. Cockles in the 0 year class appear in our samples and not previously because of differences in the timing of surveys. Previous surveys were carried out in August and September when most 0 class cockles would pass through the 5 mm mesh of the sampling sieve while our survey was carried out in the winter by which time most 0 class cockles had grown larger than 5 mm. The later timing of our survey also explains why we recorded a slightly higher total biomass for most age groups of cockles despite a small overall decrease in abundance between 2000 and 2010 (Table 4). The exceptionally high biomass of 1 year old cockles found in Tong during 2000 was not replicated in this survey.

## COCKLE BIOLOGY

Weight length relationships are given below:

Traig Leathann Mean weight (g) = 0.0004 Length (mm)$^{3.0999}$ ($R^2$ = 0.9936, n=20)

Baleshare Mean weight (g) = 0.0006 Length (mm)$^{2.9472}$ ( $R^2$ = 0.9849, n=25)

North Ford Mean weight (g) = 0.0025 Length (mm)$^{2.5047}$ ($R^2$ = 0.9754, n=26)

Vallay Mean weight (g) = 0.0005 Length (mm)$^{3.018}$ ($R^2$ = 0.9852, n=24)

Traig ear Mean weight (g) = 0.0005 Length (mm)$^{2.9653}$ ($R^2$ = 0.9895, n=29)

Vallaquie Mean weight (g) = 0.0004 Length (mm)$^{3.0876}$ ($R^2$ = 0.9884, n=23)

Luskentyre Mean weight (g) = 0.0003 Length (mm)$^{3.1884}$ ($R^2$ = 0.9962, n=27)

Tong Mean weight (g) = 0.0004 Length (mm)$^{3.0169}$ ($R^2$ = 0.9814, n=26)

The relationships were similar across beaches, with the exception of North Ford where relative weights tended to be lower than elsewhere. However these result should be interpreted with caution given the small number of cockles and age classes sampled at some locations (Table 1).

Figure 6 shows cockle age-length relationships for each beach, cockles of up to 10 years old were sampled. Again these results should be interpreted with caution as low sample sizes and sampling intensity mean that they could be skewed by atypical samples or by the over representation of cockles from marginal habitat. However they give a useful indication of growth rates and the age at which cockles would recruit into the fishery. Cockles reached a size of 30 mm after a minimum of three years, and often much longer periods of time. Cockles at Vallay, Baleshare and Traigh Leathann appear to have slower growth rates than elsewhere.

Interestingly a large number of cockles at Luskentyre seemed to have interim growth checks, perhaps caused by fishing disturbance (i.e. being turned over or collected and returned to the ground) or natural environmental disturbance. The shells of many of the cockles on Tong beach were stained black by hydrogen sulphide in the sand.

## DISCUSSION AND RECOMMENDATIONS FOR FUTURE SURVEYS

All of the cockle grounds surveyed contained a broad age range of cockles and population sizes were generally similar to estimates for 1993 and 2000. These stocks therefore appear to be stable with regular annual recruitment. This might be expected given the absence of Outer Hebrides cockle survey 2009 - 2010 7 heavy fishing pressure or other changes to the local environment. Interestingly weight to length relationships were lowest for cockles from North Ford. Although our data was based on a fairly low sample size (80 cockles) this trend was also apparent in data from 1993 and 2000, but differences were not as pronounced. Despite this North Ford has consistently supported relatively high cockle biomasses including a fair proportion of older, larger cockles. North Ford is not fished commercially at present but seems to merit consideration, perhaps in conjunction with Traigh Leathann, Baleshare and Traig ear in North Uist. Staining of cockle shells at Tong might make shell-on products unmarketable which should be born in mind if this ground is considered as a fishery.

Across the beaches surveyed few cockles larger than 30 mm were sampled. Information from Luskentyre cockle fishers suggests that larger cockles are present and would be detected by a more intensive survey of the fishery area there. The growth rates of cockles illustrated here are similar to those plotted for the 1993 survey and slower than those plotted for the fished areas of Barra (McKay and Howell, 1995). Areas of Vallay beach and probably other locations remain dry during small neap tides and this is likely to reduce growth rates.

This survey was necessarily extensive and provides an overview of the cockle stocks of Lewis, Harris and the Uists. Where cockle fishing is carried out in the future more regular and detailed surveys, focused on the fishery areas or grounds identified here, could give information for real-time management of the fishery. While we were surveying a number of people mentioned grounds we had not visited, future projects might investigate these. Future surveys should be carried out in the summer when longer daylight hours increase potential sampling times. We also noted that the majority of the cockle grounds could be accessed at low neap tides. A number of the beaches surveyed were difficult to access as the tide came in, particularly North Ford, and future surveyors should seek local advice before carrying out surveys. The Outer Hebrides Inshore Fisheries Group could consider setting up a database to ensure that cockle data is collected and stored in a way that allows easy and accurate comparisons to be made between surveys.

## ACKNOWLEDGEMENTS

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# TABLES

**Table 1.** Sample details by beach. Numbers of stations include only those sampled (i.e. not those that were inaccessible or contained substrate unsuitable for cockles). Areas with cockles were estimated by summing the areas of strata in which cockles were present in samples.

| **Beach** | **Dates** | **Stations** | **Strata size (km$_2$)** | **Stations with cockles** | **Area with cockles (km$_2$)** | **Cockles caught** |
|---|---|---|---|---|---|---|
| **Traig Leathann** | 27.2.10 | 40 | 0.198 | 18 | 2.52 | 50 |
| **Baleshare** | 26.02.10, 27.02.10 | 38 | 0.109 | 20 | 1.77 | 121 |
| **North Ford** | 31.01.10, 28.2.10, 29.2.10 | 63 | 0.181 | 30 | 3.39 | 80 |
| **Vallay** | 30.1.10, 1.2.10 | 68 | 0.112 | 39 | 2.98 | 120 |
| **Traig Ear** | 28.1.10, 29.1.10 | 64 | 0.111 | 24 | 1.60 | 178 |
| **Vallaquie** | 28.01.10 | 34 | 0.137 | 10 | 1.01 | 45 |
| **Luskentyre** | 1.12.09, 2.12.09 | 70 | 0.066 | 36 | 1.76 | 277 |
| **Tong** | 13.11.09, 16.11.09 | 39 | 0.063 | 20 | 0.71 | 193 |
| **Total** | | **416** | | **197** | **15.75** | **1064** |

**APPENDIX 7**

Not to be quoted without prior reference to the authors

Marine Laboratory, Aberdeen Report No 8/98

**A STUDY OF THE EFFECTS OF WATER JET DREDGING FOR RAZOR CLAMS AND A STOCK SURVEY OF THE TARGET SPECIES IN SOME WESTERN ISLES POPULATIONS**

October 1998



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# A STUDY OF THE EFFECTS OF WATER JET DREDGING FOR RAZOR CLAMS AND A STOCK SURVEY OF THE TARGET SPECIES IN SOME WESTERN ISLES POPULATIONS

## CONDUCTED BY FISHERIES RESEARCH SERVICES, MARINE LABORATORY ABERDEEN

## FOR THE PESCA AND WESTERN ISLES COUNCIL AND THE WESTERN ISLES FISHERMEN'S ASSOCIATION.


**Contributors**

**Fieldwork, data analysis and report preparation:**

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This report has been produced by the contributors listed above. The listing is purely alphabetical. In the initial fieldwork stages the dive team of Graham Sangster, Mike Breen, Norman Graham and Trevor Howell worked under difficult environmental conditions to make underwater observations and collect cores. Much of the laboratory based measurement of razor clams and the determination of age was carried out by Sharon Davis and John Donald with advice and histological expertise provided by Peter Wright and Fiona Kennedy. The task of sorting the core samples and identifying infaunal species was performed methodically, patiently and largely unaided by Melanie Harding and a large proportion of the data analysis and report preparation was undertaken by Ian Tuck.


**Acknowledgement**

This work would not have been possible without the full cooperation and effort of the crew of the *Ptarmigan*, Murdo Campbell and John McLeod. It was therefore with great sadness that we heard of the recent death of John. His enthusiasm and initiation of the general interest in this fishery was a significant factor in this study taking place.

## GENERAL SUMMARY

Razor clams, also known as razor fish, razor shells and "spoots" are burrowing bivalves which are found from Norway to North Africa. Two species of razor clams occur widely around the coasts of Scotland and are subject to a number of small scale fisheries. The clams inhabit sandy and shelly substrates from the lower limits of the tidal range to a depth of about 40 m, and burrow almost vertically into the sediment, with their siphons level with the seabed.

Collection of these animals by hand has traditionally taken place at low tide. A recent expansion of the Scottish fisheries for this species has led to landings and value increasing to 220 tonnes and £500,000, respectively, in 1997. A number of methods of capture have been employed including diving and the use of subsurface dredging equipment operated from vessels. There is no legal minimum landing size for razor clams, although marketing restricts landings to individuals over 4" (approximately 100 mm), and the only form of control over the exploitation of these species is closure to suction dredges in a number of areas under the Inshore Fishing (Scotland) Act 1984.

Recently, a water jet dredge has been developed which operates in a different way to the suction dredge, but by definition is still subject to the same controls. Effects of this gear are perceived to be less than suction dredging, and there have been calls to have its effects examined in advance of the 1998 review of the Act, with a view to discussing amendments to the legislation.

In an initiative from the Western Isles Fishermen's Association, with financial backing from the Western Isles Council and Pesca, the FRS Marine Laboratory was asked to conduct a study of the impact of water jet dredges and to provide an assessment of stock size. This work was done in two stages, with the initial part carrying out observations of the gear, and studying its impact, and the second part carrying out a stock survey and recording biological information in different locations around the Western Isles.

The fishing impact study was carried out in the Sound of Ronay, near Grimsay. Divers observed the dredge in operation, measured the track on the seabed produced by the dredge, and collected animals missed by the gear. Samples were also collected to examine the effects of the dredge on the sediment and the animals living within it. Observations were made on the effects of the gear upon animals living on the seabed. Comparisons were made between dredge catches and the numbers of razor clams missed, and estimates of densities from diver surveys. Further studies were carried out near Berneray, with a small mesh net surrounding the dredge to investigate the numbers and sizes of razor clams escaping through the dredge. Damage rates for razor clams both for those in catches and those left on the seabed were also examined.

The stock survey work was carried out at Broad Bay, Grimsay and Loch Carnan. During the surveys, the size distribution of catches were recorded, and shells were saved for ageing. A range of individuals from each area were also weighed. Allowing for the efficiency of the dredge, estimates were made of the density of razor clams in the surveyed area. Using this information, the potential for a razor clam fishery in the Western Isles was assessed.

## RESULTS AND CONCLUSIONS

### Impact

- Immediate physical effects were apparent upon the seabed, with the dredge leaving visible trenches about 1.2 m across and 0.15 m deep at the centre. While these trenches had started to fill with sediment after five days, and were no-longer visible after 11 weeks, the sediment in fished tracks remained fluidised (like quicksand) under a thin crust of firm sediment.

- The majority of the animals living in the sediments where razor clams are found are adapted to a mobile environment disturbed by natural processes such as strong tides. Other than being removed or displaced by the dredge they are not greatly affected by it. Species that are likely to be damaged (eg heart urchins and large bivalves) were very rare in the samples, but present in dredge catches, where damage was noted. On average, from 10-28% of these individual animals were damaged in the catch.

- On the evidence of the present study, and previous work by the Marine Laboratory, it would appear that there is little difference between the biological impact of the new hydraulic dredge and the original suction dredging, although the latter may have a greater physical effect (larger trenches) and fish less selectively.

### Gear Aspects

- Gear efficiency was high (up to 70%) during the study and could be expected to be even higher during normal fishing operations, when adjustments are made for water depth and towing speed.

- Preliminary observations suggest that the gear is selective, with the smaller individual razor clams passing through the meshes of the cage. This selectivity appears to take place as the dredge is lifted from the seabed to the vessel, and is reduced greatly when the dredge becomes filled with sand and shell material.

- Under normal conditions (when the dredge is not clogged), catches of commercially undersize razor clams are low. The marketing requirement to sort the catch quickly and keep the animals alive means discards are not kept on deck long, and survival should be high.

- Damage rates were comparable to those recorded for suction dredging for razor clams, but would be expected to be reduced under normal fishing operations.

### Stocks and Potential

- While razor clams were widespread throughout the surveyed areas (both in this and previous studies), they were only present in commercial densities at a limited number of sites in each of the areas.

- Previous studies have found razor clams are not abundant on sandy shores exposed to severe wave action, and therefore commercially fishable stocks on the west coast of the Western Isles may be scarce. However, other populations surveyed at other times to the south and east of the Islands could form part of a coordinated small scale fishery.

### Population Dynamics

- Although knowledge of razor clam growth is limited, comparison of the growth data with published studies suggests that razor clams in the Western Isles grow to a size comparable with the largest in Scotland, which is larger than recorded elsewhere in Europe.
- Ageing suggests the populations contain significant numbers of animals over 10 years old, which has an important bearing on the nature of any fishery.
- Small razor clams, as young as 1 year old, were caught during the study, but the selective nature of the gear meant that this only occurred when the dredge was clogged. Estimates of the densities of the smallest individuals could not be made.
- Estimates of recruitment could be made in the future through beach surveys and/or surveys using a less selective gear (ie suction dredge).

## RECOMMENDATIONS

This work was conducted in the context of i) an intention to try to establish a limited and controlled fishery for razor clams in the Western Isles; ii) recent changes in legislation covering Regulating Orders which makes management of such fisheries a possibility; and iii) a review of the Inshore Fisheries Act Scotland. While the findings of the Study are necessarily limited by geographic area and scale, due to the time available, nevertheless some general recommendations can be made.

Overall, the results from a single fishing event suggest that the biological effects of the hydraulic dredge in terms of damage to the seabed and other marine organisms are only short term in nature. Long term physical effects are less well understood, and may be exacerbated by repeated fishing of the same area. There are also uncertainties about the recruitment and sustainability of the razor clam populations. On balance the gear appears to be potentially less disruptive than suction dredging, but given the concerns expressed above a precautionary approach is necessary, and we would suggest a very limited fishery is established in the first instance.

### Likely Nature of A Sustainable Fishery for Razor Clams in the Western Isles

It is recommended that a fishery for razor clams in the Western Isles, consistent with a precautionary approach, should embody the following features:

1. The fishery should be small in scale to the resource. In the absence of more information on razor clam population dynamics (particularly recruitment) it is suggested that a limit of 3-4 boats should be set initially. An open fishery with unlimited access should be avoided.

2. Areas should be fished rotationally. From the age structure of the population it appears likely that several years may be required for recovery of razor clam populations after fishing.

3. Ideally, the current practice of fishing a single water jet dredge in short 15 minute tows should be adopted as standard. Use of suction dredges may not need to be totally ruled out but a day's aggregate continuous fishing time should be of similar duration to that of the water jet dredge total (see 5).

4. The size and design of dredge should be close to that currently in use (Appendix 1) and should be carefully defined. In the light of future studies on the size of maturity, mesh sizes for the dredge cage and a supporting Minimum Landing Size could be established.

5. Additional control measures could include the setting of catch limits and/ or limiting the number of hauls made in a days fishing. While offering a more conservative approach from the stock point of view, these measures would also ensure that market supply could be controlled.

6. All participating vessels should be required to complete detailed logbooks containing information on positions fished, catch composition and weight and tow duration. Samples of shells should be made available for measuring and ageing. Attempts should be made to initiate and support further studies including biological studies on recruitment, growth and reproduction, and impact studies on longer term effects.

## Special Comments Regarding Areas of Access for Water Jet Dredges

At present, all forms of suction dredge and water jet dredge are grouped in a catch all definition within the Inshore Fishing (Prohibition of Fishing and Fishing Methods) (Scotland) Order 1989. Although suction dredging is a continuous process and removes sediment to the surface, both gears appear to produce similar effects on the seabed. It would seem therefore, that there is little justification for changing the definitions of these gears.

The reasons for having the current system of closed areas for mobile gears include the protection of various species of fish in their juvenile stages and the protection of sensitive inshore areas. In the absence of other types of control, closures have prevented unacceptably large influxes of vessels into areas which could not support them. Some aspects of the biology of the razor clam populations studied here, and some features of the physical disturbance caused by the gear, suggest that prevention of unlimited fishing activity has been a prudent policy.

Under a more restrictive regime, a limited and controlled suction or water jet dredge fishery should be possible in some areas. A balance needs to be struck such that fishing allows recovery and sustainability of both the razor clam populations and benthic communities. The important point is that some control over levels of activity are required and that it would be unwise to allow any gear of this type complete freedom of access.

Recent changes to the legislation concerning Regulating Orders mean that these Orders can now offer a way of establishing limited and controlled fisheries of the type described. It is recommended that the most suitable way for a dredge fishery to be developed in the Western Isles is through the setting up of a Regulating Order.

## 1. INTRODUCTION

Razor clams (*Ensis* spp.), also known as razor fish, razor shells, "spoots" and mhusgan are found from the south of Norway to the Mediterranean and north Africa, and occur widely around the coasts of Scotland. They inhabit sandy and shelly substrates from the lower limits of the tidal range sub-tidally down to about 40 m. They are found burrowed roughly vertically into the sediment, with their siphons level with the seabed, and like most bivalves, feed on phytoplankton. They are fast deep burrowers, but contribute significantly to the diet of the edible crab (*Cancer pagurus*) which is able to excavate them (Shelton *et al.*, 1979), and is the main predator in many areas. Once out of the sediment they are vulnerable to a range of scavengers.

Of the three species of razor clams, *Ensis ensis*, *Ensis siliqua* and *Ensis arcuatus* the latter two were found in Western Isles waters during earlier Marine Laboratory surveys (McKay, 1992). Particularly high densities of *Ensis arcuatus* were found around Barra and Vatersay. Howson (1991) also confirms that this is the most commonly found of the species. From studies in other areas, *E. siliqua* has been found to be the largest, and may grow up to 25 cm in length with a mean age of 25 years.

A small fishery for razor clams has existed for many years in Scotland and "by hand", artisanal collection of these animals has traditionally taken place low on the shore. Improvements in handling and transport coupled with ever developing markets have led to rapid expansion of the fisheries for this species in Orkney and on the west coast mainland, with landings reported in Scotland increasing from 38 to 220 tonnes between in 1994 and 1997. Over this time the value of the fishery has increased from roughly £60,000 to £500,000. With the requirements for razor clam classification under various Food Safety Regulations, there has been a slight interruption in fishery development but with increasing numbers of samples being provided for classification, opportunities are opening up in areas including the Western Isles. A number of methods of capture have been employed including diving and the use of subsurface dredging equipment operated from vessels. There is no legal minimum landing size for *Ensis* spp., although marketing restricts landings to individuals over 4" (approximately 100 mm).

Suction dredges and related gears have been in use around Scotland for a number of years and used in the harvesting of shallow burrowing bivalves such as the cockle *Cerastoderma edule* (eg Chapman *et al.*, 1994) and also to collect deeper burrowing species such as *Ensis* (McKay, 1992). Use of these gears has tended to attract adverse comments because of the disturbance caused to the habitat and associated fauna. Work on the impact of shallow suction dredging on intertidal areas suggested that recovery following fishing occurred after about 56 days (Hall and Harding, 1997).

In response to opposition to the introduction of deep suction dredge gear, commissioned research was conducted in the Gairloch by the Marine Laboratory. Results suggested that although immediate effects were dramatic, the effects of the gear could no longer be observed after about 40 days (Hall *et al.*, 1990). Reservations were, however, expressed about the use of such gears in more sheltered sites and the Inshore Fishing (Scotland) Act 1984 was amended to specifically exclude the use of these gears from certain areas. Recently, a water jet dredge has been developed which operates in a different way to the suction dredge but by definition is still subject to the same controls. There have been calls to have the effects of this gear examined in advance of the 1998 review of the Act with a view to discussing amendments to the legislation. Although gear of this type has only recently been applied in Scotland, it has been used in other places (including America, Canada, and Italy) for some time. Studies of the impact of these gears have given results ranging from slow recovery of infauna following fishing (eg Vaccarella *et al.*, 1994) to serious effects on recruitment of target species such as the trough shell *Spisula* (eg Weinberg and Nordahl, 1995).

In view of likely different conditions, fauna and intensity of fishing, these earlier findings are not necessarily applicable in Scottish waters and a local study of the effects is desirable. In an initiative from the Western Isles Fishermen's Association, with financial backing from the Western Isles Council and Pesca, the FRS Marine Laboratory was approached to conduct a study of the impact of water jet dredges and to provide an assessment of stock size.

### Overall Aims

There were two overall aims to this study:

i) To provide information about the impact of water jet dredging for razor clams on the benthic environment and associated fauna.

ii) To collect information on stock size and structure of razor clams and other non-target bycatch species in Western Isles populations located in areas currently closed under the Inshore Act

### Specific Objectives

- To locate beds of razor clams at sites suitable for conducting the impact study.
- To observe and document the operation and action of the subsurface component of the gear.
- To investigate the impact of a single fishing of the gear on the physical environment, associated infauna and other non-target bivalves, comparing the effects in sheltered and exposed conditions.
- To estimate the efficiency of the water jet dredge so as to be able to correct catch rates in the survey to stock densities.
- To conduct quantitative surveys in two areas with a view to providing estimates of stock size and structure.

## 2. METHODS

### 2.1 Study Area

The study was carried out in the Outer Hebrides, or Western Isles, which form the largest and most westerly offshore island group in Britain (Fig. 2.1.1). The main islands are divided in two by the Sound of Harris, with Harris and Lewis to the North, and North and South Uist, Benbecula, Barra and Mingulay to the south. There are also smaller islands to the west and north of the main group.

The Western Isles are subject to some of the most severe storms affecting the British Isles, the west coast being fully exposed to the Atlantic. The east coast is more protected, but is exposed to Atlantic swell at the northern and southern approaches to the Minch. The islands, and in particular, the Uists, have a highly indented coastline, forming a series of lochs, many of which are further divided. These areas provide extreme shelter from wave action, and a wide range of tidal stream strengths through the many narrow channels and rapids. Previous marine biological surveys in the Western Isles (Howson, 1989; 1991) have found areas of shelly, gravelly and clean sand (suitable substrate for razor fish) to be widely distributed, and *Ensis arcuatus* and *Ensis siliqua* to be common.

The dredging impact study was carried out in the vicinity of Grimsay and the selectivity study near Berneray, while the stock survey covered areas just to the north of Loch Carnan (Bagh Nam Faoilean), Grimsay and Broad Bay (Fig. 2.1.2). Details of track locations are provided in the results section (Table 3.2.1. and Figs 3.2.1a-c).

All fishing work was carried out by the commercial water jet dredging vessel *Ptarmigan*, KY451 (11.13 m, 180 hp). The towed dredge used throughout this study was developed by the operators (*mhusgan-teers*) of the MFV *Ptarmigan*, as a commercial fishing gear. A scale drawing of the gear is provided in Appendix 1.

## 2.2 Impact of the Gear

The impact of the water jet dredge operation was examined by monitoring catches throughout the stock survey exercise, and also through direct observations and a small "impact of fishing" study. The direct observations and "impact" study were carried out in March 1998 in the Sound of Ronay, near Grimsay, where six fished tracks were intensively studied by divers, with the sites being re-examined five days after fishing, and also in May 1998, 11 weeks later. Direct diver observations were made of the more obvious physical effects to the environment by the dredge during normal fishing practices on six occasions, in order to assess the initial benthic effect of the operation. (The locations of these sites are shown in Fig. 2.2.1.). The water depth at the study site was between 2-5 m below chart datum, with a 2.5-4 m tidal range. Tidal streams reached in excess of three knots in the shallower areas.

### 2.2.1 Gear description and deployment

Observations were made on the operation of the gear throughout the study. In addition, diver observations, along with video and still photography were used to record underwater operation of the gear during the six tows described above.

### 2.2.2 Gross physical effects

The dredge was shot away normally and lowered to the sea bed. Two divers then entered the water from a Zodiac inflatable support boat and followed the towing warp to the dredge on the seabed. A 10 Kg weight with a leaded rope attached to a surface marker buoy was placed to one side of the static dredge as a starting position marker. A signal was given by the divers to the surface staff to start the pump and commence towing. Visual, still photography and video observations were made of the dredge in action where possible. On many occasions however, this was not possible, as due to the nature of dredging operation, visibility at times was reduced to almost zero. Towing duration was for a set period of ten minutes. At the end of this time, the vessel stopped towing, the pump was switched off and the divers placed a similar end marker close to the dredge. The dredge track was now marked. The divers returned to the surface and were picked up by the inflatable boat while the gear was hauled. For safety reasons, the divers only re-entered the water after the dredge was recovered on board. The direction and strength of the tidal flow determined which marker the divers would return to and commence their observation of the track. Normally, the divers operated with the tide rather than against it. The second dive usually began at the start marker with the tide flowing in the direction of observations. Markers were positioned to the north side of the track, a line was then attached to the start marker and as observations and measurements were taken at 10 m intervals, the line was paid out along the full length of the track and attached to the end marker weight. Measurements taken are indicated in Figure 2.2.2., and included width of track bottom (*A*) and top (*B*) and track depth (*C*). The sediment in the base of the tracks was noted to be extremely soft and mobile (fluidised), with the divers easily able to put their hands into the seabed, and the extent of this was measured both in-track (*I*) and outside track (*II*) (control). This fluidisation measurement was achieved by measuring the penetration of a 70 cm long 12 mm diameter probe (622 g in air), graduated in centimetres for part of its length. For most tracks, penetration measurements were taken in the centre of the track and at a distance of 2 m to the side of the track (adjacent to the control cores). The diver gently pushed the probe into the fluidised (in-track) and natural (out-track, control) sand until firm sand could be felt underneath (to ensure continuity, this was always performed by the same diver). Substrate fluidisation at the sides of fished tracks was also examined on some occasions (Fig. 2.2.2.). During each track measuring dive, one sediment core (10 cm dia) was taken from the fished and unfished areas and frozen prior to particle size analysis (dry sieving). Following this analysis, the effect of the fishing on various sediment parameters were examined using repeated measures ANOVA with treatment and date as fixed factors.

Measurements of track parameters and sediment samples were repeated approximately five days and 11 weeks after fishing.

### 2.2.3 Effects on non-target species (those not directly fished for)

Infauna (Animals Living in the Sediment)

The effects of water jet dredging for razor clams on non-target infauna were examined at the same six tracks mentioned above (also see Fig. 2.2.1). At each site, fishing was conducted for 10 minutes, although track length varied considerably depending on the sediment and the wind and tidal strength. At each of the experimental tracks, shortly after fishing ceased, divers entered the water and collected five cores for infaunal samples. Cores were collected by the divers pushing hollow tubes (10 cm diameter) into the seabed, sealing the upper end of the tube with a bung, and then removing the tube from the seabed, along with its contents. The lower end of the tube was then sealed, and the retained sediment and animals returned to the surface for preservation. The sampling locations were spread out along the track, with samples not taken within 5 m of the end of the track. A control sample was also collected from an unfished area adjacent to the location of each of the treatment samples. Similar sets of infaunal samples were collected from treatment and control areas from each track approximately five days and 11 weeks days after fishing. Infaunal samples were fixed in 5% formalin.

On returning to the laboratory, the infaunal samples were washed over a 0.5 mm mesh, and preserved in 75% alcohol. The infauna was counted and identified to species where possible.

Statistical Analysis

Standard statistical techniques commonly used to examine changes in benthic communities were employed (Tuck *et al.*, 1998). Changes in the total numbers of individuals, number of species, biomass, species diversity indices, and the abundance of selected individual species, were examined using repeated measures ANOVA with treatment and date as fixed factors. Following identification of effects, box plots (Tukey, 1977) were constructed to visually examine the data and identify disturbance effects. Abundance data were ln ($x$+1) transformed prior to analysis to homogenise variances (confirmed through examination of residuals). In addition, effects on the proportion of individuals each phyla contributes to total abundance were examined with analysis of deviance using a binomial distribution of errors with a logit link. Multivariate community analyses were undertaken using non-metric multidimensional scaling based on a Bray-Curtis dissimilarity matrix calculated on fourth root transformed data (Faith *et al.*, 1991; Field *et al.*, 1982; Clarke and Green, 1988). *A priori* differences between treatments and dates were tested with "analysis of similarities" randomisation test (two-way nested ANOSIM), available in the *Primer* statistical software package published by the Plymouth Marine Laboratory, with differences between individual treatments and dates investigated with *a posteriori* pairwise tests. The SIMPER routine, a program within *Primer*, was then used to establish which species contributed most to the similarity (or dissimilarity) between treatments or dates (Clarke, 1993). SIMPER computes the average similarity (or dissimilarity) between all pairs of inter-group samples and then breaks this average down into contributions from each species. *k*-dominance curves (Lambshead *et al.*, 1983) were also constructed to examine species frequency distributions for each treatment and date, and effects were examined by comparing curves for abundance and biomass (ABC method, Warwick, 1986).

Epifauna (Animals Living on the Seabed Surface)

General, qualitative observations of the epifauna associated with the areas of the six fished tracks were made by divers, before, during and after fishing. In addition, divers made video recordings of the tracks and adjacent ground using a hand held Sony video camera. These recordings were made several minutes after the dredge had been lifted so as to allow the sediment to settle and the water clarity to improve. The divers swam along the track recording observations of static or damaged epifauna and of activity by larger mobile epifauna.

In the laboratory, the video tape recordings were reviewed and all events logged and tabulated. Organisms were identified as far as possible. This task was fairly straightforward for crab species but small fish were noted as either "round" or "flat". Numerous infaunal bivalves were turned up by the dredge and these were also noted, although smaller species (*Dosinea, Lucinoma* and *Venus*) were very difficult to distinguish from the video. Razor clams were recorded as lying on the seabed, partly recessed (at least part of shell buried) or damaged.

Bycatch (Non-target Species Retained in the Gear)

Throughout the study, observations were made on the bycatch of the gear, with particular note being taken of the larger infauna (bivalves and heart urchins), any crabs or fish that were caught, and the condition of the animals (damaged/undamaged). Catch and damage rates were estimated for each of the species caught, in order to estimate the impact the gear would have on these animals.

### 2.2.4 Effects on target species

Efficiency

We define dredge efficiency as the percentage of *Ensis* in the path of the gear that are retained as catch.

Dredge efficiency was estimated in two ways i) by comparing catches in the dredge from a track of known dimensions, with the abundance in undisturbed sediment of the same area adjacent to the track (estimated in May 1998 by diver survey; Section 2.3.2); and ii) by comparing the catches in the dredge with the numbers of razor clams missed by the dredge combined with the number passing through the cage of the dredge. Immediately after fishing, divers collected the *Ensis* remaining within the extremities of the track. Initially this was confined only to those lying on the surface of the track. However, after the first track it became evident that some *Ensis* had quickly succeeded in re-burying between the time of fishing and collection by the divers, on average a period of less than 15 minutes. Therefore, the sand was "felt" for *Ensis* by the diver placing his arm in the fluidised track substrate up to elbow depth in an attempt to extract any others. This collection method may therefore mean that efficiency data for the later hauls are not comparable with those for the first haul.

*In Situ* Damage and Mortality

The animals collected from the fished tracks by divers for the gear efficiency study (see above) were measured and examined for damage, to provide an estimate of the damage to individuals not retained by the gear. Observations were also made by the divers on the ability of these individuals to reburrow, and the activities of scavenging epifaunal species.

Selectivity

Gear selectivity is the process through which smaller animals that enter the gear are able to escape through the meshes. Methods for determining the selectivity of towed fishing gears are well established (Wileman *et al.*, 1996) and several alternatives are available. After consideration of the available options, it was decided to use a modification of the small mesh cover (SMC) technique. This method is commonly used for trawl cod-end selectivity assessment. In order to determine selectivity, the population entering the gear must be known, and those escaping must be retained by some means. In demersal trawling the SMC surrounds the cod-end and is supported by hoops to prevent masking of the cod-end meshes. Any fish that escape through the trawl cod-end meshes are retained by the smaller mesh cover and this allows for a direct comparison to be made between the catches in both cod-end and cover. In the present *Ensis* study, a steel frame constructed from 1" square mild steel box section was fitted over the cage and the small mesh cover netting material attached over it (Plate 1). The SMC nylon netting was 20 mm stretched mesh (inside mesh) terminating to form a 3 m long cod-end. The gear was operated normally, as much as possible within the bounds of the experiment. On hauling, the SMC catch and the dredge cage contents were kept separate. The two catches were counted and measured to determine if any size selectivity was occurring. Direct diving observations were made on this modified gear, but due to adverse weather conditions, only two tows were observed, both in the Sound of Harris area, near Berneray.

The selectivity parameters of the gear were calculated using the logistic model

$$P = \frac{e^{a+b.L}}{1+e^{a+b.L}}$$

which was fitted to the proportion of the total catch (dredge + cover) retained in the dredge $P$, observed by length class $L$. The logistic parameters $a$ and $b$ were estimated by least squares regression analysis, and the $L_{50}$ (size at which 50% of individuals are retained) calculated as follows:

$$L_{50} = \frac{-a}{b}$$

Due to the small sample sizes, data from the two tows were pooled for each species. The numbers of animals in either the dredge or cod-end then were grouped into 10 mm size classes (ie 20.0-29.9, 30.0-39.9 etc).

Discards (Target Species Caught and Returned to the Sea)

During normal commercial practices, all *Ensis* smaller than approximately 100 mm (four inches), and those damaged (through shell breakage, or the foot extending through the side opening of the valves, and therefore unable to purge itself) are discarded. It is unknown whether undamaged undersize *Ensis* would be able to reburrow before being predated upon, following discarding, but it is assumed that all damaged *Ensis* would die following discarding. Being unable to reburrow, they would soon fall prey to mobile epifaunal predators.

During the stock survey, the length frequency distribution of the whole catches were recorded, and note was made of damaged individuals (Section 2.3.1). This information was used to estimate the amount of undersize and damaged discards from each tow.

## 2.3 Stock Survey and Aspects of Ensis Biology in Western Isles Populations

### 2.3.1 Survey using commercial gear

While an element of the survey work was associated with identifying areas with commercially viable catch rates, the most important aspect was the estimation of the stock distribution, overall abundance (and biomass) and the stock structure in terms of age and length of razor clams and non target bivalves. In order the meet this requirement, adjustment of the catch rates was attempted using the data collected from the small mesh cover study.

Survey design - following an initial estimation of the area of suitable sediment available, the survey took the form of a stratified-random layout in order to be able to assign some confidence limits to the estimates generated. Standard tows of 10 minutes duration were made at all stations and a full record of haul parameters collected. All species of large bivalve were sorted, counted and measured.

Following sorting of the catch, all *Ensis* were measured to produce a length frequency distribution for each species (see for example, Fig. 3.2.2). Measurements were taken to the mm below using callipers. Note was also taken of the condition of each individual, with those damaged (and therefore of no commercial value, and little chance of survival when discarded, recorded separately). These data were then used to calculate catch rates (numbers and, using the length weight relationships, weight), and examine differences in species and size composition between areas.

For each species, individual haul catches were also corrected for the efficiency of the gear. Catch rates from samples taken within a strata were averaged and the abundance and biomass calculated. Overall biomass was obtained by summing across strata. Where possible, disaggregated information was also presented for undersize individuals, allowing comments to be made about likely recruitment levels.

Length Frequency Distribution Analysis

Length frequency distributions were further analysed to provide comparisons of growth parameters between areas. These plots of number at length against length were examined to identify peaks in the distribution (assumed to be year classes), and the difference in length between subsequent year classes was used to calculate growth. This analysis was carried out with the dedicated Otter Research software package "Multifan" (Fournier *et al.*, 1990).

"Multifan" splits the length frequency distributions into age classes using the von Bertalanffy growth equation

$$L_t = L_\infty.(1 - e^{-k(t-t_0)})$$

where $L_t$ is the length at age $t$, and $t_0$ is the age at which length is zero, to calculate the growth parameters ($L_\infty$ and k). $L_\infty$ is the asymptotic length or average maximum length for the population, and k is the Brody growth coefficient, and defines the growth rate towards the maximum.

From this analysis of the length frequency distributions, information on the proportions at age in the catch were obtained. Catch-curve analysis (Hilborn and Walters, 1992) was used to estimate total mortality rates for the fully recruited age classes.

Direct Ageing Methods

Following measurement of the catches, a sample of shells representing the size range of animals caught was saved for each species from each area. These shells were used to estimate the ages of individual *Ensis*, by counting annual age rings laid down in the shell. For consistency the left valve was always retained.

Work was initially carried out to develop a suitable methodology for obtaining a thin section of *Ensis* shell which clearly displayed growth bands from the umbo to the edge of the shell. This method is described below. Once finalised, the methodology was applied to a sample of *E. arcuatus* shells from Grimsay and Loch Carnan, and *E. siliqua* shells from Loch Carnan and Broad Bay, to provide age estimates for a range of sizes of *Ensis*. The von Bertalanffy growth equation was fitted to the length at age data, to provide estimates of the growth parameters which were compared with those estimated using "Multifan".

Methodology

The shells were initially trimmed down in size to ease sectioning; a rough cut being made approximately 1 cm to each side of the umbo (Fig. 2.3.1). To give them improved support during the more precise sectioning procedure, the razor shells were embedded in historesin, according to the following procedure.

a) Infiltration Solution: 50 ml basic resin (containing hydroxyethyl methacrylate) + one packet of activator (containing 50% benzoylperoxide phlegmatically).

b) Embedding solution: 15 ml infiltration solution + 1 ml hardener (dimethyl sulfoxide)

The embedding solution was poured into individual plastic moulds. Given that resin polymerisation is a rapid process, the shells were immediately transferred to the moulds and allowed to sink by themselves. The embedded hard tissues were left overnight to ensure proper hardening of the resin.

The hardened blocks of resin were sectioned using an Isomet® 1,000 precision saw fitted with a diamond wafering blade. Shell sections of 1.5 mm width were cut from the area as close to the umbo as possible. The blade was kept constantly lubricated with Isocut® Plus Cutting Fluid. The blade speed was maintained at 300 rpm, and each cut took approximately two minutes. Section widths <1.5 mm were attempted, but the resultant sections were found to be fragile and prone to fracturing. To further reduce the thickness of the sections, the shells were mounted onto glass slides and polished using a lapping wheel fitted with 2500 grit metallographic grinding paper discs and lubricated with 14 Fm diamond paste slurry. Given the dense nature of the shells, the speed of the grinding plate could be set at a fast speed, reducing the time taken to complete the polish (5-6 minutes).

Razor macrostructure was investigated using a Zeiss Axioskop Routine microscope at magnifications of 25x-100x.

Length Weight Relationships

During the stock survey exercise, the length and weight of a sample of the catch of each species were recorded from each of the four areas. Weighing was carried out ashore, to the nearest 0.01 g, using a Mettler PM6000 balance. These data were used to construct length weight relationships, for use in estimation of stock size.

### 2.3.2 Diver based surveys

Suction Sampling

Initially, an attempt was made to estimate the number of individual *Ensis* in a known volume of sediment. Using a venturi lift system, divers filtered the sediment contained within a 0.1 $m^2$ box core through a fine mesh bag. Few *Ensis* were recovered using this technique because of the bivalve's escape response. When the sea bed was first disturbed by the divers, individual *Ensis* in the immediate vicinity responded by digging deeper into the sediment. This was achieved by protraction of the muscular foot into the sediment followed by a rapid retraction drawing the main body of the bivalve deeper into the sediment in the manner described by Trueman (1967). Although the venturi lift excavated the sediment to depths in excess of 0.5 m the burrowing rate of individual *Ensis* sp. generally exceeded the rate of excavation. This technique was abandoned.

Quadrat Survey

The divers noted that a feature of the *Ensis* escape response was the sudden ejection of a plume of light sediment from burrow openings on the sediment surface. After this, the burrows quickly filled leaving a small depression in the sediment surface. An exercise was undertaken to confirm that individual *Ensis* were responsible for these burrows and associated behaviour. The sediment was disturbed by a diver inserting a blade into the sediment and repeatedly moving it from side to side. This action generally revealed burrows and sediment plumes within a radius of about 25 cm. Two techniques were used to identify the occupant of a burrow. The first was to penetrate the sediment next to the burrow with a blade and trap the animal against the side of the burrow preventing any further movement. The diver would then excavate around the blade to recover any resident animal. The second technique involved injecting a saturated salt solution into the burrows and waiting a short period (3-5 minutes) for the resident animals to eject from the sediment. These techniques did not identify the burrowing animals in all cases, however only *Ensis* were associated with the burrows with the rapidly ejecting plume. Other burrow forms were noted in the sediment by divers. The same techniques were used to identify any resident burrow forming animals. These were principally the heart urchin *Echinocardium*, but also included bivalve species, but not *Ensis*.

The survey involved the same two divers, each performing an independent count of adjacent areas, following a transect parallel and 3-5 m to the side of a previously marked dredge track. In addition, two surveys of the *Ensis* population within the tracks were undertaken during the final survey of the area. This counting technique was clearly not able to differentiate between *Ensis* species.

# 3. RESULTS

## 3.1 Impact of the Gear

### 3.1.1 Gear description and deployment

The dredge operates by fluidising the sand immediately ahead of it and then extracting the razor clams (*Ensis*) from the substrate by means of a hollow blade which protrudes 11" (0.279 m) into the sediment. During the forward movement of the dredge, this blade penetrates the fluidised sand and lifts the *Ensis* upwards and backwards into a collecting cage assisted by a backward water jet. The fluidisation of the sand is achieved by pumping large volumes of water (1500 gall.min$^{-1}$) from a deck mounted pump down to the dredge. A length of 100 mm diameter fire hose is used between the pump and the dredge driven by a 120 hp deck mounted engine. At the dredge, the water enters a manifold where it is split, the majority entering the hollow blade and the remainder forming the backward water jet mentioned earlier. The blade is 0.325 m wide and is constructed from hollow box section with a 10 mm gap at the front edge. Furthermore, several holes drilled out of the leading face of the blade allow the water to be jetted forward. Therefore, as the dredge is towed slowly across the sea bed, the high pressure water from the blade, fluidises the sand ahead, dislodging the *Ensis* and denying them a solid substrate in which to bury themselves. Smooth movement over the sea bed is assisted by two skids attached along both to the port and starboard sides of the collecting cage.

The dredge is stored on the aft starboard deck when not in use. At the fore end of the dredge, a towing bridle and tow warp (combination wire) is attached along with a lifting link. When shooting, the dredge is raised from the deck on to the gunwale, and then lowered into the water. In preparation for fishing, a water intake pipe from the pump is lowered into the sea. The dredge is lowered on to the sea bed on its normal length of towing warp. The deck pump is then started and as the vessel moves down tide the fishing commences. After the duration of the haul, the vessel stops towing, the pump is switched off and the dredge hauled to the surface. The dredge is then lifted clear of the starboard gunwale and hung inboards. The catch is emptied into the deck fish pond by means of a levered hatch on the after end of the collecting cage. This fishing process continues until the end of each day, where the dredge is stowed inboard after the final haul.

### 3.1.2 Gross physical effects

During the diver observations on the dredge, it was only possible for the divers to feel the extremities and depth features of the track left behind by the dredge. This was due to poor visibility owing to the back jetting of the sand by the water jets. The track immediately behind the dredge had distinct vertical walls and a depth similar to that of the dredge blade. The substrate in the bottom of the track was in extreme suspension not unlike "quicksand". However, once the dredge was hauled and the divers returned to the start of the track, it was immediately obvious that the vertical side walls had collapsed and the cross sectional form of the track was more a flat bottomed "v" shape (Plate 2). Track dimensions measured on each survey are provided in Table 3.1.1. The average initial dimensions of the tracks (based on all data in Table 3.1.1.) were as follows; surface width 1.2 m, base width 0.5 m, depth 0.15 m. However, in locations where the dredge had remained stationary for some time, the track was somewhat larger (surface width 2.6 m, base width 1.3 m, depth 0.24 m). Upon further inspection and measurement, it was clear that the sediment within the base of the track was fluidised to approximately 0.3 m and within both side walls to approximately 0.15 m. Fluidisation of the adjacent control area (as measured by penetration of the probe) was on average, 0.065 m, significantly less than within the fished tracks ($P<0.0001$). It was also noted that in a few places, the track disappeared for several metres before reforming again. Whilst conducting observations of the gear, the blade could occasionally be seen lifting clear of the sediment for a short time before re-entering the sand. This was probably due to undulations in the sea bed topography and/or coupled with vessel surging caused by the dredge entering patches of denser sand. The track lengths varied between 26 and 122 m, depending on the sediment and the wind and tidal strength.

Observations five days later showed that the tracks were still clearly visible, but less pronounced. On these return dives, the average track depth had reduced to 0.13 m and while the surface width remained 1.2 m, the base width had reduced to 0.3 m. The average depth of fluidised sediment within the track remained unchanged at 0.3 m, and was still significantly greater than unfished areas ($P<0.0001$). This was even the case in some places where the track was no longer visible.

On return to the site in May 1998, the marked tracks were only visually identifiable by the twine markers left in position along the north edges of each track during the initial survey in March. It was not possible to visually distinguish between the towed and un-towed areas. This was probably due to the strong tidal currents found in this area, filling in the "V" channel tracks left by the dredge. So much so, that diving observations on some of the tracks were hampered by the strong current. However, upon further examination of the cross section of the track using the "dibbing" action with the graduated probe, the substrate was found to be still in a state of fluidisation to a depth of 0.2 m, a lesser degree than was previously recorded, but significantly greater than the adjacent control sediment outside the track. It was also noted that when "dibbing" the in-track substrate that a slight resistant crust, a few millimetres thick had formed over the track. This crust gave a little resistance to the point of the rod before it passed through into a more fluidised medium and eventually struck hard compact sediment at the base of the track.

Particle size analysis of the core samples found all the sediments in the area to be well or moderately well sorted medium or fine sand. The mean particle size was 0.23 mm, with 2.5%

silt. The effects of the fishing disturbance on sediment particle size was examined through repeated measures ANOVA on median phi, mean phi, % silt, coefficient of sorting, skewness and kurtosis, but only the effect on the % silt was significant ($P < 0.05$). Figure 3.1.1. shows that immediately after fishing, % silt was higher in the unfished areas, but that the difference was no-longer significant after five days.

### 3.1.3 Effects on non-target species

Infauna

A total of 147 infaunal invertebrate species were collected at the six sites during the study, comprising 52% polychaete worms, 23% crustaceans, 18% molluscs and 7% other phyla. The Paraonid polychaete *Aricidea minuta* was the most abundant species, and contributed 31% of the animals collected. A species list for each track is provided in Appendix 2.

In the cores from the unfished control areas, polychaetes, amphipods and bivalves made up 86.4, 9.7 and 3.3%, respectively, of the total abundance of individuals on the first sampling occasion. Although not identified as significant by the ANOVA (Table 3.1.2), examination of Figure 3.1.2 shows that fishing had an effect on these proportions. Within a day of fishing the proportion of polychaetes had reduced, in the fished areas, and the proportion of amphipods had increased. After five days, the differences in proportions of these phyla between fished and unfished tracks had increased further, with medians becoming significantly different (Fig. 3.1.2). After 11 weeks, neither polychaetes or amphipods showed fishing effects.

Examining the community parameters (Table 3.1.2), it can be seen that both the number of species and number of individuals also showed fishing effects. Both parameters varied significantly with treatment and date, and showed a significant interaction effect. Within a day of fishing the numbers of species and individuals were significantly lower in the fished track (Fig. 3.1.3), but no difference was recorded after five days. Biomass (excluding *Echinocardium*, a relatively rare species in cores, whose large weight would heavily influence the biomass data) was reduced in the fished tracks within a day of fishing, and remained so after five days. Examination of the diversity parameters (Fig. 3.1.4), showed that while none of the calculated parameters exhibited significant effects, it would appear there was a slight reduction in Hill's N1 (sensitive to changes in rare species), and a slight increase in Evenness (a measure of how evenly individuals are distributed among species).

Changes in the abundance [ln(x+1) transformed] of the 20 commonest species were examined in relation to treatment and date using repeated measures ANOVA (Table 3.1.3). A number of species showed significant treatment effects, with the abundance of polychaetes reducing after fishing, and the abundance of amphipods increasing (as shown by Fig. 3.1.2). Box plots of abundance for selected species are shown in Figure 3.1.5. Changes in the polychaete species (*Nephtys longosetosa*, *Chaetozone setosa* and *Streptosyllis websteri*) were identified within one day of fishing, while the amphipod (*Megaluropus agilis*) was more abundant at the fished site after five days recovery. No effects were recorded after 11 weeks.

MDS (Multidimensional Scaling) plots of the infaunal data for the unfished tracks on the first survey are shown in Figure 3.1.6. (Refer to Fig. 2.2.1. for track locations). Stations which are more similar to one another in their infaunal community occur closer together on the figure. It can be seen that the pairs of tracks (12 and 13, 18 and 19, 22 and 23), which were close spatially (Fig. 2.2.1) were also close (similar infaunal composition) on the plot. These subjective impressions were confirmed by analysis of similarities (ANOSIM; Clarke and Green, 1988). Pairwise ANOSIM with Bonferroni adjusted probabilities for multiple comparisons showed that while there was no significant difference within pairs, all other comparisons were significantly different except tracks 13 and 18.

Combining the data for the pairs of tracks, ANOSIM identified significant differences between fished and unfished tracks within one day of fishing at 12 and 13 and 18 and 19 ($P < 0.05$), but not at 22 and 23. No significant differences between fished and unfished tracks were recorded after five days or 11 weeks.

ABC (Abundance Biomass Comparison) curves (Warwick, 1986), are shown for fished and unfished areas for track 22, for the first survey, in Fig. 3.1.7. The ABC curves for this track are shown as an example, each of the other tracks showed a similar pattern of no fishing effect. These figures plot cumulative dominance curves for abundance and biomass on the same graph, allowing comparison of the forms of these curves. In undisturbed communities the biomass curve would be expected to lie above the abundance curve throughout its length, with the reverse for grossly disturbed communities (Warwick, 1986). In moderately disturbed areas the two curves are closely coincident and may cross each other one or more times.

Adopting the ABC criterion for a disturbed community, it can be seen that both the fished tracks and unfished controls were moderately disturbed (Fig. 3.1.7) on the survey within one day of fishing. This pattern continued through the second and third surveys (ABC curves not shown), suggesting that the effect of fishing on the cumulative dominance curves was comparable to background disturbance to the community (probably due to strong tidal currents). This suggestion is supported by examination of boxplots of the W statistic (Fig. 3.1.4; a measure of the difference between the abundance and biomass lines on an ABC plot, standardised to a common scale; Clarke, 1990), which shows no evidence of any fishing effect. Two-way ANOVA of the W statistic showed significant date ($P < 0.001$) term, but treatment and interaction terms were not significant.

Epifauna

Diver observations made prior to fishing the study area in the channel between Grimsay and Rossinish, revealed that there was a very sparse epifauna in the area. Shore crabs, *Carcinus maenas*, were sometimes seen amongst the debris of detached and decaying brown algae and, although not obvious, small flatfish were also observed on occasions. The flat sandy bottom was characteristic of an area swept by strong tidal flow and the surface appeared to be fairly "scoured", any material disturbed into the water column was carried by the current. Given these physical features, the paucity of epifauna is not surprising. Openings of numerous larger infaunal animals such as various bivalve species were another common feature.

Post-fishing diver observations showed that the main effect on the epifauna was the movement of crab species (mainly *Carcinus maenas*) into the region of the track to scavenge on material disturbed by the dredge. Analysis of the video material made during each run is provided in Appendix 3. Unfortunately, two aspects of the video recording made quantitative analysis extremely difficult. Firstly, there was an intermittent camera fault which marred some of the video tape recordings. The fault consisted of a few seconds of clear recording followed by about a second or so of severe interference- the incidence of the fault is shown in the tables of Appendix 3. Secondly, the tape counter available for the video recorder was neither frame or time based making it difficult to establish any kind of scale on the recordings. Based on the details in Appendix 3 some qualitative comments can be made.

Video recordings confirmed the visual observations that the main species of the larger epifauna were crabs and that, following fishing, these were very abundant in the area of the tracks. *Carcinus maenas* was the commonest species with the swimming crabs *Liocarcinus depurator* and *Necora puber* occurring occasionally. The tapes provided considerable evidence of their presence being associated with scavenging for food and there were numerous records of razor clams being eaten or carried away by crabs. Damaged razor clams with the foot extended appeared to be particularly targeted. There were a limited number of fish sightings.

The video tapes also provided additional observations on disturbed infaunal bivalves, the commonest of which were razor clams. These were most frequently seen unrecessed and lying on the surface of the sediment. Smaller numbers were seen partially recessed or in the act of burrowing into the sand and a number of damaged specimens were observed particularly in tracks 22 and 23. Small bivalve species eg *Dosinea* were frequent on some tracks eg track 13 while the larger *Lutraria* was also seen occasionally (tracks 12, 22 and 23). Somewhat surprisingly, there were comparatively few recordings of the heart urchin *Echinocardium cordatum* which was the most abundant bycatch species. This suggests either that disturbed specimens were able to burrow very quickly after the dredge had passed, or that the dredge was very efficient at catching this organism.

<u>Bycatch</u>

A list of the larger species caught as bycatch is provided in Table 3.1.4. These species are listed in approximate order of abundance, averaged over the whole study.

The commonest bycatch species, and also the most prone to damage, was the heart urchin, *Echinocardium cordatum*. An average of 28% of the individuals retained by the dredge were destroyed. The small bodied bivalve species retained in the dredge were not damaged, but the three larger sized species of bivalves (*Lutraria lutraria, Arctica islandica* and *Mya truncata*) were vulnerable to damage (10-20%). A number of crustacean species, and on rare occasions, two fish species, were also retained in the dredge, but were not damaged.

Also retained in the dredge on some occasions, usually when a large bulk of seabed material filled the dredge, were various polychaete worms. These were not identified to species level, and are not listed in Table 3.1.4, due to the difficulties in estimating abundance, but included the Glycerid, Nereid, Terebellid and Phyllodocid families. Damage appeared low, except for large Nereid worms (> 30 cm long), which were sometimes broken into pieces.

### 3.1.4 Effects on target species

<u>Efficiency</u>

Efficiency was examined using two approaches, comparing catches with i) estimates of abundance in unfished areas; and ii) numbers of *Ensis* left behind after fishing. Although some of the *Ensis* not captured by the gear, and later collected or counted by divers, will be the result of selectivity (passing through the gear) rather than efficiency (completely missed by the gear), selectivity is ignored in this analysis for simplicity. The values are therefore a combination of selectivity and what is traditionally considered efficiency.

i) Diver estimates of *Ensis* density for some of the fished tracks and unfished adjacent areas are provided in Table 3.1.5 (see Section 3.2.2 for fuller details of results). These data are used in conjunction with density estimates from the dredge catches to estimate gear efficiency. Density estimates from the dredge catches require an effective fished track width, to multiply with the track length, to calculate the fished area. Using the dredge blade width appears to underestimate the fished area, since efficiencies are estimated at over 100%. Given the shape of the track left on the seabed (see Section 3.1.2) it is more realistic to consider a wider fished area, and we have the width of the dredge (0.708 m) as a compromise between the width of the blade (0.325 m) and the average width of the track on the surface (1.2 m). Using this value, gear efficiency remains above 100% for track 19, but ranges from 68-78% (mean 72%) for the other three tracks examined.

Comparing diver estimates of *Ensis* density from fished and unfished areas provided efficiency estimates from 50-77% (mean 64%) (Table 3.1.5).

ii) Efficiency data from the first haul was not outwith the range of values collected from the other stations, and so all the data was included in the analysis. Comparing the numbers of *Ensis* caught in the dredge with those collected by divers following fishing, efficiency values ranged from 57-86% (mean 76%) *E. arcuatus* and 33 - 100% (mean 65%) for *E. siliqua*. The data for *E. arcuatus* are likely to be more reliable however, since while over 2500 individuals of this species were collected (catch + diver collection), only 150 *E. siliqua* were collected during the six hauls examined. Excluding the smallest individuals (> 60mm), since these would be difficult for the divers to see, and may well have been missed, there was no apparent trend between efficiency and *Ensis* size.

Efficiency values based on the different techniques (diver survey, diver collection after fishing) were comparable, suggesting an overall gear efficiency of 64-76%.

*In situ* damage and mortality

When observing the track after the fishing operation had been completed, *Ensis* missed by the dredge were collected by divers. It was noted that some of these were damaged. Either the shell was smashed, presumably by its inability to avoid the dredge blade or the foot was sticking out at 90° to the shell. It is questionable how this damage may happen, but it is hypothesised that the foot is forced from the shell by the pressure of water exiting the blade. If the razor clam is orientated in such a manner as to have the hinged side of the shell facing the dredge with the foot exposed, it may be possible that the foot is forced upward and away from the shell. Several *Ensis* were observed with this damage, but it did not impede their ability to burrow in the soft sediment.

Damage rates of individuals collected from the tracks by the divers ranged from 0-22% (mean 13%) for *E. arcuatus* and 0-80% (mean 20%) for *E. siliqua*. It must be remembered however, that the densities of *E. siliqua* were quite low at this site, and the damage estimates from such low returns are likely to be less reliable (more variable) than those for *E. arcuatus*. Damage rates in both species appeared to increase with tow length, suggesting greater damage with greater fishing speed. The data also suggest that damage rate increased with increased catch rate.

Observations of all tracks immediately after dredging revealed the presence of crabs (*Carcinus maenas*) entering the "V" sided channels from the outside. On occasion quite significant numbers were seen >10 aggregating around partly damaged *Ensis* and *Ensis* "meat" that had lost or partly lost their protective shells. These crabs were capable of lifting these exposed *Ensis* and either eating the flesh immediately or carrying the whole damaged individual out of the track and away from the fished area. On one or two occasions, *Ensis* lying on the surface of the track bottom were seen to attempt to burrow into the sediment and on other dives exposed *Ensis* were seen moving across the surface 10-15 cm apparently by a jetting action.

Selectivity

The SMC technique seemed to work well, with *Ensis* being retained in the cod-end when the cover came on deck. Unfortunately, catch rates were low and due to adverse weather conditions in the Sound of Harris, operations had to be cancelled earlier than anticipated, with the result that only two tows were performed with the dredge.

Using data pooled from both tows, it was possible to carry out a preliminary analysis for *E. arcuatus*. Thirty four individuals were retained in the dredge (range 90-167 mm) while

40 individuals were collected in the codend (range 20-147 mm). Figure 3.1.8 shows length frequency distributions for the dredge and codend catches. It can clearly be seen that most of the smaller individuals passed through the dredge, ending up in the codend, while most of the larger individuals were retained by the dredge. The percentage retained by the dredge at each size class is shown in Figure 3.1.9., and the curve on this plot is the selectivity curve calculated by fitting the logistic model to the data. The logistic parameters *a* and *b* were estimated to be -5.6316 and 0.04816, respectively, producing an estimated $L_{50}$ of 116.9 mm (ie 50% of Ensis of length 116.9 mm were retained). Although catches of *E. siliqua* were higher than for *E. arcuatus*, with 128 individuals retained in the dredge (range 91-105 mm), only five individuals were caught in the cod-end (range 73-181 mm), and the number of small animals was not sufficient to produce a realistic selectivity curve.

Diver observations of the codend prior to its leaving the seabed suggest selectivity by the dredge took place as the gear is lifted to the surface. Given the poor sea conditions at the time, it is possible that more "riddling" took place on those days than at other times during the study. Individuals as small as 20 mm were caught in the dredge on a number of occasions, and it is likely that when large catches of *Ensis* or other material (eg shell) are taken, smaller individuals would be retained.

One main concern of using the small mesh cover technique, was that it was not possible to determine if any small *Ensis* were escaping through the base of the cage. However, if more time were available, further work should be carried out in this context.

Discards

The mean percentage of damaged and commercially undersized (<100 mm) individuals in catches for each area are shown in Table 3.1.6. It can be seen that percentage of damage was generally higher for *E. siliqua* (12-22%) than *E. arcuatus* (5-15%), while the percentage undersize generally showed the opposite trend (ignoring Broad Bay, due to the very low catches of *E. arcuatus*), although catch rates of undersize individuals were very low (Table 3.1.6).

Although sample sizes were very small, the data do suggest that damage rates decrease with animal size, particularly for *E. arcuatus*, the species for which more small individuals were caught. Damage rates also varied between areas, with both species showing the same trend (Grimsay < Loch Carnan < Berneray, and Broad Bay highest for *E. siliqua*). From the six tracks measured (length range 26-122 m) the data suggested an increase in damage to individuals retained in the dredge with increasing fishing speed. Comparing the damage rates for these six tracks for *Ensis* retained in the dredge with those missed by the dredge and collected by divers (for the efficiency and *in situ* mortality studies), damage rates were lower for the catch (6% and 17% for *E. arcuatus* and *E. siliqua*, respectively), than the track animals (13% and 20%, for the same species, respectively). As with the *in situ* damage, the data also suggest damage rate increased with increased catch rate.

Overall damage rates reported here are likely to be greater than those for a commercial operation. During survey operations, we aimed to maintain a constant vessel speed and water jet pressure, to try to maintain constant track lengths. Under commercial operations, these would be varied with water depth and sediment type, to minimise damage to the catch. Also a number of sites were fished in Broad Bay which were slightly too deep for the length of hose on the gear, and the dredge was therefore not penetrating as deeply into the seabed as it would normally.

## 3.2 Stock Survey and Aspects of *Ensis* Biology in Western Isles Populations

### 3.2.1 Survey using commercial gear

Throughout the study, only one individual of *Ensis ensis* was caught, the remaining *Ensis* catch comprising wholly of *E. siliqua* and *E. arcuatus*. The total catch, broken down by species (number and weight) for each fished track, is shown in Table 3.2.1. The distribution of abundance (catch rate kg.10min$^{-1}$) for each area and species shown in Figures 3.2.1a-c. These figures also show the strata boundaries on which the stratified random survey design was based.

In Broad Bay (Fig. 3.2.1a) the catches were predominantly *E. siliqua*, with *E. arcuatus* only caught at three stations (in fact only one individual was caught at each of two of these). Catches appeared highest near headlands (5-8 kg.tow$^{-1}$), and reduced further inshore on Coll (2.5 kg.tow$^{-1}$) and Melbost (0.3 kg.tow$^{-1}$) Sands. The central area of Broad Bay was too deep to fish with the dredge gear (>12 m), and south-eastern area had a rocky seabed, unsuitable for *Ensis*.

At Grimsay (Fig. 3.2.1b), *E. arcuatus* was dominant in the catches, with *E. siliqua* relatively scarce. Catches between Grimsay and Ronay, and south of Ronay (mean 2 kg.tow$^{-1}$), were generally lower than those either side of the sand bank between Grimsay and Rossinish (mean 9.5 kg.tow$^{-1}$). This is the main channel between North Uist and Benbecula, and although the islands are now linked by a causeway, tidal streams are still strong. Catches were variable throughout, and within this later area varied from 1.8-23.7 kg.tow$^{-1}$, but appeared to be highest in the centre of these strong tidal channels. As well as the tows indicated in Figure 3.2.1b, two further sites were examined to the east and north of Ronay (tows 16 and 17, Table 3.2.1), neither of which had any *Ensis*.

At Loch Carnan (Fig. 3.2.1c), *E. siliqua* dominated catches. Catches of both species were lowest at the south of the area investigated, increasing in a north-westerly direction, towards the centre of the channel between Benbecula and South Uist. The most northerly of these stations provided the largest catch of *E. siliqua* of any tow during the survey (8.2 kg.tow$^{-1}$).

By allowing for gear efficiency (assuming 70% efficiency for both species, see section 3.1), an estimate of the density of *Ensis* on the ground can be made. Table 3.2.2 provides estimates of the mean weight (and standard error of this mean) of each species (divided into commercial and non-commercial sizes) per 100 m$^2$ for separate strata in each area. Mean weights provided are per 100 m$^2$, assuming an average tow length in 10 mins of 68 m, and an effective fished track width of 0.708 m (the width of the dredge, see Section 3.1). It was attempted to have at least two tows in each strata, but the very patchy nature of the substrate in some areas meant that it was difficult to find suitable ground. This was particularly the case at Grimsay, where the patchiness was also reflected in the *Ensis* densities, and some adjacent tows had markedly different catch rates.

<u>Age and Size Structure of the Populations</u>

Length frequency distributions of catches from selected sites where good catches were taken (or of the total catch of a species from an area) were analysed to estimate growth parameters. Example length frequency distributions are shown in Figure 3.2.2. These analyses are summarised in Table 3.2.3. $L_{\infty}$ ranged from 178-196 mm for *E. arcuatus*, and 200-251 mm for *E. siliqua*. The difference between the species was reflected in the generally larger size of *E. siliqua* individuals in the catches.

Growth parameters were also estimated by fitting the von Bertalanffy growth equation to the age - length data derived from the direct ageing method. Shell samples were prepared for *E.*

*arcuatus* from Grimsay and Loch Carnan, and *E. siliqua* from Loch Carnan and Broad Bay. The shells were found to show prominent banding patterns (assumed to be annual rings) subdivided by finer increments. Example shell sections are shown in Figure 3.2.3. Unfortunately, the large size of the shells from the Broad Bay sample meant that the shell portions were too large to be completely submerged in resin in the mounting trays. This meant that the resin did not set sufficiently, and only two of the sample of 14 shells could be sectioned. It was therefore not possible to estimate growth parameters for *E. siliqua* from Broad Bay by this method.

The age - length data are plotted for each species in Figure 3.2.4, with the estimated growth curves also plotted. The growth parameters are provided in Table 3.2.3. $L_\infty$ ranged from 175-178 mm for *E. arcuatus*, and was 212 mm for the one *E. siliqua* data set.

The two techniques produced comparable results for each species. Although the analyses using Multifan produced larger $L_\infty$ values (because of the way Multifan works, $L_\infty$ must be larger than the largest individual in the distribution), the values were in reasonable agreement, and showed the same pattern between species.

The proportions at each putative age, as calculated by Multifan for each length frequency distribution analysed, are shown in Table 3.2.4. The catch curves showing the age structures of the catches, are shown in Figure 3.2.5. For each sample, the numbers at age are low at the youngest ages, increase to a maximum, and then decline in the oldest ages. The youngest (smallest) individuals are less vulnerable to the gear, and make up a small proportion of the catch. As they get older (bigger) they become fully recruited, and appear in their highest proportion in the catch. As they get older still, catches decline simply because there are fewer of them due to mortality. The rate of decline in abundance after full recruitment is assumed to represent mortality. From this analysis, the instantaneous total mortality rate is estimated from 0.32-0.78 (mean 0.6). A value of 0.69 equates to 50% mortality each year. The analysis assumes constant recruitment, however, and is heavily dependent on the accuracy of the division of the catches into ages, and the results should only be taken as a guide. This mean value is larger than would be expected given the ages estimated from the direct ageing method (ie individuals living over 40 years), and more work is required before natural mortality can be estimated with confidence.

Length Weight Relationships

The length weight relationships are shown in Figure 3.2.6. The parameters for the best fit to the equation

$$\text{Weight (g)} = a * \text{length (mm)}^b$$

where a and b are constants, are provided in Table 3.2.5.

*E. arcuatus* was rare in Broad Bay, while *E. siliqua* was relatively scarce in the Grimsay area. Sufficient animals were therefore not available to construct length frequency relationships for these species in these areas.

Analysis of the length weight relationships showed that there were highly significant differences between the species, and between sites, but that a similar pattern of differences between sites was shown for both species. For a given length, *E. siliqua* was heavier than *E. arcuatus*, and the weight of individuals followed the pattern Broad Bay or Grimsay > Berneray > Loch Carnan, although the differences between individual sites were not always significant.

### 3.2.2 Diver based surveys

*Ensis* densities estimated through quadrat counts are summarised in Table 3.2.6. During the March visit a total of 78 $m^2$ of sea bed next to dredge tracks of hauls 22 and 23 (Fig. 2.2.1) were examined for *Ensis*. Counts ranged from 3-26 $m^{-2}$ (mean 11.6 $m^{-2}$) adjacent to track 22, and 4-27 $m^{-2}$ (mean 14.6 $m^{-2}$) adjacent to track 23. The overall mean for the two tracks was 13.1 $m^{-2}$. Further population surveys were carried out during May on areas close to marked tracks 13, 19 and 23.

Five of the quadrat stations sampled next to track 19 were taken on very soft sediment and are presumed to have been inadvertently taken from within the track. These five stations were therefore excluded from the estimation of background *Ensis* densities, and used to calculate opportunist estimates of *Ensis* density in the track post fishing. Of the 50 quadrat samples taken in the track 23 area, six were taken on fliudised sediment (within the track). Because the boundaries were indistinct, owing to the track filling in, only the *Ensis* burrows found in the middle could be positively placed within the original track. Of the remaining 44 quadrat samples five were taken to the north of the track, and the remainder to the south. Mean densities for the areas adjacent to tracks 13, 19 and 23 were 2.2.$m^{-2}$, 15.$m^{-2}$ and 13.5.$m^{-2}$, respectively. The differences in densities between the tracks are also reflected in the catch rates from the survey using the dredge (Table 3.2.1, Fig. 3.2.7). The mean density adjacent to track 23 did not differ greatly from that estimated in March. Densities from within fished tracks (fluidised areas) ranged from 0.5.$m^{-2}$ (track 13) to 7.$m^{-2}$ (track 23).

The counting procedure was based on the ejection of a plume of sediment due to the escape response of *Ensis* when disturbed. However, it was noted that individual *Ensis* may have produced more than one plume. Repeated disturbance in the same area resulted in the appearance of most plumes in close proximity. These plumes appeared progressively over a short period (30 seconds - two minutes). It is thought that the delayed appearance of plumes, close to one another, may show repeated attempts at retraction into the sediment by the same animal. Generally, these plumes appeared in successive order along a line originating from the first observed hole. The linear appearance of the plumes may be attributed to the angle of penetration of the burrowing *Ensis*. The survey counts attempted to allow for the appearance multiple plumes from one individual, but the possibility of over estimating means that the densities should be regarded as maximum estimates.

## 4. DISCUSSION

During the course of this work a number of aspects of the biology of razor clams and their exploitation by water jet dredge have been examined in a short study conducted in the Western Isles. This discussion draws together the findings on matters related to the fishing gear and on population dynamics and stocks of razors in order to provide recommendations pertinent to razor clam exploitation in Western Isles waters.

### Impact of Water Jet Dredging

In this study, the impact of water jet dredges has been conducted using "single fishing events". While the findings provide valuable information, they probably do not replicate commercial fishing practise under all circumstances. On locating a patch of *Ensis*, fishermen are more likely to cross the area a number of times which may produce more profound effects and it would be helpful to conduct "repeat fishing" studies to provide a more complete picture. Studies of similar gears in other areas have shown that repeated fishing has a greater effect than a single operation (Vaccerella *et al.*, 1994). Furthermore, this study was carried out in an area which was sheltered from the effects of wind induced wave action but which turned out to have rapid tidal currents scouring the bottom. Shortage of time prevented us from locating and working in a very "sheltered" area. There is a question, therefore, over the extent to which our findings can be extrapolated to other areas supporting razor clam populations. A fully comprehensive study covering all possible habitat types and exposure levels in which razor clams occur was beyond the scope of this work and some caution is required in drawing general conclusions. Nevertheless, the findings are applicable to a number of similar inlets around the coasts of the Western Isles.

The dredge gear clearly had a physical impact on the seabed, leaving a trench along the fished track, up to 2 m wide in places, with fluidised sediment to the sides and below. These trenches had reduced slightly after five days, and were no longer visible after 11 weeks, although examination of the seabed showed that under a thin crust of more resistant sediment, the substrate in the fished areas was still much more fluidised that that in the unfished areas. The presence of a hard "crust" has been noticed by the fishermen themselves in some areas. Whether this phenomenon arises solely as a result of fishing or whether environmental factors such as wave action, causing major substrate disturbance, also leads to the subsequent development of a "crust" is not yet clear. It would appear that compared to suction dredging, the gross physical effect of this water jet method is smaller. Hall *et al.* (1990) reported tracks up to 3.5 m wide, with depths exceeding 0.6 m in some places for suction dredges. The water jet dredge used here produced a far smaller track. Previous studies using hydraulic dredges have recorded sediment fluidisation in fished tracks (Lambert and Goudreau, 1996), and Kauling and Bakus (1979) suggested that disturbance of bottom sediments in the Bering Sea by a hydraulic dredge left traces that persisted from several days to several years.

From analysis of the particle size distributions, only the % silt showed a treatment effect (reduction in % silt in the fished areas immediately after fishing). This effect was presumably due to dispersal of the finest fraction of the sediment by tidal currents as the sediment was disturbed by the dredge. The divers noted that visibility was very poor during fishing operations, due to sediment in the water column. The difference in % silt was no longer significant after five days, and given the diver observations, it may have been more enlightening to examine a parameter more pertinent to fluidisation (sediment shear strength or pore water content). The results documented here are similar to those of Hall *et al.* (1990), who noted a larger median particle size (possibly due to removal of the finer fraction), and considerable fluidisation in fished areas. However, at the wave exposed site examined by Hall *et al.* (1990), no evidence of fishing remained after 40 days whereas in the present study, at a more sheltered site, effects in the form of sediment fluidisation were still observed after 11 weeks.

Experimental fishing had a number of effects on the infauna. There was an immediate reduction in the number of species, number of individuals, and biomass in fished tracks (probably due to removal and redistribution of all the infauna), but measures of diversity showed no effects. There appeared to be a general reduction in polychaete abundance, while the abundance of amphipod species increased, particularly in the cores collected five days after fishing. This may have been due to the generally more mobile nature of amphipods, compared to polychaetes, and an attraction of mobile predators and scavenging species to disturbed areas. Multivariate analysis of the infaunal community data showed an immediate change following fishing, but no longer term effect (no significant difference after five days). This is perhaps not surprising, given that although the habitats examined were sheltered from wave action, they were subjected to strong tidal currents, and the ABC plots suggested the unfished community was in a moderately disturbed state. Hall *et al.* (1990) examined infauna immediately after fishing, and found similar patterns to the present study in the number of species, the number of individuals and individual species abundances. No effects were noted 40 days after fishing (Hall *et al.*, 1990). Similar effects were also recorded by Pranovi and Giovanardi (1994), using a hydraulic dredge in the Venetian Lagoon, although recovery times appeared longer in this medium/low energy environment. The observed rate of recovery may well be contingent upon the "single fishing" aspect of this study. If a larger proportion of the overall razor clam bed were affected (by 'repeat fishing') then it is quite conceivable that the scope for movement by the associated benthos would reduce and the recovery take longer (Hall *et al.*, 1994).

Owing to the timing of this study, we interpret "recovery" to be the result mainly of movement of organisms (either the return of displaced animals or migration of animals from adjacent areas). A study over a period covering a larger portion of the life cycle of benthic organisms would allow recruitment processes to be considered also. It would be useful to know whether the observed physical changes (for example generation of the crust) had an effect on recruitment if the two events coincided. This could be particularly important if sustained fishing resulted in extensive areas of affected seabed.

In the areas examined during the present study, the epifauna appeared to be very limited and there was no evidence of macroalgae (eg *Zostera*) living on the sediment - damaging gear effects on the epifauna do not appear to be an issue at this site. One aspect which should not, however, be overlooked is that the gear disturbed larger infaunal species which provided food for scavenging epifaunal crab species. The long term effect of sustained fishing may be to benefit such groups and the effect of this on the overall balance of these shallow areas needs to be considered. The attraction of epifaunal scavengers to fished areas has been recorded by other studies into the effects of hydraulic dredges (Meyer *et al.*, 1981; Lambert and Goudreau, 1996) and other fishing gears (Kaiser and Spencer, 1994; Ramsay *et al.*, 1996). It is difficult to comment on possible effects of the gear in areas with more obvious and diverse epifauna. Mobile forms such as crabs etc appear to survive the gear quite well. It would be surprising, however, if substrate attached surface living species including macroalgae were similarly unaffected. The long term effects require to be examined in areas where these organisms occur.

Damage to the bycatch was limited to the larger bodied bivalves (*Lutraria lutraria*, *Arctica islandica* and *Mya truncata*), and the very fragile heart urchin, *Echinocardium cordatum*. While the *Echinocardium* may have been crushed while within the dredge, the bivalve shells are more robust, and damage to these species probably occurred as they came into contact with the blade, while still within the sediment. McKay (1992) recorded damage rates to bivalves using a suction dredge, and found similar rates to the present study (ie *Ensis arcuatus* 12.7%, *Ensis siliqua* 9.8%, *Lutraria* spp. 29.9%). Mobile epifaunal species (*Carcinus maenas*, *Corystes cassivelaunus*, *Cancer pagurus*) were retained by the dredge, but the very slow fishing speed of the gear (approximately 7 $m.min^{-1}$) meant that no damage was inflicted on these species.

Below we discuss the potential sustainability of populations of the target species of *Ensis*. Similar discussions apply to other large bivalves and benthic organisms taken incidentally by the dredge. Although not always targeted or retained by fishermen, damaged and discarded bycatch species are likely to be removed from the population by scavengers. This study has not been able to examine the long term effects of fishing on this group but it is important that these species, which are often subject to rather sporadic recruitment (Caddy, 1989), are not overlooked.

### Water Jet Dredging for Razor Clams

*Ensis* discards consist of commercially undersize individuals, and those damaged in some way (either through breakage, or the foot being extended through the side opening of the shell). Undersize catch rates were low (maximum of 7% of catch for *E. arcuatus*, 2.5% for *E. siliqua*), and although damage rates were high on some occasions (maximum of 80%), our practices did not truly reflect commercial operations, and they are almost certainly over-estimates of commercial values. When fishing for the surf clam *Spisula solidissima*, Meyer *et al* (1981) found that damage could vary from 30-92%, depending on dredge performance (altered through adjustments to the dredge gear and towing speed). Damage rates appeared to be highest at small sizes, and this is perhaps not surprising, given the very fragile nature of the shells of small individuals.

The main export market for *Ensis* is for live animals, so that great care is taken to sort the catch quickly, and therefore undersize discards are soon returned to the water. Although no discard survival studies have been carried out, observations of displaced *Ensis* on the seabed following dredging suggest that undamaged individuals would be able to reburrow following discarding. Individuals with limited shell damage may also survive to reburrow, since Gaspar *et al.* (1994) found evidence of repaired dredge damage to shells of *Ensis*. Individuals with their foot extended through the side opening of the shell were observed re-burrowing in soft sediment by divers, but since they appear unable to retract their foot into the body of the shell, may not be capable of burrowing into firmer substrate. If this was the case, then they would be prone to predation from mobile epifaunal predators.

Too few data are available to regard the selectivity parameter values as definitive and these should be treated cautiously at this stage. There does however, appear to be evidence of selection taking place within the dredge, especially when there are only small amounts of sediment retained. Comparing the length frequency distributions of catches from the present study with those from suction dredging (McKay, 1992), it can be seen that a greater proportion of the catch in the earlier study was made up of small (<50 mm) *Ensis*. While differences in recruitment strength may account for this, the nature of the suction dredge technique would suggest it is less selective than the hydraulic dredge technique.

First impressions suggested that water jet dredging represented a rather inefficient system. Our more detailed calculations show that the efficiency was in fact up to 70% and, it should be remembered, these estimates are derived from a protocol which did not allow the settings of the gear to be adjusted during the study. Under fully commercial conditions, tailoring the dredge blade and towing speed etc to particular sediments would almost certainly lead to improvements. As with damage rates, Meyer *et al.* (1981) found dredge efficiency could be improved from 80-91%, through gear adjustments.

## Stock Surveys in A Limited Number of Areas of the Western Isles

The present study concentrated on areas with known *Ensis* populations, but a previous survey (McKay, 1992), found that sandy bottoms in areas exposed to the prevailing wind, and subject to severe wave action, were largely devoid of large bivalve species, including *Ensis*. This would suggest that while *Ensis* are known to occur along the relatively wave sheltered eastern side of the Western Isles, they may not be very abundant on the more exposed western shores.

*Ensis* were widespread throughout the areas surveyed, but densities varied considerably, even between adjacent stations. We estimate a small (10 m) vessel exploiting *Ensis* with a hydraulic dredge would need to land on average about 170 kg.day$^{-1}$ (fishing 175 days each year). This means that average survey catch rates from the present study of between 7-8 kg.10 min tow$^{-1}$ are required for commercial viability. Therefore, only relatively small patches of each of the areas surveyed would have sufficient density to support commercial operations.

In the areas studied, the best catches were generally in the centres of the strong tidal channels (Grimsay and Loch Carnan), and around headlands (Broad Bay), where one might expect tidal currents to be strongest. Given that *Ensis* is a filter feeder, it is perhaps not surprising that the highest densities are in areas with the greatest water exchange. Henderson and Richardson (1994) also suggest that within a suitable area, locations subjected to the strongest tidal currents should be most favourable for growth.

From discussions with the crew of the MFV *Ptarmigan*, and observations throughout the study, estimations of the potential scope of the fishery have been made. Since the hydraulic dredge retains the catch within the gear (rather than delivering it to the surface, as with a suction dredge), fishing takes place as a series of separate tows, with the gear hauled to the surface to be emptied between each operation. Experience has shown that the vessel typically completes 10-15 15 min tows each day. Assuming average speeds from the present study, and a fished track width of 0.708 m (dredge width), this would result in an area of 722-1083 $m^2$ fished each day. Based on a working year of 150-200 days, this would lead to an area of 0.108-0.216 $km^2$ fished each year by a single vessel.

This area appears quite small when compared to the extent of the areas surveyed (Coll Sands and surrounds - 3 $km^2$, Melbost Sands and surrounds - 4.5 $km^2$, Grimsay - 4 $km^2$, Loch Carnan - 2.5 $km^2$), particularly when it is remembered that the survey areas were limited to a maximum depth of 11 m, and a maximum working depth of 18 m is possible with longer water hose. However, *Ensis* densities were patchy, and abundances were not sufficient to support a fishery throughout each of these areas, thus reducing the extent of suitable ground. Effort would therefore not be distributed evenly, but concentrated in the areas of greatest return until catches become uneconomic. While the initial exploitation of an area would fish individuals from a number of age classes (4 and above, with the bulk of the catch coming from ages 3-7), subsequent exploitation would only be able to fish those individuals left after fishing became uneconomic, and new recruits to the commercial stock since that time. Therefore, it may take up to seven (or more) years for catches to return to suitable levels to sustain a fishery.

Even assuming a regular recruitment to an exploited area, the results suggest a fairly lengthy replacement time for razor clams after an initial removal of the commercial sizes. Some degree of "resting" of grounds would seem sensible and a rotational fishery based on numerous grounds worked by a relatively small fleet would probably be more sustainable than uncontrolled access. This survey was only able to examine a limited number of the potential grounds available around the Western Isles. The earlier work by McKay (1992) pointed to substantial populations in a number of areas including Loch Maddy, Barra and Vatersay, and recent fishing performed by the MFV *Ptarmigan* in connection with classification of razor clams (under Food Safety Regulations) has found that commercial quantities remain in a number of these areas.

## Aspects of the Population Dynamics of Razor Clams in Western Isles Populations

The timing of the study meant that we were able to examine only a few aspects of the population dynamics of razor clams.

### Age Structure

Growth parameters calculated from direct ageing methods and analysis of length frequency distributions were similar, and indicated that while the two species had similar growth rates, *Ensis siliqua* grew to a larger maximum size. Previous studies examining the growth of *Ensis* have also shown differences between species, with *E. siliqua* growing to a larger size than *E. ensis* (Gaspar *et al.*, 1994; Henderson and Richardson, 1994). These studies found that *E. siliqua* grew to its maximum size at a faster rate than recorded in the present work (von Bertalanffy parameter k = 0.65 in Portugal (Gaspar *et al.*, 1994) and 0.56 in North Wales (Henderson and Richardson, 1994), compared to 0.21 in the present work), but the maximum size recorded in these previous studies was considerably smaller than that in the Western Isles.

Direct ageing methods indicated that the majority of the catches were made up of individuals aged between three and seven, although a significant number were aged between 10 and 15 years, and a couple of specimens were estimated at over 30 years. There is scope for further examination of some of these most extreme cases, but nevertheless the population appears to be composed of generally older animals than has been found elsewhere (Gaspar *et al.*, 1994; Henderson and Richardson, 1994). This has implications for the sustainability of the fishery, because if these older individuals are quickly removed, there may be a delay of a number of years before densities recover to a level suitable for exploitation. Size at maturity in *Ensis* is unknown, as is the extent to which a local population of adults contributes to local recruitment, and so the long term effects of removing the majority of commercial sized *Ensis* from an area cannot be predicted.

### Recruitment

Catches of commercially undersize individuals were low due to the selectivity of the gear, although in situations where the dredge was clogged with sand, individuals down to 20 mm in length were retained. Because of this gear selectivity, while we can state that very small individuals were present at a number of locations, we cannot provide any quantitative measure of their abundance. In order to predict future recruitment to the fished population from the density of undersize individuals, a less selective sampling technique, such as suction dredging, should be employed.

Very little is known about recruitment in *Ensis*, but Beukema and Decker (1995), found that recruitment in *Ensis directus* in the Wadden Sea was very variable between years, and significant numbers were only recorded in two years between 1983 and 1994. This species is a recent invader to European waters, however, and recruitment patterns may not match native species. Henderson and Richardson (1994) suggest a gradual down-shore migration of juveniles occurs in *Ensis*. Tidal currents at the locations more favourable for growth are too strong for settlement, and recruitment is thought to occur further up the beach, with juveniles migrating downshore once they are able to cope with the stronger currents. Our surveys did not provide sufficient data to examine this in depth, but we did record for example, that the smallest mean sizes of individuals in catches in Broad Bay were found at the highest stations up the beaches of Coll and Melbost Sands. Given that initial settlement appears to occur in the intertidal zone, beach sampling at the end of the summer could provide an indication of future cohort strength, although obviously sampling ages closer to entry to the fishery would provide a more accurate estimate.

More information on the reproductive cycle would be helpful. In particular the size/age of first maturity would be useful in making recommendations on a minimum landing size and gear regulations.

## CONCLUSIONS

### Impact

- Immediate physical effects are apparent, with the dredge leaving visible trenches in the seabed. While these trenches had started to fill after five days, and were no-longer visible after 11 weeks, the sediment in fished tracks remained fluidised beyond this period.
- The majority of the infaunal community is adapted morphologically and behaviourally to a dynamic environment, and other than initial removal through dispersal, is not greatly affected by the dredge. Species that are likely to be affected (eg *Echinocarium cordatum, Arctica islandica* and other large bivalves) were very rare in infaunal samples, but present in dredge catches, where damage was noted, and ranged on average from 10-28%.
- On the evidence of the present study, and the work of Hall *et al.* (1990) and McKay (1992), it would appear that there is little difference between the biological impact of

hydraulic and suction dredging, although the latter may have a greater physical effect (larger trenches) and fish less selectively.

## Gear aspects

- Gear efficiency was high (up to 70%) during the study and could be expected to be even higher during normal fishing operations, when adjustments are made for water depth and towing speed.
- Preliminary observations suggest that the gear is selective, with an $L_{50}$ of 116.9 mm for the gear as rigged during the study. This selectivity appears to take place as the dredge is lifted from the seabed to the vessel, and is reduced greatly when the dredge becomes filled with sand and shell material.
- Under normal conditions (when the dredge is not clogged), catches of commercially undersize individuals are low. The marketing requirement to sort the catch quickly and keep the animals alive means discards are not kept on deck long, and survival should be high.
- Damage rates were comparable to those recorded for suction dredging for *Ensis*, but would be expected to be reduced under normal fishing operations.

## Stocks and potential

- While *Ensis* were widespread throughout the surveyed areas (both in this and previous studies), they were only present in commercial densities at a limited number of sites in each of the areas.
- Previous studies have found *Ensis* are not abundant on sandy shores exposed to severe wave action, and therefore commercially fishable stocks on the west coast of the Western Isles may be scarce. However, other populations surveyed at other times to the south and east could form part of a coordinated small scale fishery.

## Population dynamics

- Although knowledge of *Ensis* growth is limited, comparison of the growth data with published studies suggests that *Ensis* in the Western Isles grow to a size comparable with the largest in Scotland, which is larger than recorded elsewhere in Europe.
- Ageing suggests the populations contain significant numbers of animals over 10 years old, which has an important bearing on the nature of any fishery.
- Small *Ensis*, as young a one year old, were caught during the study, but the selective nature of the gear meant that this only occurred when the dredge was clogged, and quantitative estimates of the smallest individuals could not be made.
- Estimates of recruitment could be made in the future through beach surveys and or surveys using a less selective gear (ie suction dredge).

# RECOMMENDATIONS

This work was conducted in the context of i) an intention to try to establish a limited and controlled fishery for razor clams in the Western Isles; ii) recent changes in legislation covering Regulating Orders which makes management of such fisheries a possibility; and iii) a review of the Inshore Fisheries Act Scotland. While the findings of the Study are necessarily limited by geographic area and scale, due to the time available, nevertheless some general recommendations can be made which could form a basis for taking this issue forward.

Overall, the results suggest that following fishing, infaunal effects are only short term in nature, but question marks remain over the significance of the crust formation and underlying fluidised sediment. There are also uncertainties about the recruitment and sustainability of the *Ensis* populations. On balance the gear appears to be potentially less disruptive than suction dredging, but given the concerns expressed above a precautionary approach is necessary here, and we would suggest a very limited fishery is established in the first instance.

## Likely Nature of A Sustainable Fishery for Razor Clams in the Western Isles

It is recommended that a fishery for razor clams in the Western Isles, consistent with a precautionary approach, should embody the following features:

1. A small scale fishery with limited access is necessary. In the absence of more detail on *Ensis* population dynamics (particularly recruitment) it is suggested that a limit of 3-4 boats should be set initially. This figure could be reviewed and adjusted in the light of new data obtained during the course of the fishery. An open fishery with unlimited access should be avoided.

2. Areas should be fished on a rotational basis. Owing to the age structure it appears likely that several years may be required for recovery of *Ensis* populations. This constraint would, in addition, be beneficial to the associated benthic fauna and should allow full recovery of the physical characteristics of the substrate.

3. Ideally, the current practice of fishing a single water jet dredge in short 15 minute tows should be adopted as standard. Use of suction dredges may not need to be totally ruled out but a day's aggregate continuous fishing time should be of similar duration to that of the water jet dredge total (see 5).

4. The size and design of dredge should be close to that currently in use (Appendix 1) and should be carefully defined. In the light of future studies on the size of maturity, mesh sizes for the dredge cage and a supporting Minimum Landing Size could be established.

5. Additional control measures could include the setting of catch limits and/or limiting the number of hauls made in a days fishing. While offering a more conservative approach from the stock point of view, these measures would also ensure that market supply could be controlled.

6. All participating vessels should be required to complete detailed logbooks containing information on positions fished, catch composition and weight and tow duration. These data should form the basis of ongoing assessments which should be used to refine and modify the nature of the fishery. Samples of shells should be made available for measuring and ageing. Attempts should be made to initiate and support biological studies (particularly of recruitment processes) and independent stock assessments.

## Special Comments Regarding Areas of Access for Water Jet Dredges

At present, all forms of suction dredge and water jet dredge are grouped in a catch all definition within the Inshore Fishing (Prohibition of Fishing and Fishing Methods) (Scotland) Order 1989. Use of these gears is currently restricted in a number of areas, including areas around the Western Isles. Based on this study and the study by Hall *et al.* (1990) both gears appear to produce impact effects on the seabed but recovery appears to take place fairly quickly. It could be argued that the continuous fishing method of the suction dredge and its more dramatic removal of sediment to the surface poses more of a threat than the intermittent water jet dredge method. On balance, however, it would seem that there is little justification for changing the definitions of these gears. The all encompassing approach also allows for any further gear developments which may occur.

The reasons for having the current system of closed areas for mobile gears include the protection of various species of fish in their juvenile stages and the protection of sensitive inshore areas. In the absence of other types of control, closures have prevented unacceptably large influxes of vessels into areas which could not support them. Some aspects of the biology of the razor clam populations studied here, and some features of the physical disturbance caused by the gear, suggest that prevention of unlimited fishing activity has been a prudent policy.

The question is whether under a more restrictive regime, a limited and controlled suction or water jet dredge fishery would be possible in some of these areas. The results presented here suggest that recovery of the infauna occurs after fishing and we have made cautious suggestions about the type of fishery which would allow sustainability of the target razor clam populations.

Just as the recovery and sustainability of the razor clam populations following fishing will depend on adjusting fishing activity to ensure adequate replacement takes place, so the recovery and maintenance of seabed and its associated fauna requires a similar balance to be struck. While water jet dredges appear to cause less obvious disturbance to the seabed than suction dredges, it is likely that unlimited activity in an area could lead to long term changes in the benthic community and unsustainable fisheries. The important point is that some control over levels of activity are required and that it would be unwise to allow any gear of this type complete freedom of access.

Recent changes to the legislation concerning Regulating Orders mean that these Orders can now offer a way of establishing limited and controlled fisheries of the type described. It is recommended that the most suitable way for a dredge fishery to be developed in the Western Isles is through the setting up of a Regulating Order.

## Future Studies Required

It is necessary to reiterate the earlier comment that results of the studies presented here are relevant to the areas in which they were conducted. It is unclear how transferable the findings are. Studies in other areas would provide a broader picture of the responses of both the target populations of *Ensis* and the communities in which they live.

1. More general studies on the biology of *Ensis*, and in particular, growth, natural mortality, reproduction and most importantly, recruitment are required. This latter topic could include:

    i) an investigation into variability in recruitment, and
    ii) the effect of fishery induced disturbance on the recruitment of *Ensis*.

Both these studies would require the use of sampling gear which is less selective ie takes higher proportion of small animals.

2. Further impact work - particularly effects of repeat fishing or sustained fishing over a number of seasons. The impact on larger less abundant species (eg *Arctica islandica*, *Lutraria lutraria*) should also be examined in greater detail.

3. Further studies related to gear could include improvements in selectivity and reduction of damage to catch and bycatch.

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**TABLE 3.1.1**

Measured dimensions of tracks left by dredge. See Figure 2.2.2 for details of measurements.

| Date | | | 1st survey 12/03/98 | | | | | 2nd survey 17/03/98 | | | | | Final survey 25/05/98 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Haul | Dredged | | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| 12 | 12/03/98 | *A* | 40 | 40 | 55 | 45 | 30 | 35 | 40 | 30 | 40 | 30 | - | - | - | - | - |
| | | *B* | 70 | 70 | 85 | 85 | 75 | 120 | 95 | 105 | 110 | 110 | - | - | - | - | - |
| Length | 59 m | *C* | 10 | 10 | 10 | 15 | 15 | 15 | 8 | 4 | 6 | 14 | - | - | - | - | - |
| | | *I* | | | | | | 22 | 45 | 30 | 30 | 32 | 17 | 10 | 8 | 15 | 16 |
| | | *II* | | | | | | | | | | | 7 | 7 | 8 | 11 | 9 |
| | | | | 13/03/98 | | | | | 17/03/98 | | | | | 25/05/98 | | | |
| 13 | 12/03/98 | *A* | 37.5 | 52.5 | 0 | 40 | 65 | 20 | 10 | 40 | 30 | 40 | - | - | - | - | - |
| | | *B* | 120 | 110 | 90 | 130 | 95 | 120 | 110 | 125 | 105 | 105 | - | 57 | - | - | 60 |
| Length | 55 m | *C* | 20 | 7 | 0 | 22 | 4 | 12 | 12 | 12 | 9 | 11 | - | 0 | 0 | - | 0 |
| | | *I* | | | | | | 45 | 35 | 47 | 41 | 40 | 9 | 33 | 12 | 7 | 41 |
| | | *II* | | | | | | 7 | 14 | 14 | 11 | 12 | 7 | 6 | 6 | 7 | 8 |
| | | | | 13/03/98 | | | | | 17/03/98 | | | | | 26/05/98 | | | |
| 18 | 13/03/98 | *A* | 52.5 | 97.5 | 0 | 52.5 | 40 | 55 | - | 45 | 40 | 50 | - | - | - | - | - |
| | | *B* | 85 | 132.5 | 135 | 100 | 105 | 105 | 80 | 125 | 95 | 155 | 40 | 60 | 50 | 60 | 65 |
| Length | 60 m | *C* | 10.5 | 12 | 5 | 14 | 22.5 | 7 | 4 | 14 | 10 | 21 | 0 | 0 | 0 | 0 | 0 |
| | | *I* | | | | | | 32 | 22 | 26 | 24 | 31 | 17 | 19 | 34 | 34 | 38 |
| | | *II* | | | | | | 6 | 7 | 6 | 7 | 7 | 10 | 7 | 12 | 7 | 12 |
| | | | 14/03/98 | | | | | | 18/03/98 | | | | | 26/05/98 | | | |
| 19 | 13/03/98 | *A* | - | 135 | 65 | 75 | 75 | 40 | 30 | - | - | - | - | - | - | - | - |
| | | *B* | 250 | 262 | 137 | 155 | 185 | 140 | 160 | 170 | 160 | 190 | 95 | - | - | - | - |
| Length | 26 m | *C* | - | 24 | 9 | 10 | 29 | 60 | 16 | 23 | 28 | 12 | - | - | - | - | - |
| | | *I* | 65 | 44 | 14.5 | 23 | 53 | 40 | 22 | 28 | 11 | 30 | 12 | 11 | 8 | 9 | 5 |
| | | *II* | 8 | 4 | 6 | 7 | 8 | 21 | 9 | 17 | 11 | 9 | 7 | 7 | 8 | 8 | 5 |
| | | *III*(left) | | | | | 15 | | | | | | | | | | |
| | | *III*(right) | | | | | 15 | | | | | | | | | | |
| | | | 14/03/98 | | | | | | 19/03/98 | | | | | 26/05/98 | | | |
| 22 | 14/03/98 | *A* | 45 | 64 | 48 | 56 | 55 | 15 | 40 | - | 35 | 25 | - | - | - | - | - |
| | | *B* | 163 | 104 | 102 | 94 | 86 | 120 | 115 | 70 | 130 | 105 | 140 | 105 | 10 | 10 | 95 |
| | | | | | | | | | | | | | | | 5 | 0 | |
| Length | 123 m | *C* | 43 | 43 | 14 | 14 | 8 | 22 | 10 | - | 14 | 11 | 33 | 19 | 9 | 11 | 8 |
| | | *I* | 21 | 22 | 12 | 19 | 24 | 25 | 19 | 27 | 21 | 16 | 44 | 40 | 37 | 42 | 44 |
| | | *II* | 6 | 4 | 6 | 4 | 5 | 6 | 5 | 6 | 3 | 6 | 10 | 20 | 5 | 8 | 8 |
| | | *III*(left) | 13 | 12 | 18 | 12 | 13 | | | | | | | | | | |
| | | *III*(right) | 12 | 12 | 14 | 12 | 11 | | | | | | | | | | |
| | | | 14/03/98 | | | | | | 19/03/98 | | | | | 26/05/98 | | | |
| 23 | 14/03/98 | *A* | 55 | 55 | 75 | 60 | 45 | 45 | 25 | - | 10 | 20 | - | - | - | - | - |
| | | *B* | 117 | 125 | 115 | 130 | 155 | 130 | 120 | 130 | 140 | 145 | - | - | - | - | - |
| Length | 87 m | *C* | 12 | 11 | 7 | 18 | 24 | 11 | 16 | 6 | 9 | 11 | - | - | - | - | - |
| | | *I* | 27 | 29 | 32 | 19 | 13 | 35 | 35 | 29 | 25 | 29 | 54 | 31 | 27 | 29 | 24 |
| | | *II* | 5 | 11 | 8 | 10 | 6 | 7 | 11 | 9 | 7 | 9 | 9 | 8 | 7 | 8 | 8 |

**TABLE 3.1.2**

Summary of ANOVA for the effects of treatment and date on log(*x*+1) transformed counts of total numbers of species and total numbers of individuals, and untransformed biomass, diversity and evenness from infaunal samples. p-values provided for treatment, date and interaction effects. Also included is summary of analysis of deviance examining effects of treatment and date on the proportion of the total number of individuals made up by the main phyla.

| | Treatment | Date | Interaction |
|---|---|---|---|
| Number of species | **<0.01** | **<0.005** | **<0.001** |
| Number of individuals | **<0.005** | **<0.005** | **<0.001** |
| Biomass | 0.15 | 0.21 | 0.086 |
| Biomass (exc. Echinocardium) | 0.43 | 0.89 | 0.82 |
| Hill's N1 | 0.11 | 0.17 | **<0.005** |
| Hill's N2 | 0.63 | 0.31 | 0.31 |
| Polychaetes | 0.13 | 0.37 | 0.72 |
| Amphipods | 0.15 | 0.37 | 0.76 |
| Bivalves | 0.74 | 0.89 | 0.89 |

**TABLE 3.1.3**

Summary of ANOVA for the effects of treatment and date on log(*x*+1) transformed counts of abundance of the 20 commonest species. p-values provided for treatment, date and interaction effects. Densities provided are averages per 10 cm dia core from all samples collected throughout the experiment. Where significant treatment or interaction effects were noted, the change indicated represents the change in abundance relative to the unfished track associated with fishing (? - change unclear).

| Species | Density | | Treatment | Date | Interaction | Change |
|---|---|---|---|---|---|---|
| *Aricidea minuta* | 7.55 | Polychaete | **<0.05** | 0.18 | 0.07 | -ve |
| *Exogone hebes* | 2.89 | Polychaete | **<0.05** | 0.50 | 0.25 | -ve |
| *Chaetozone setosa* | 2.20 | Polychaete | 0.24 | 0.18 | **<0.05** | -ve |
| *Pontocrates arenarius* | 1.72 | Amphipod | **<0.05** | **<0.001** | <0.05 | ?+ve |
| *Streptosyllis websteri* | 1.55 | Polychaete | **<0.05** | **<0.01** | <0.05 | -ve |
| *Megaluropus agilis* | 1.34 | Amphipod | **<0.01** | **<0.05** | 0.83 | +ve |
| *Nephtys longosetosa* | 1.28 | Polychaete | **<0.001** | **<0.001** | <0.001 | -ve |
| *Capitella sp.* | 1.04 | Polychaete | 0.08 | 0.31 | 0.54 | |
| *Magelona filiformis* | 0.60 | Polychaete | **<0.01** | 0.33 | 0.25 | ? |
| *Bathyporeia pelagica* | 0.45 | Amphipod | 0.06 | **<0.001** | 0.36 | |
| *Bathyporeia pilosa* | 0.45 | Amphipod | 0.08 | **<0.001** | 0.81 | |
| *Clausinella fasciata* | 0.35 | Bivalve | 0.17 | **<0.05** | 0.61 | |
| *Scoloplos armiger* | 0.28 | Polychaete | 0.70 | **<0.05** | 0.99 | |
| *Pseudocuma longicornis* | 0.20 | Amphipod | 0.07 | **<0.05** | 0.10 | |
| *Aonides paucibranchiata* | 0.18 | Polychaete | 0.78 | 0.62 | 0.35 | |
| *Exogone naidina* | 0.16 | Polychaete | 0.94 | 0.69 | 0.26 | |
| *Spiophanes bombyx* | 0.16 | Polychaete | 0.84 | 0.80 | 0.21 | |
| *Magelona mirabilis* | 0.15 | Polychaete | 0.18 | 0.07 | 0.93 | |
| *Bathyporeia nana* | 0.14 | Amphipod | 0.89 | **<0.05** | 0.12 | |
| *Spio filicornis* | 0.13 | Polychaete | 0.17 | **<0.05** | 0.83 | |

**TABLE 3.1.4**

Bycatch details and mortality. Abundance values relate to abundance in the dredge catch at the sites where they occurred. Very common - almost all sites, Common - more than half sites, less common - less than half sites, Rare - less than a quarter of sites, Very rare - only one or two sites.

| Species | | Abundance (average number per tow) | Damage % mean (range) |
|---|---|---|---|
| *Echinocardium cordatum* | Heart urchin | Very common - 120 | 28 (12-42) |
| *Dosinia lupinus* | | Very common - 30 | 0 |
| *Venus striatula* | | Very common - 20 | 0 |
| *Lucinoma borealis* | Northern lucine | Common - 5 | 0 |
| *Gari fervensis* | | Common - 3 | 0 |
| *Carcinus maenas* | Shore crab | Common - 6 | 0 |
| *Lutraria lutraria* | Common otter-shell | Less common - 3 | 10 (0-60) |
| *Artica islandica* | Iceland-cyprina (Quahog) | Less common - 2 | 10 (0-50) |
| *Mya truncata* | Blunt gaper | Less common - 2 | 20 (0-50) |
| *Donax vittatus* | Banded wedge-shell | Less common - 2 | 0 |
| *Mactra corallins* | Rayed trough-shell | Less common - 2 | 0 |
| *Liocarcinus depurator* | Swimming crab | Less common - 3 | 0 |
| *Corystes cassivelaunus* | Masked crab | Less common - 3 | 0 |
| *Pagurus bernhardus* | Hermit crab | Less common - 1 | 0 |
| *Acanthocardia aculeata* | Spiny cockle | Rare - 1 | 0 |
| *Venerupis pullastra* | Pullet carpet-shell | Rare - 1 | 0 |
| *Crangon crangon* | Brown shrimp | Rare - 3 | 0 |
| *Cancer pagurus* | Edible crab | Rare - 1 | 0 |
| *Ammodytes lanceolatus* | Greater sandeel | Rare - 2 | 0 |
| *Buccinum undatum* | Whelk | Rare - 1 | 0 |
| *Pleuronectes platessa* | Plaice | Very rare - 1 | 0 |
| *Aphrodita aculeata* | Sea mouse | Very rare - 1 | 0 |

**TABLE 3.1.5**

Estimated gear efficiency from comparison of catches and diver density estimates.

| Track | Length (m) | *Ensis* (catch) | Density ($m^{-2}$) | | | | Efficiency %* | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | catch‡ | | Diver | | catch | | Diver |
| | | | (0.325m) | (0.708m) | fished | unfished | (0.325m) | (0.708m) | |
| 13 | 55 | 58 | 3.24 | 1.49 | 0.5 | 2.2 | 147 | 68 | 77 |
| 19 | 25.8 | 341 | 40.66 | 18.67 | 5.2 | 15 | 271 | 124 | 65 |
| 22 | 122.5 | 784 | 19.69 | 9.04 | | 11.6 | 170 | 78 | |
| 23 | 87.3 | 607 | 21.39 | 9.82 | 7 | 14† | 153 | 70 | 50 |

† - averaged over two dates.
‡ - density and efficiency estimated from catch based on effective track width of either 0.325 m (blade width) or 0.708 m (dredge width).
* - efficiency calculated from catch as density estimated by catch divided by density estimated in unfished area by diver, efficiency calculated from diver as (density in unfished area minus density in fished area) divided by density in unfished area.

**TABLE 3.1.6**

Summary table of catches during stock survey.

| Area | No tows | Ensis siliqua | | | | Ensis arcuatus | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | mean catch No | mean catch wt (kg) | % damaged | % undersize | mean catch No | mean catch wt (kg) | % damaged | % undersize |
| Loch Carnan | 8 | 51.1 | 2.5 | 17.2 | 0.9 | 39.5 | 1.2 | 11.0 | 2.2 |
| Grimsay | 23 | 12.6 | 0.6 | 12.2 | 0.7 | 124.6 | 4.0 | 5.3 | 7.0 |
| Berneray | 2 | 66.0 | 4.2 | 19.9 | 2.3 | 26 | 0.8 | 14.3 | 1.2 |
| Broad Bay | 23 | 43.2 | 3.3 | 21.8 | 2.5 | 0.6 | 0.02 | 0 | 0 |

## TABLE 3.2.1

Total *Ensis* catch for each fished track, broken down by species. Lat and Long provided in decimal degrees. Comm wt - weight of commercial sized catch (>100 mm length).

| Tow | | | *Ensis siliqua* | | | *Ensis arcuatus* | | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Lat (N) | Long (W) | count | wt (kg) | comm wt (kg) | count | wt (kg) | comm wt (kg) | wt (kg) | comm wt (kg) |
| **Grimsay** | | | | | | | | | | |
| 1 | 57.477 | 7.1970 | 28 | 1.378 | 1.234 | 0 | 0 | 0 | 1.378 | 1.234 |
| 2 | 57.475 | 7.2100 | 10 | 0.693 | 0.626 | 72 | 2.638 | 2.559 | 3.331 | 3.186 |
| 3 | 57.468 | 7.2080 | 3 | 0.165 | 0.165 | 79 | 2.658 | 2.503 | 2.823 | 2.668 |
| 4 | 57.459 | 7.2097 | 3 | 0.117 | 0.117 | 205 | 6.809 | 6.533 | 6.927 | 6.650 |
| 5 | 57.468 | 7.2033 | 20 | 1.178 | 1.178 | 95 | 3.276 | 3.140 | 4.454 | 4.318 |
| 6 | 57.466 | 7.1989 | 11 | 0.626 | 0.626 | 2 | 0.060 | 0.060 | 0.687 | 0.687 |
| 7 | 57.474 | 7.1988 | 13 | 0.751 | 0.751 | 67 | 2.105 | 2.035 | 2.857 | 2.787 |
| 8 | 57.477 | 7.1913 | 18 | 0.974 | 0.974 | 65 | 1.999 | 1.959 | 2.973 | 2.933 |
| 9 | 57.480 | 7.1999 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10 | 57.463 | 7.1959 | 1 | 0.020 | 0.020 | 6 | 0.152 | 0.152 | 0.172 | 0.172 |
| 11 | 57.467 | 7.1971 | 38 | 2.010 | 1.959 | 3 | 0.077 | 0.072 | 2.087 | 2.031 |
| 12 | 57.467 | 7.2155 | 24 | 1.438 | 1.205 | 12 | 0.445 | 0.445 | 1.884 | 1.650 |
| 13 | 57.467 | 7.2168 | 11 | 0.549 | 0.549 | 47 | 1.604 | 1.566 | 2.154 | 2.116 |
| 14 | 57.457 | 7.2037 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 15 | 57.470 | 7.2177 | 30 | 1.674 | 1.244 | 33 | 1.006 | 0.977 | 2.681 | 2.221 |
| 16 | 57.488 | 7.1726 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 |
| 17 | 57.502 | 7.1695 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 18 | 57.468 | 7.2194 | 9 | 0.322 | 0.322 | 305 | 9.664 | 9.350 | 9.986 | 9.673 |
| 19 | 57.469 | 7.2215 | 2 | 0.101 | 0.101 | 339 | 10.255 | 9.350 | 10.356 | 9.451 |
| 20 | 57.471 | 7.2311 | 9 | 0.397 | 0.397 | 384 | 13.075 | 12.208 | 13.473 | 12.606 |
| 21 | 57.476 | 7.2337 | 8 | 0.373 | 0.240 | 92 | 2.391 | 2.031 | 2.765 | 2.271 |
| 22 | 57.470 | 7.2190 | 22 | 0.977 | 0.800 | 762 | 22.724 | 21.826 | 23.701 | 22.626 |
| 23 | 57.470 | 7.2199 | 30 | 0.970 | 0.970 | 577 | 16.686 | 16.371 | 17.656 | 17.341 |
| **Loch Carnan** | | | | | | | | | | |
| 24 | 57.386 | 7.2773 | 47 | 2.076 | 1.985 | 32 | 0.914 | 0.914 | 2.990 | 2.899 |
| 26 | 57.390 | 7.2746 | 168 | 8.231 | 7.769 | 80 | 2.583 | 2.394 | 10.814 | 10.164 |
| 27 | 57.390 | 7.2741 | 76 | 4.885 | 4.512 | 1 | 0.051 | 0.051 | 4.936 | 4.564 |
| 28 | 57.385 | 7.2624 | 65 | 2.573 | 2.528 | 92 | 2.432 | 2.267 | 5.006 | 4.796 |
| 29 | 57.384 | 7.2762 | 6 | 0.306 | 0.306 | 20 | 0.761 | 0.761 | 1.067 | 1.067 |
| 30 | 57.382 | 7.2738 | | 0 | 0 | 1 | 0.022 | 0.022 | 0.022 | 0.022 |
| 31 | 57.383 | 7.2704 | | 0 | 0 | 4 | 0.116 | 0.087 | 0.116 | 0.087 |
| 32 | 57.387 | 7.2769 | 47 | 2.372 | 2.316 | 86 | 2.930 | 2.829 | 5.303 | 5.146 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Berneray** | | | | | | | | | | |
| 33 | 57.691 | 7.1083 | 44 | 2.122 | 2.061 | 41 | 1.348 | 1.115 | 3.471 | 3.177 |
| 34 | 57.695 | 7.1400 | 88 | 6.331 | 6.122 | 11 | 0.320 | 0.320 | 6.651 | 6.442 |
| **Broad Bay** | | | | | | | | | | |
| 35 | 58.264 | 6.3076 | 16 | 1.443 | 1.357 | 0 | 0 | 0 | 1.443 | 1.357 |
| 36 | 58.264 | 6.3152 | 34 | 2.526 | 2.435 | 0 | 0 | 0 | 2.526 | 2.435 |
| 37 | 58.259 | 6.3204 | 41 | 2.075 | 1.895 | 0 | 0 | 0 | 2.075 | 1.895 |
| 38 | 58.254 | 6.3199 | 44 | 2.962 | 2.770 | 0 | 0 | 0 | 2.962 | 2.770 |
| 39 | 58.248 | 6.3134 | 87 | 6.510 | 6.296 | 0 | 0 | 0 | 6.510 | 6.296 |
| 40 | 58.251 | 6.3161 | 56 | 4.354 | 4.128 | 0 | 0 | 0 | 4.354 | 4.128 |
| 41 | 58.260 | 6.3109 | 41 | 2.985 | 2.907 | 1 | 0.038 | 0.038 | 3.024 | 2.946 |
| 42 | 58.262 | 6.3002 | 63 | 5.575 | 5.144 | 0 | 0 | 0 | 5.575 | 5.144 |
| 43 | 58.262 | 6.2955 | 47 | 3.919 | 2.522 | 0 | 0 | 0 | 3.919 | 2.522 |
| 44 | 58.239 | 6.3177 | 63 | 4.608 | 4.324 | 11 | 0.318 | 0.318 | 4.926 | 4.642 |
| 45 | 58.236 | 6.3218 | 51 | 4.179 | 3.856 | 1 | 0.031 | 0.031 | 4.211 | 3.888 |
| 46 | 58.234 | 6.3254 | 28 | 2.242 | 2.166 | 0 | 0 | 0 | 2.242 | 2.166 |
| 47 | 58.229 | 6.3299 | 8 | 0.321 | 0.321 | 0 | 0 | 0 | 0.321 | 0.321 |
| 48 | 58.220 | 6.3156 | 7 | 0.271 | 0.271 | 0 | 0 | 0 | 0.271 | 0.271 |
| 49 | 58.224 | 6.3079 | 69 | 4.779 | 3.858 | 0 | 0 | 0 | 4.779 | 3.858 |
| 50 | 58.216 | 6.3026 | 9 | 0.689 | 0.461 | 0 | 0 | 0 | 0.689 | 0.461 |
| 51 | 58.213 | 6.2905 | 8 | 0.536 | 0.403 | 0 | 0 | 0 | 0.536 | 0.403 |
| 52 | 58.208 | 6.2869 | 21 | 0.902 | 0.858 | 0 | 0 | 0 | 0.902 | 0.858 |
| 53 | 58.214 | 6.2839 | 12 | 0.784 | 0.467 | 0 | 0 | 0 | 0.784 | 0.467 |
| 54 | 58.221 | 6.2996 | 73 | 5.106 | 3.879 | 0 | 0 | 0 | 5.106 | 3.879 |
| 55 | 58.231 | 6.3113 | 57 | 4.772 | 4.111 | 0 | 0 | 0 | 4.772 | 4.111 |
| 56 | 58.232 | 6.3167 | 71 | 5.705 | 4.834 | 0 | 0 | 0 | 5.705 | 4.834 |
| 57 | 58.267 | 6.2826 | 89 | 8.008 | 5.996 | 0 | 0 | 0 | 8.008 | 5.996 |

Note: Tow 25 was excluded since the dredge was on its side.

**TABLE 3.2.2**

Estimated mean weight (kg) and standard error of *Ensis* 100 m$^{-2}$ for strata in which tows were made. Strata numbers are shown on Figures 3.2.1a-c.

| Strata | No tows | Commercial stock | | | | Undersize stock | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | *E. siliqua* | | *E. arcuatus* | | *E. siliqua* | | *E. arcuatus* | |
| | | wt (kg) | se | wt (kg) | se | wt (kg) | se | wt (kg) | se |
| **Grimsay** | | | | | | | | | |
| 1 | 1 | 1.107 | - | 7.097 | - | 0.392 | - | 1.070 | - |
| 4 | 3 | 2.326 | 0.121 | 1.977 | 0.198 | 0.142 | 0.014 | 0.039 | 0.004 |
| 6 | 7 | 2.116 | 0.059 | 31.800 | 0.873 | 0.257 | 0.018 | 1.427 | 0.044 |
| 7 | 4 | 2.578 | 0.083 | 6.689 | 0.184 | 0.222 | 0.016 | 0.274 | 0.010 |
| 8 | 3 | 3.351 | 0.131 | 2.219 | 0.201 | 0.050 | 0.005 | 0.074 | 0.007 |
| 11 | 2 | 0.174 | 0.0174 | 10.103 | 1.010 | 0 | 0 | 0.409 | 0.041 |
| 12 | 1 | 0.059 | - | 0.453 | - | 0 | - | 0 | - |
| **Loch Carnan** | | | | | | | | | |
| 2 | 2 | 19.459 | 0.496 | 3.909 | 0.375 | 1.237 | 0.013 | 0.281 | 0.028 |
| 5 | 1 | 7.637 | - | 7.218 | - | 0.134 | - | 0.488 | - |
| 6 | 4 | 3.527 | 0.179 | 3.433 | 0.184 | 0.109 | 0.007 | 0.074 | 0.007 |
| 7 | 1 | 0 | - | 0.345 | - | 0 | - | 0.085 | - |
| **Broad Bay** | | | | | | | | | |
| 1 | 1 | 7.496 | - | 0 | - | 0.268 | - | 0 | - |
| 2 | 2 | 10.414 | 0.613 | 0 | 0 | 0.767 | 0.0511 | 0 | 0 |
| 4 | 1 | 23.763 | - | 0 | - | 5.970 | - | 0 | - |
| 5 | 3 | 9.289 | 0.196 | 0 | 0 | 0.591 | 0.004 | 0 | 0 |
| 6 | 1 | 8.858 | - | 0.115 | - | 0.230 | - | 0 | - |
| 7 | 1 | 11.630 | - | 0 | - | 4.146 | - | 0 | - |
| 8 | 2 | 16.496 | 0.282 | 0.471 | 0.047 | 0.739 | 0.010 | 0 | 0 |
| 9 | 2 | 3.802 | 0.285 | 0 | 0 | 0.112 | 0.011 | 0 | 0 |
| 10 | 2 | 14.666 | 0.226 | 0.046 | 0.004 | 1.770 | 0.081 | 0 | 0 |
| 11 | 1 | 14.160 | - | 0 | - | 1.960 | - | 0 | - |
| 12 | 1 | 0.805 | - | 0 | - | 0 | - | 0 | - |
| 13 | 2 | 8.112 | 0.606 | 0 | 0 | 1.703 | 0.102 | 0 | 0 |
| 14 | 2 | 8.373 | 0.677 | 0 | 0 | 2.017 | 0.162 | 0 | 0 |
| 15 | 1 | 2.327 | - | 0 | - | 0.939 | - | 0 | - |
| 16 | 1 | 2.678 | - | 0 | - | 0.131 | - | 0 | - |

**TABLE 3.2.3**

Growth parameters for *E. arcuatus* and *E. siliqua* from the Western Isles estimated from length frequency distributions and direct ageing methods.

| Species | Area | $L_\infty$ (mm) | k | No.[†] |
|---|---|---|---|---|
| **length frequency** | | | | |
| *E. arcuatus* | Grimsay | 178.8 | 0.196 | |
| | Loch Carnan | 196.2 | 0.264 | |
| *E. siliqua* | Grimsay | 200.2 | 0.215 | |
| | Loch Carnan | 235.5 | 0.383 | |
| | Broad Bay | 251.8 | 0.234 | |
| **Direct ageing** | | | | |
| *E. arcuatus* | Grimsay | 174.9 | 0.238 | 11 |
| | Loch Carnan | 177.5 | 0.209 | 14 |
| *E. siliqua* | Loch Carnan | 211.9 | 0.213 | 11 |

[†] - Number of shells for direct ageing technique.

**TABLE 3.2.4**

Proportions of catch at putative age as calculated by Multifan.

| Age | *Ensis siliqua* | | | *Ensis arcuatus* | |
|---|---|---|---|---|---|
| | Grimsay | Loch Carnan | Broad Bay | Grimsay | Loch Carnan |
| 1 | 0.01 | 0.02 | 0.03 | 0.00 | 0.00 |
| 2 | 0.03 | 0.04 | 0.05 | 0.01 | 0.01 |
| 3 | 0.15 | 0.29 | 0.05 | 0.02 | 0.04 |
| 4 | 0.15 | 0.25 | 0.12 | 0.02 | 0.04 |
| 5 | 0.18 | 0.24 | 0.27 | 0.05 | 0.2 |
| 6 | 0.18 | 0.13 | 0.22 | 0.12 | 0.38 |
| 7 | 0.15 | 0.03 | 0.22 | 0.17 | 0.15 |
| 8 | 0.05 | - | 0.03 | 0.33 | 0.13 |
| 9 | 0.09 | - | 0.02 | 0.19 | 0.01 |
| 10 | 0.00 | - | - | 0.09 | 0.03 |
| 11 | 0.00 | - | - | - | - |
| 12 | 0.01 | - | - | - | - |

**TABLE 3.2.5**

Equation parameters for length weight relationships for *E. siliqua* and *E. arcuatus* at Berneray, Broad Bay, Grimsay and Loch Carnan, where equation fitted was:

Weight (g) = constant*length(mm)$^{power}$

| | constant | st dev | power | st dev | N |
|---|---|---|---|---|---|
| *Ensis siliqua* | | | | | |
| Berneray | 6.15E-06 | 4.64E-06 | 3.1351 | 1.44E-01 | 109 |
| Broad Bay | 2.53E-06 | 1.9E-06 | 3.3209 | 0.140336 | 90 |
| Grimsay† | - | - | - | - | - |
| Loch Carnan | 2.32E-06 | 1.9E-06 | 3.3132 | 0.154939 | 72 |
| *Ensis arcuatus* | | | | | |
| Berneray | 1.29E-05 | 8.40E-06 | 2.9677 | 1.31E-01 | 82 |
| Broad Bay† | - | - | - | - | - |
| Grimsay | 9.58E-06 | 3.81E-06 | 3.0365 | 8.00E-02 | 140 |
| Loch Carnan | 6.89E-06 | 2.92E-06 | 3.0816 | 8.30E-02 | 75 |

† - This species was not caught in sufficient numbers at this site to calculate a length weight relationship.

**TABLE 3.2.6**

Estimated *Ensis* densities from diver quadrat counts.

| Date | Track | No quadrats | | Density ($m^{-2}$) | |
|---|---|---|---|---|---|
| | | track | control | track | control |
| March 98 | 22 | | 40 | | 11.6 |
| | 23 | | 38 | | 14.6 |
| May 98 | 13 | 13 | 17 | 0.5 | 2.2 |
| | 19 | 5† | 15 | 5.2† | 15 |
| | 23 | 6† | 44 | 7† | 13.5 |

† - These quadrats were inadvertently positioned over fluidised sediment which is assumed to be the remnants of the fished track (see Section 3.1). They may however be on the fluidised area to the side of the area fished by the blade (where *Ensis* were removed), and so estimates of gear efficiency using these values are likely to be under estimates.

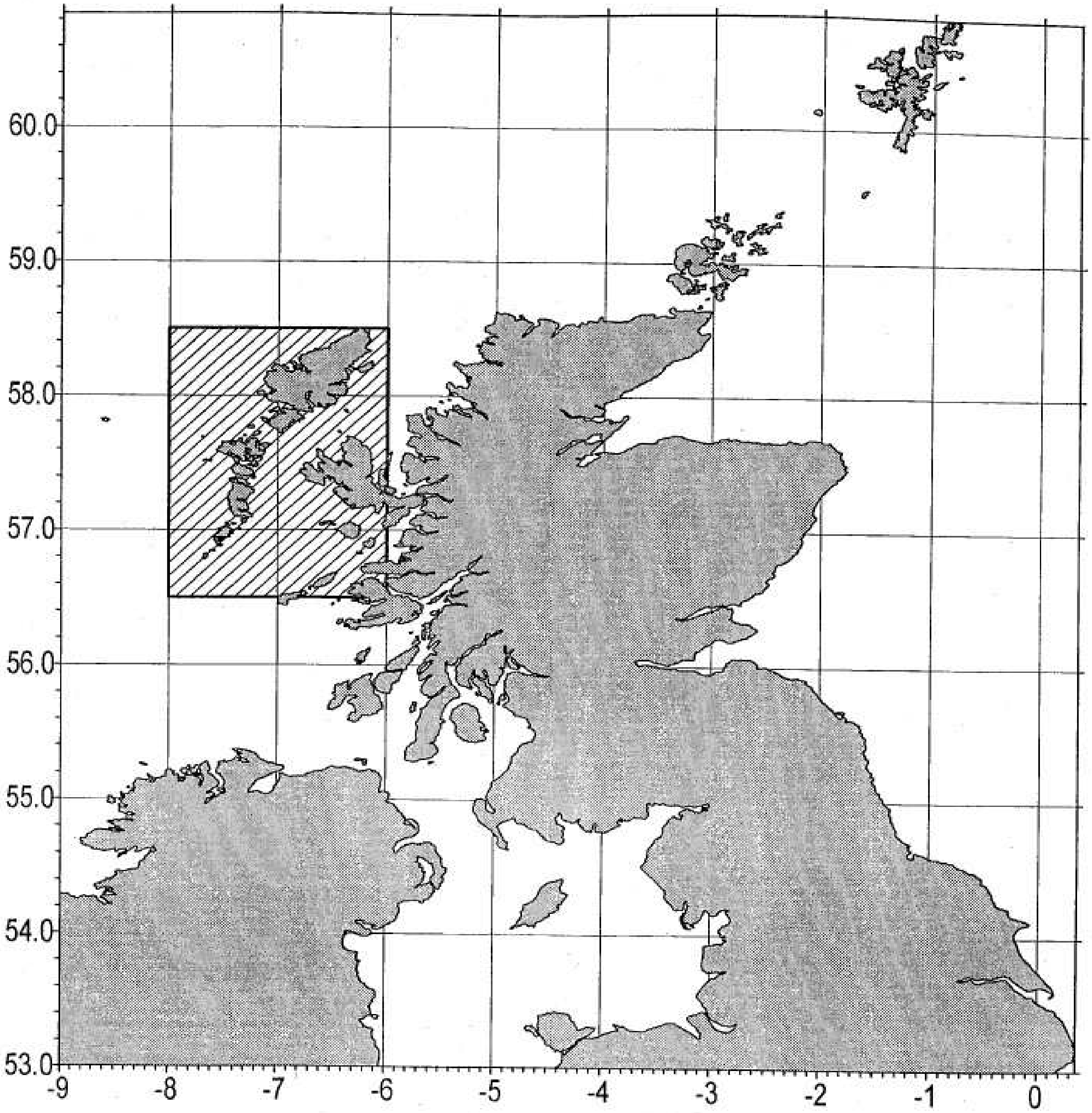



**Fig.2.1.1. Map showing location of the Western Isles. Hatched area is expanded in Fig.2.1.2.**

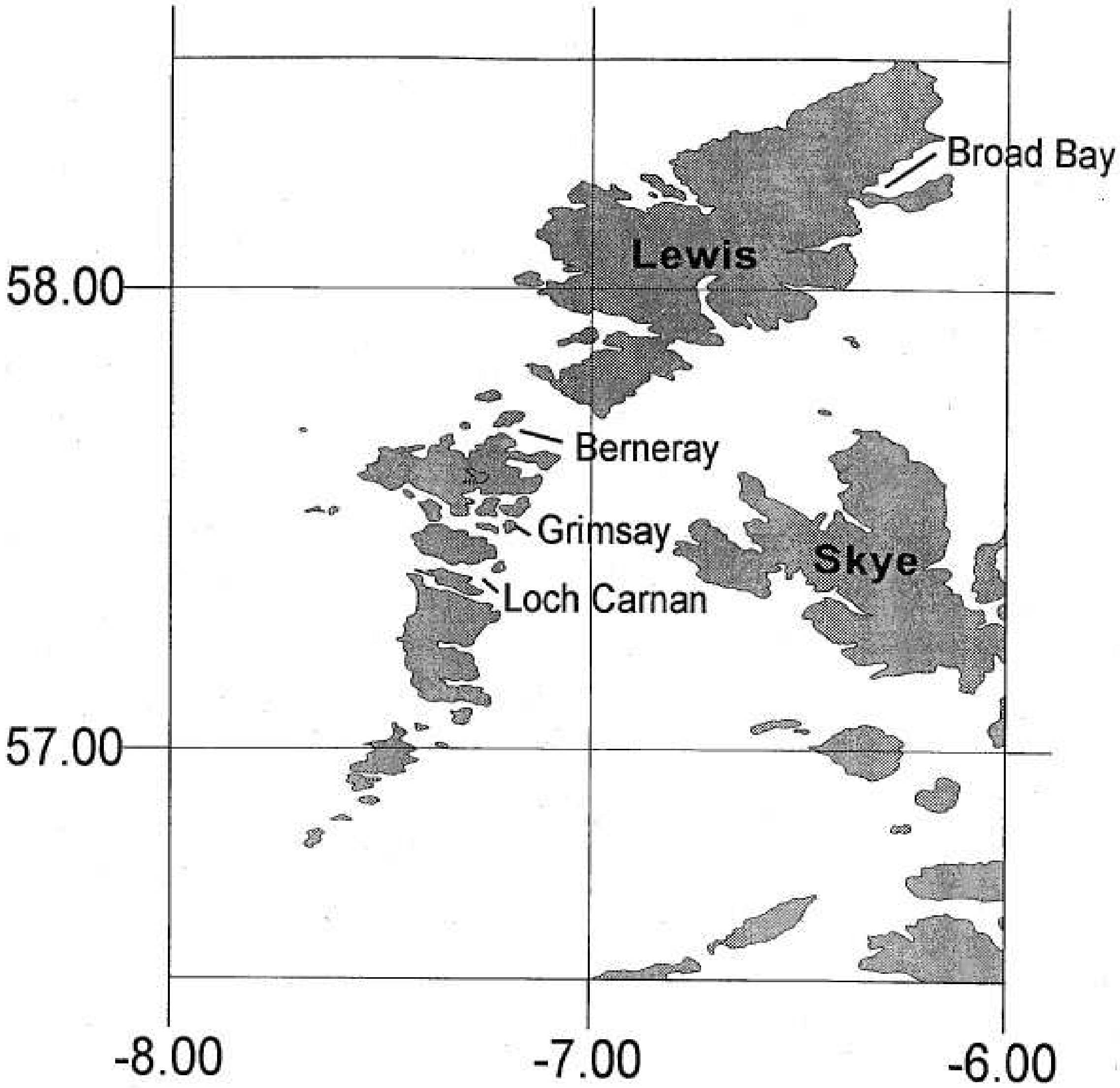



**Fig. 2.1.2. Map of the Western Isles, showing the study areas.**

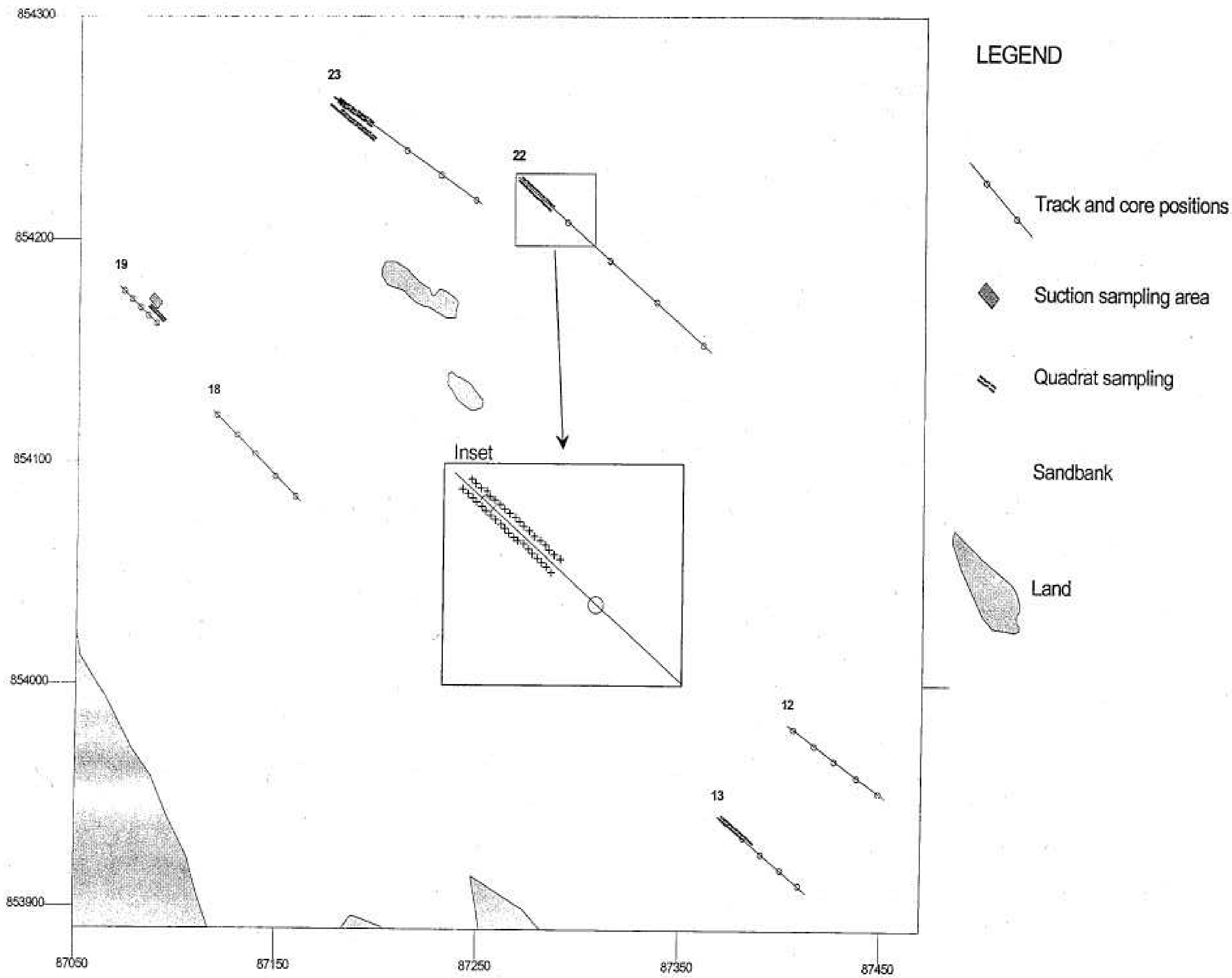



Figure 2.2.1 Map showing location of experiments in the Sound of Ronay, Grimsay
Coordinates are OS northings and eastings

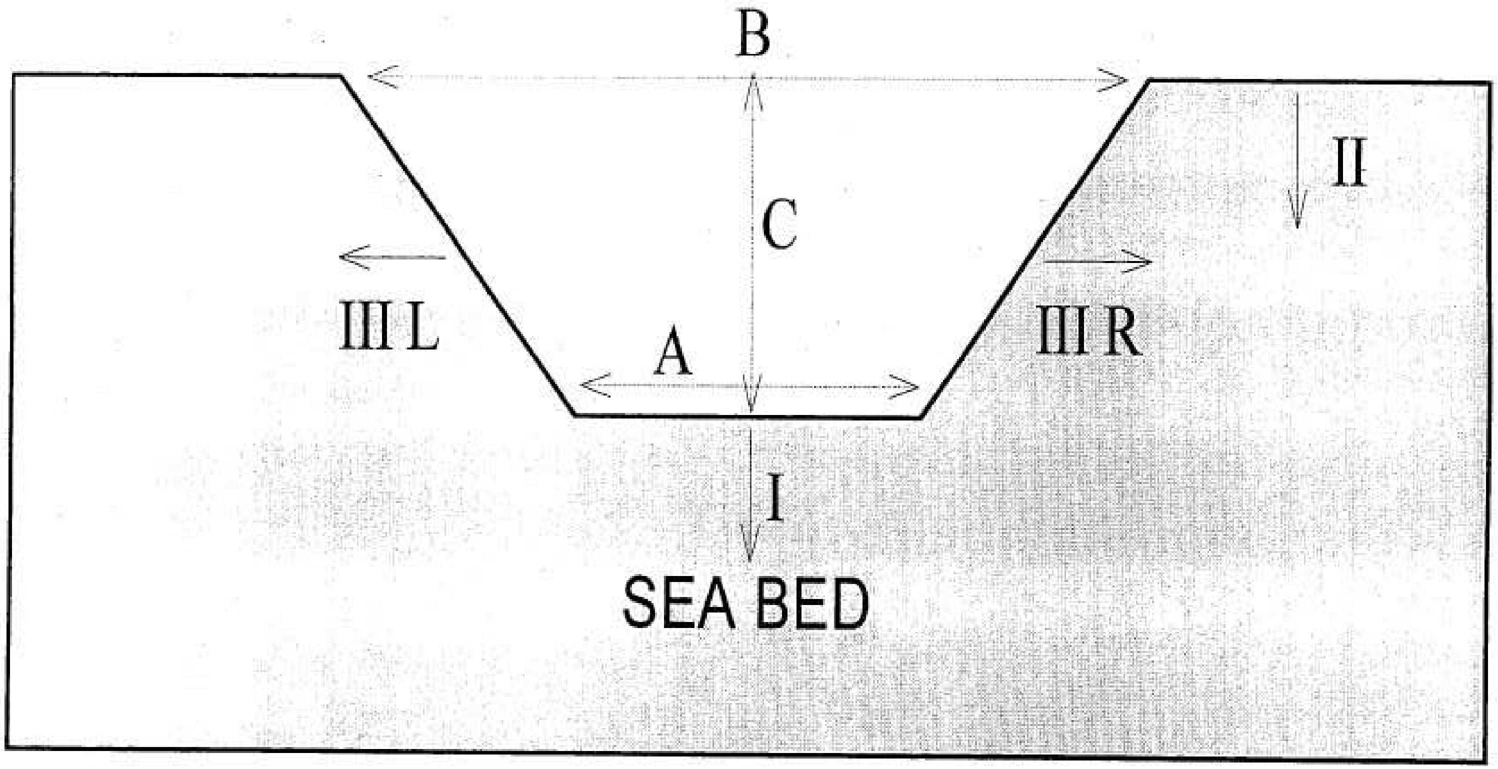



Figure 2.2.2 Diagrammatic cross section of a typical dredge track showing measurements taken during post-fishing monitoring

In particular , width of track bottom (A), track top (B), depth of track (C), depth of fluidisation in track (I) and outside of track in control area (II)

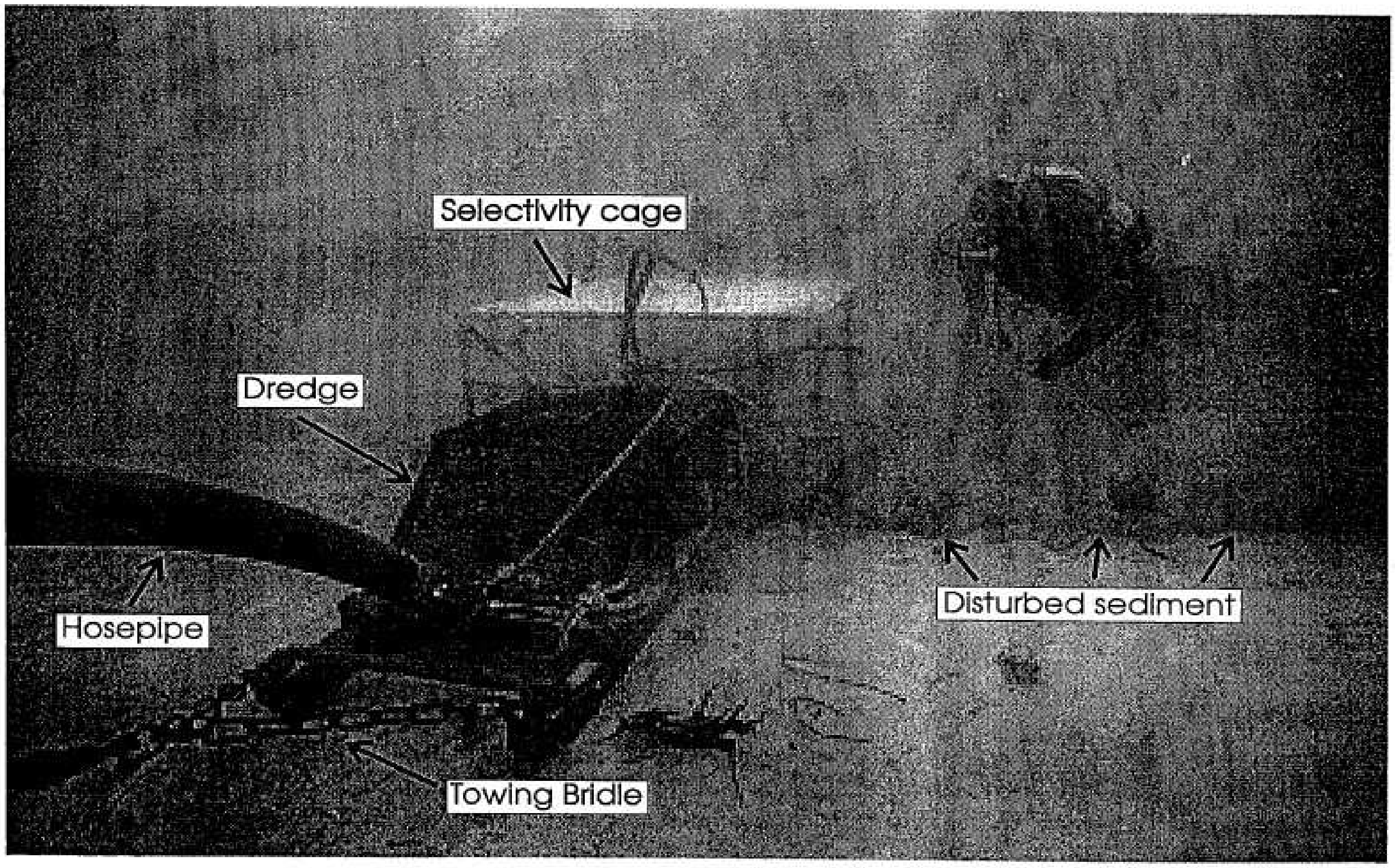



Plate 1. In situ photograph of water jet dredge in operation with selectivity cage attached and diver monitoring performance.

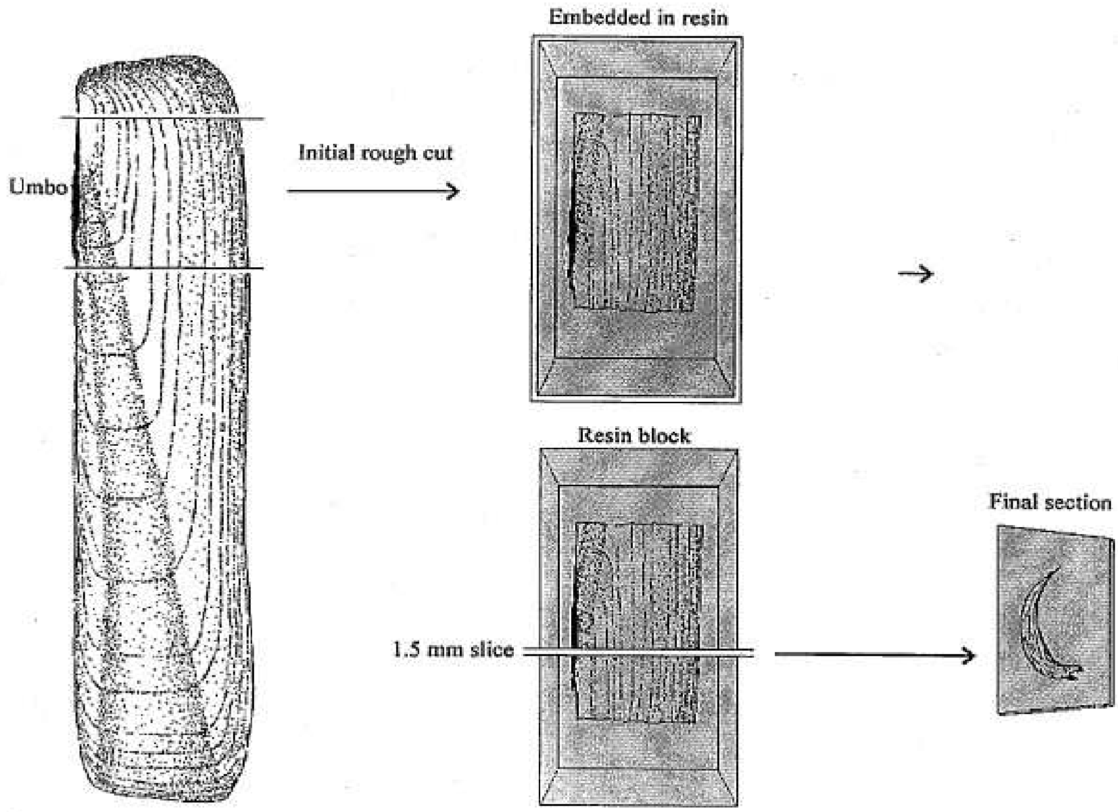



Fig. 2.3.1. Sectioning procedure, showing position of the cuts made to section of *Ensis* shell

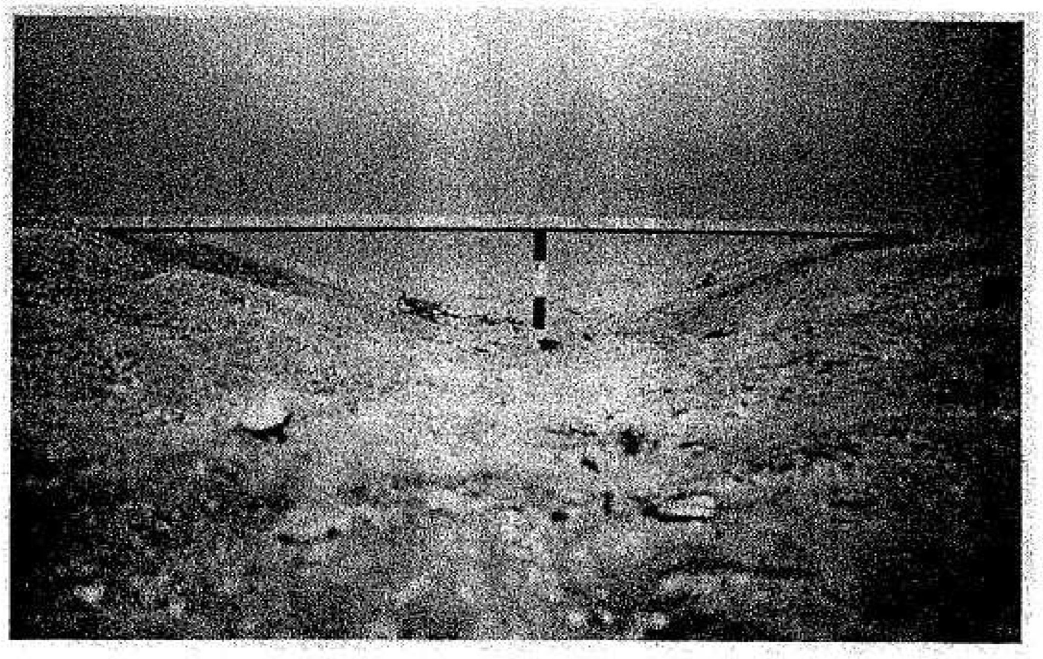


Plate 2 Photograph of cross section of water jet dredge track with depth marker in place. Banding on vertical rod = 5cm

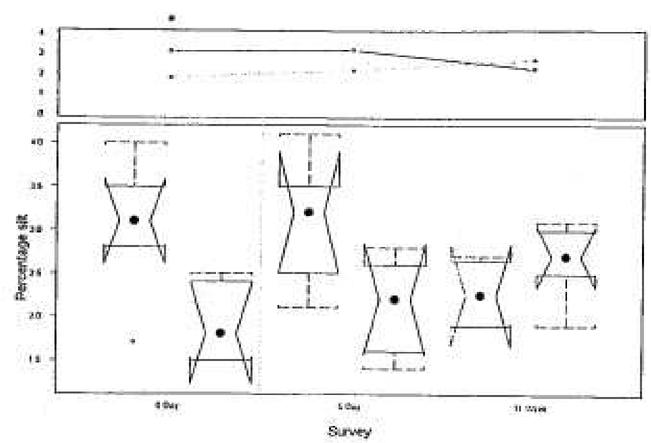



Fig. 3.1.1. Box plot of Percentage silt (lower panel), along with the time series for the median value for each sampling date. Box-plots are arranged in pairs in order of time (survey), with the unfished plot on the left for each pair. Surveys in which medians of two sites were significantly different are marked by an asterisk.

The notches in the boxes indicate 95 % confidence intervals of the median. If the intervals around two population medians do not overlap the population medians can be considered significantly different ($P < 0.05$). The dashed lines represent whiskers and extend to the largest observation that is less than or equal to the upper quartile plus 1.5 times the interquartile range (or the smallest observation that is greater than or equal to the lower quartile minus 1.5 times the interquartile range).

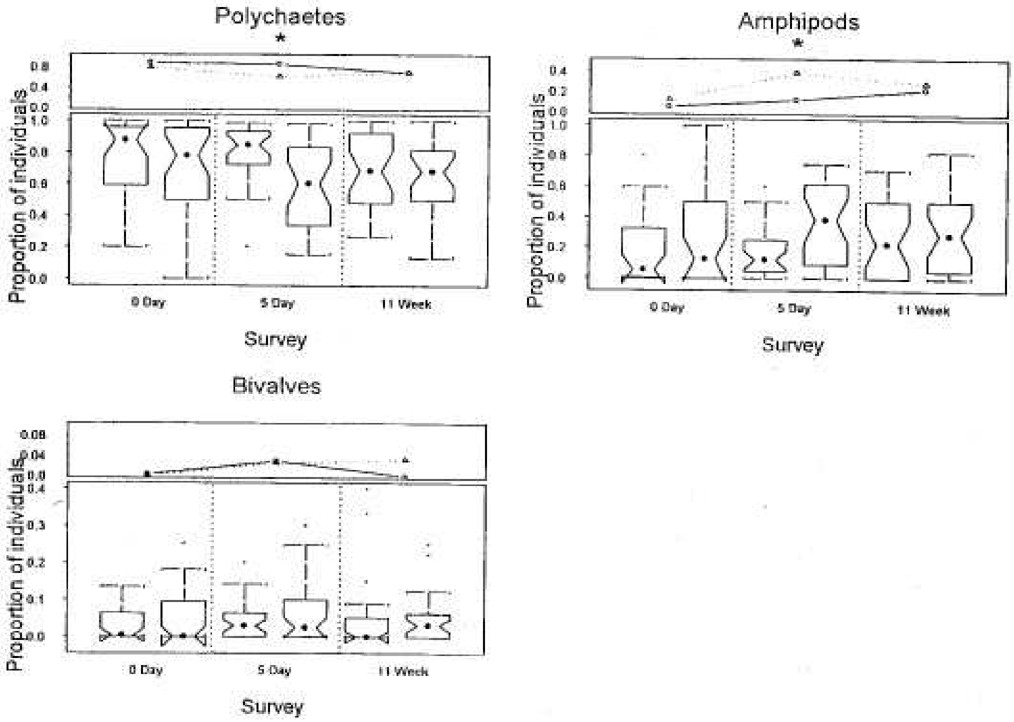



Fig. 3.1.2. Box plot and time series of median values of the proportions of individuals made up by polychaetes, amphipods and bivalves. Further details as for Fig. 3.1.1.

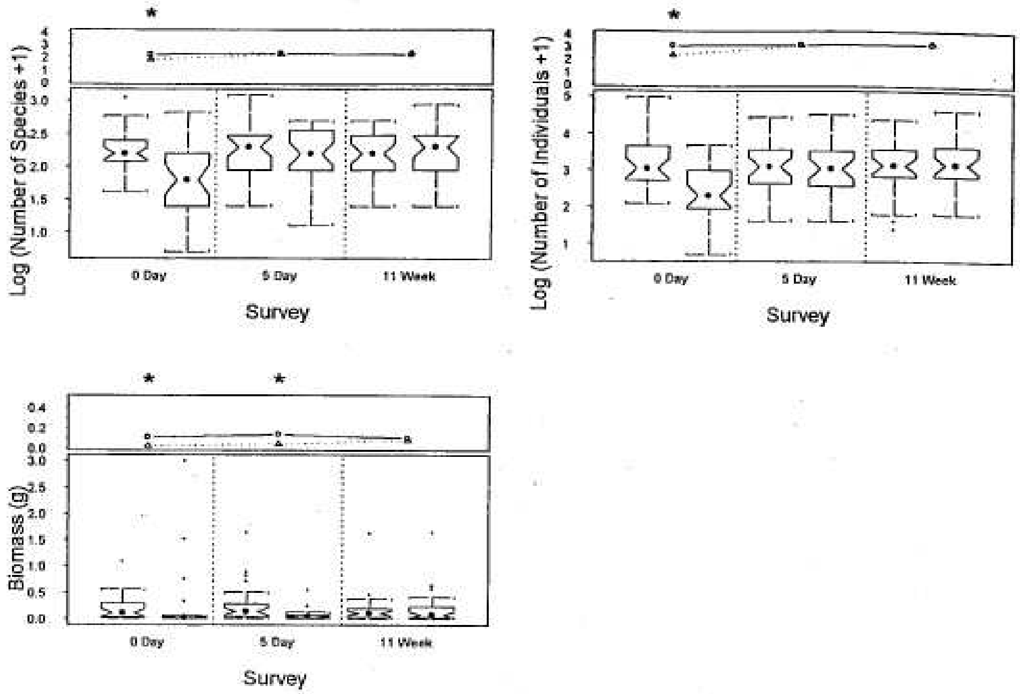



Fig. 3.1.3. Box plot and time series of median values of numbers of species, number of individuals and biomass (10cm dia core). Further details as for Fig. 3.1.1.

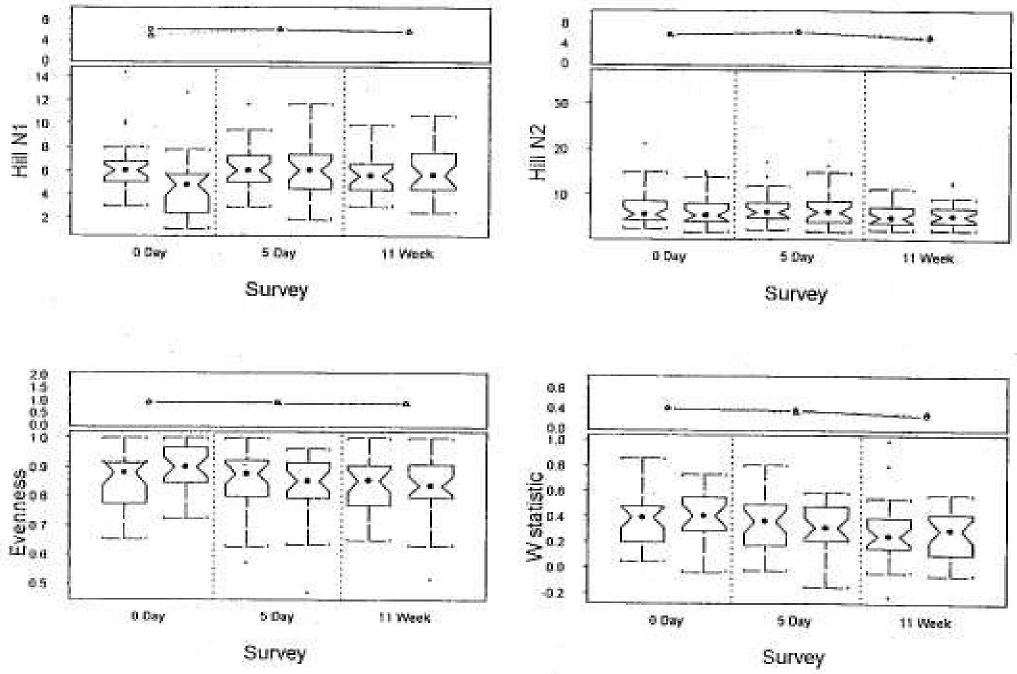



Fig. 3.1.4. Box plot and time series of median values of Hill's N1, Hill's N2, Evenness and the W statistic. Further details as for Fig. 3.1.1.

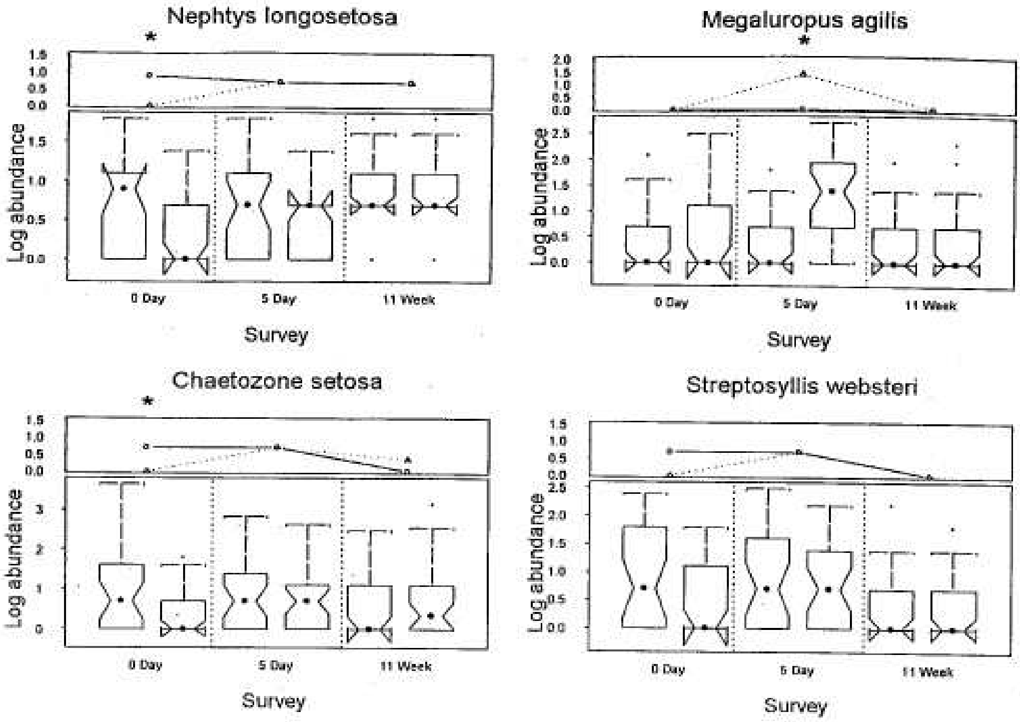



Fig. 3.1.5. Box plot and time series of median values of abundance of 4 infaunal specis showing a change in abundance in response to the dredging. Further details as for Fig. 3.1.1.

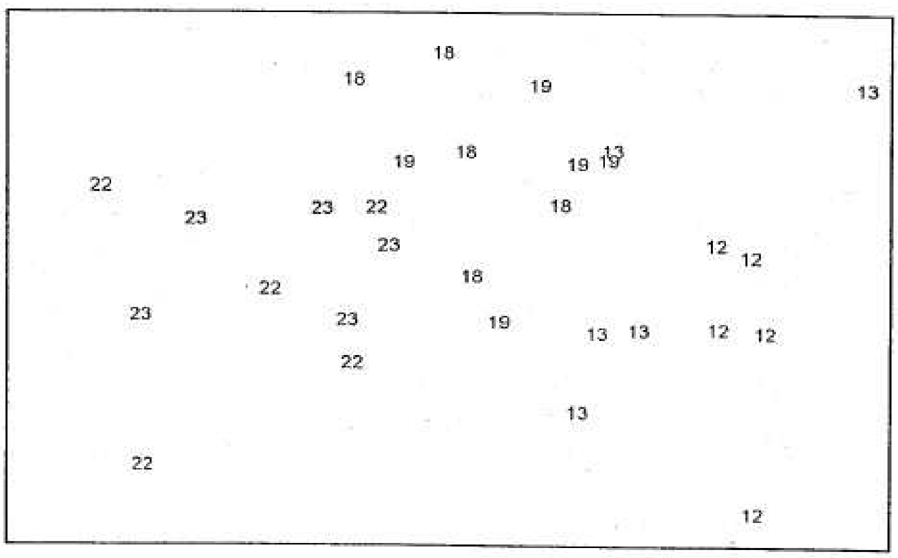


Fig. 3.1.6. MDS plot of infaunal data for unfished tracks on initial survey. Numbers represent track numbers.

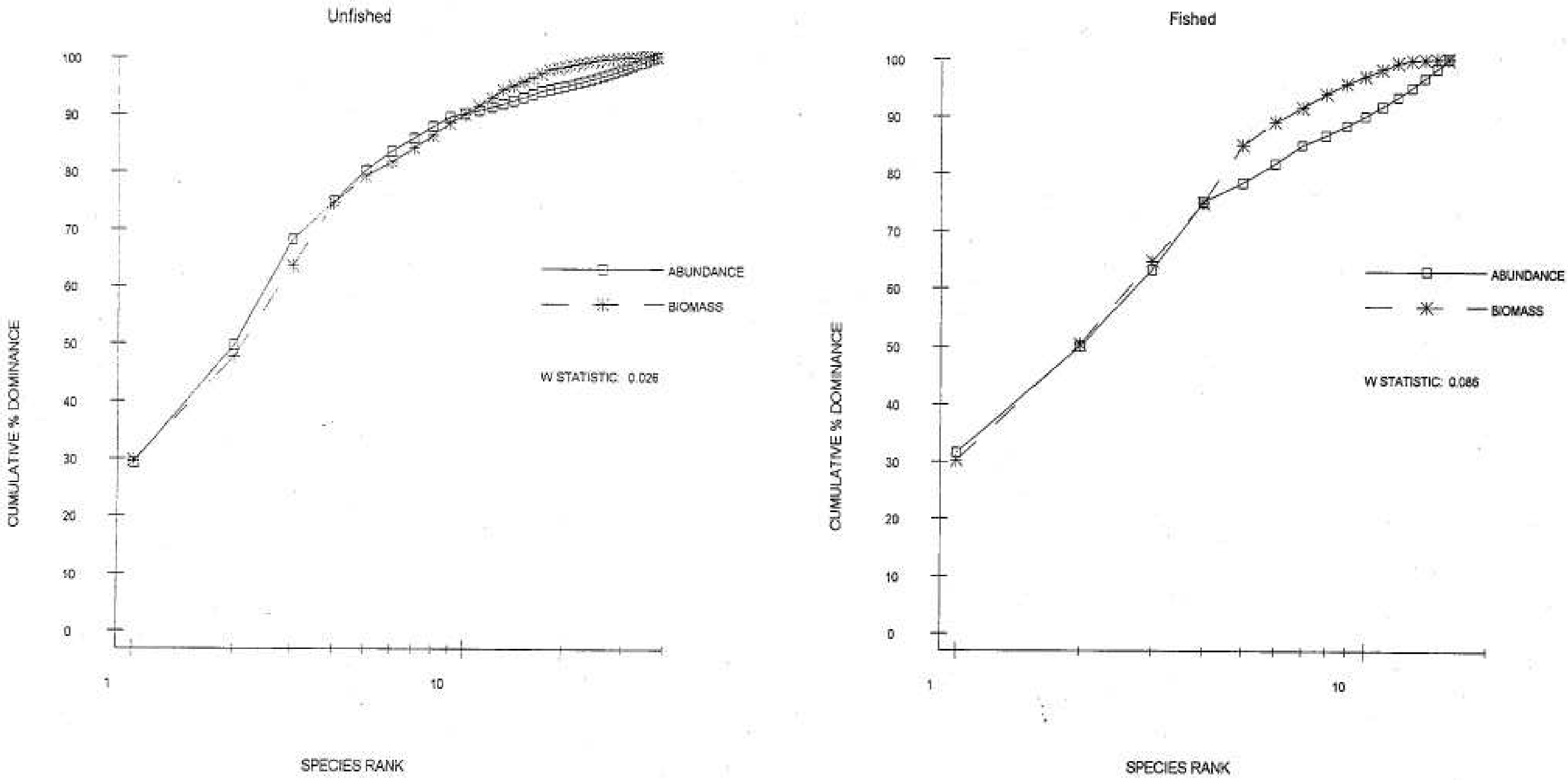



Fig. 3.1.7. ABC curves for track 22 within one day of fishing.

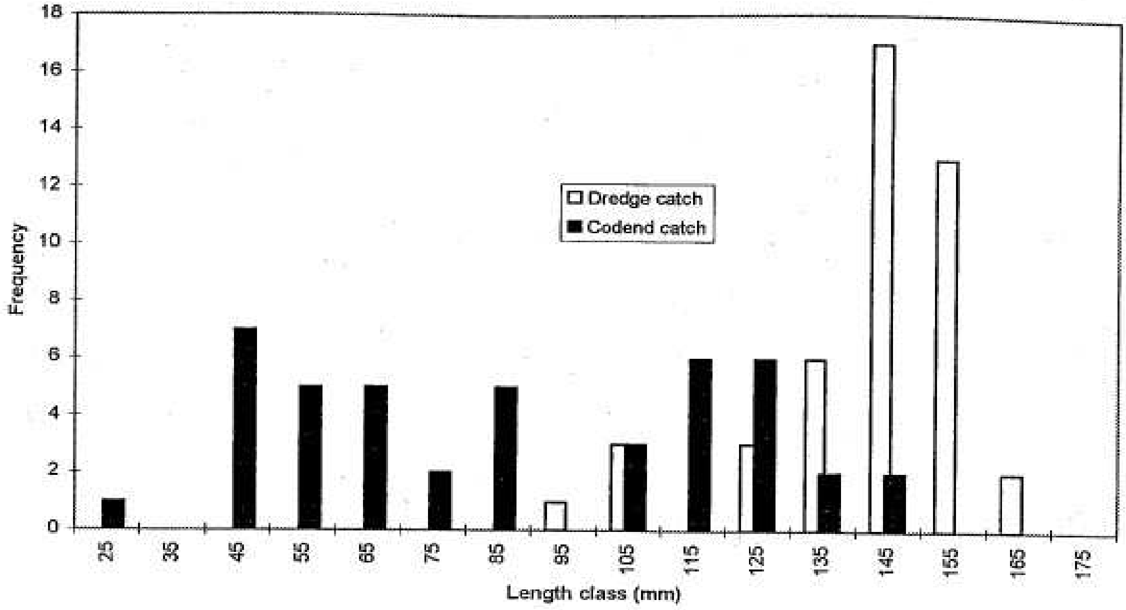



Fig. 3.1.8. Length frequency distribution of dredge and small mesh codend catch from selectivity study. *E. arcuatus* only.

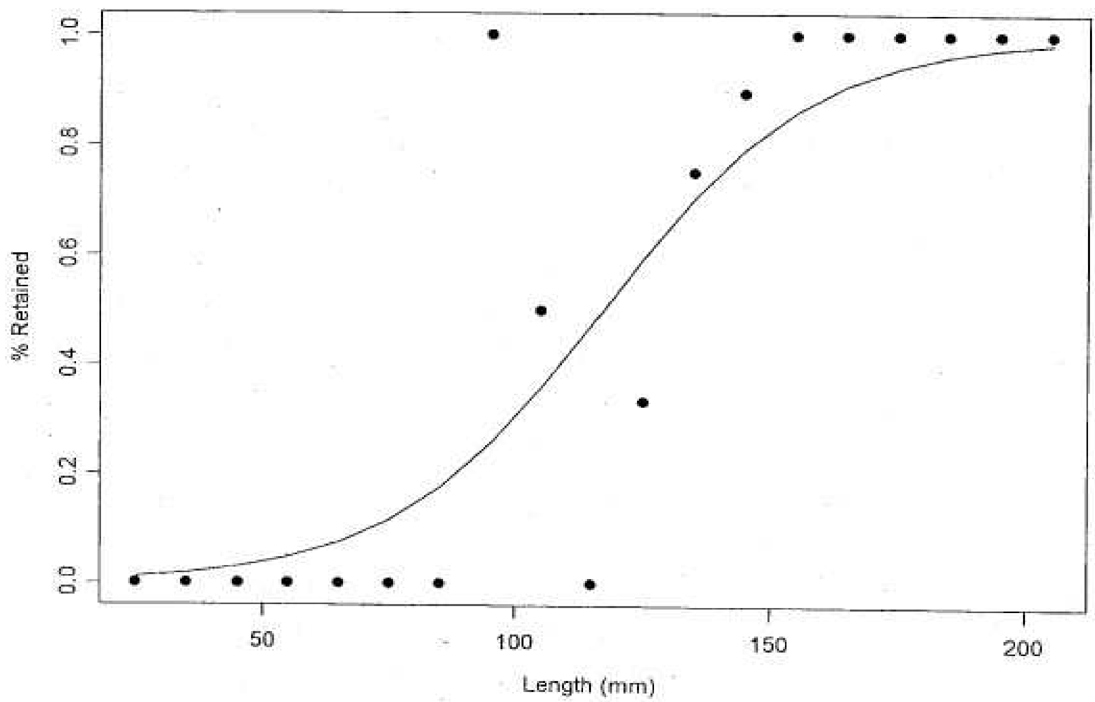



Fig. 3.1.9. Selectivity curve for E. arcuatus form small mesh codend experiment.

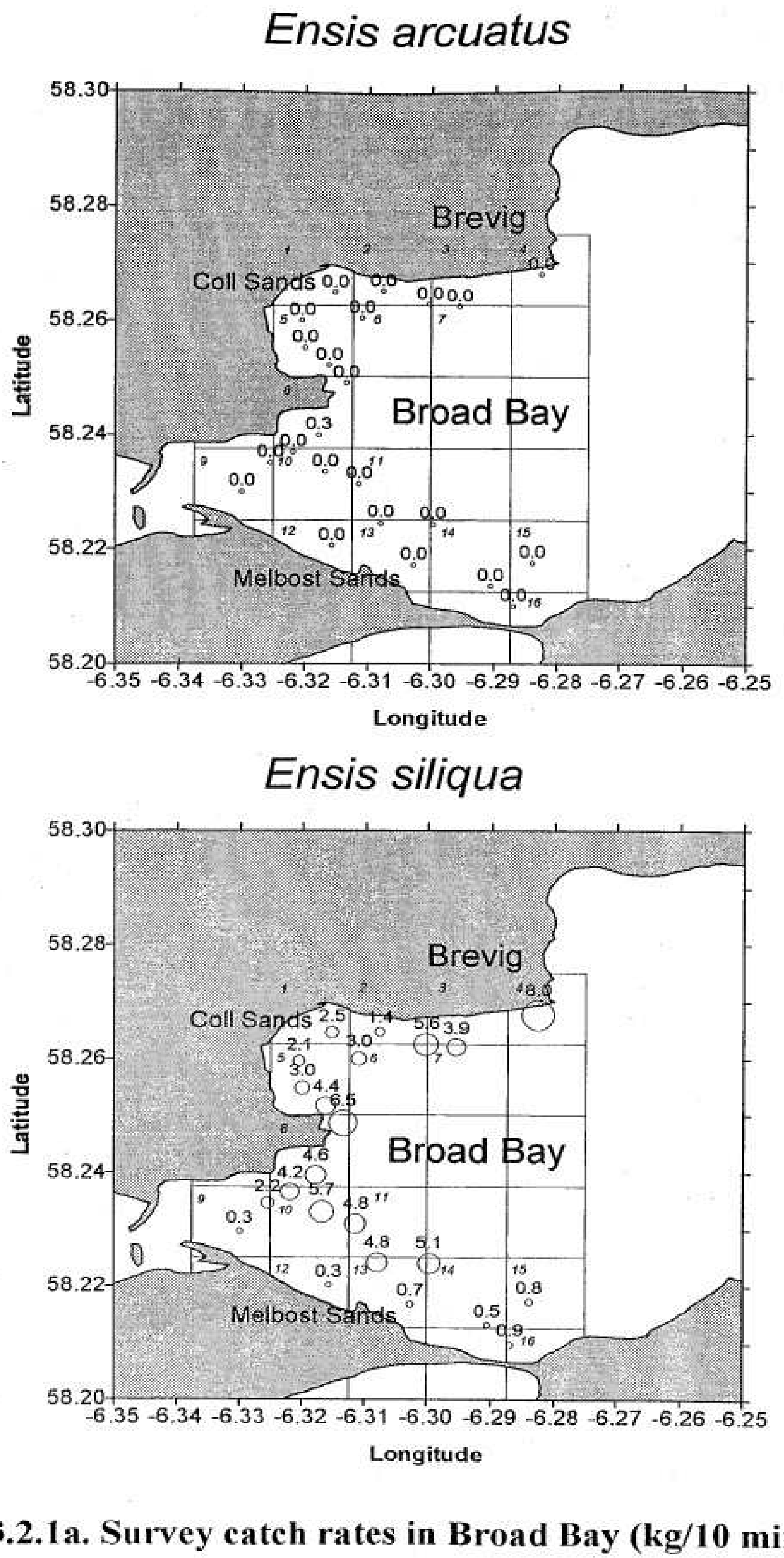



**Fig. 3.2.1a. Survey catch rates in Broad Bay (kg/10 min)**

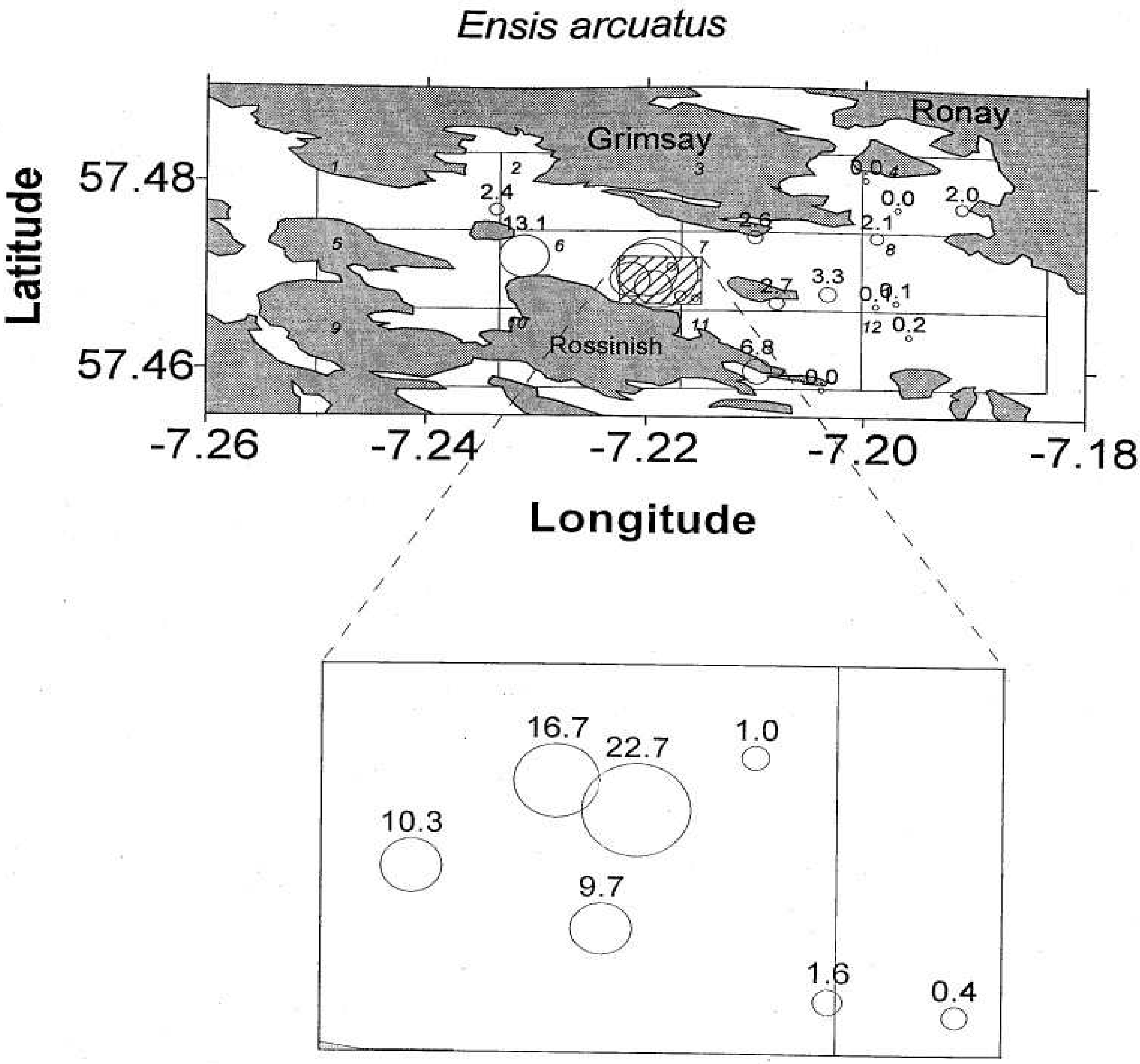



**Fig. 3.2.1bi. Survey catch rates at Grimsay (kg/10 min)**

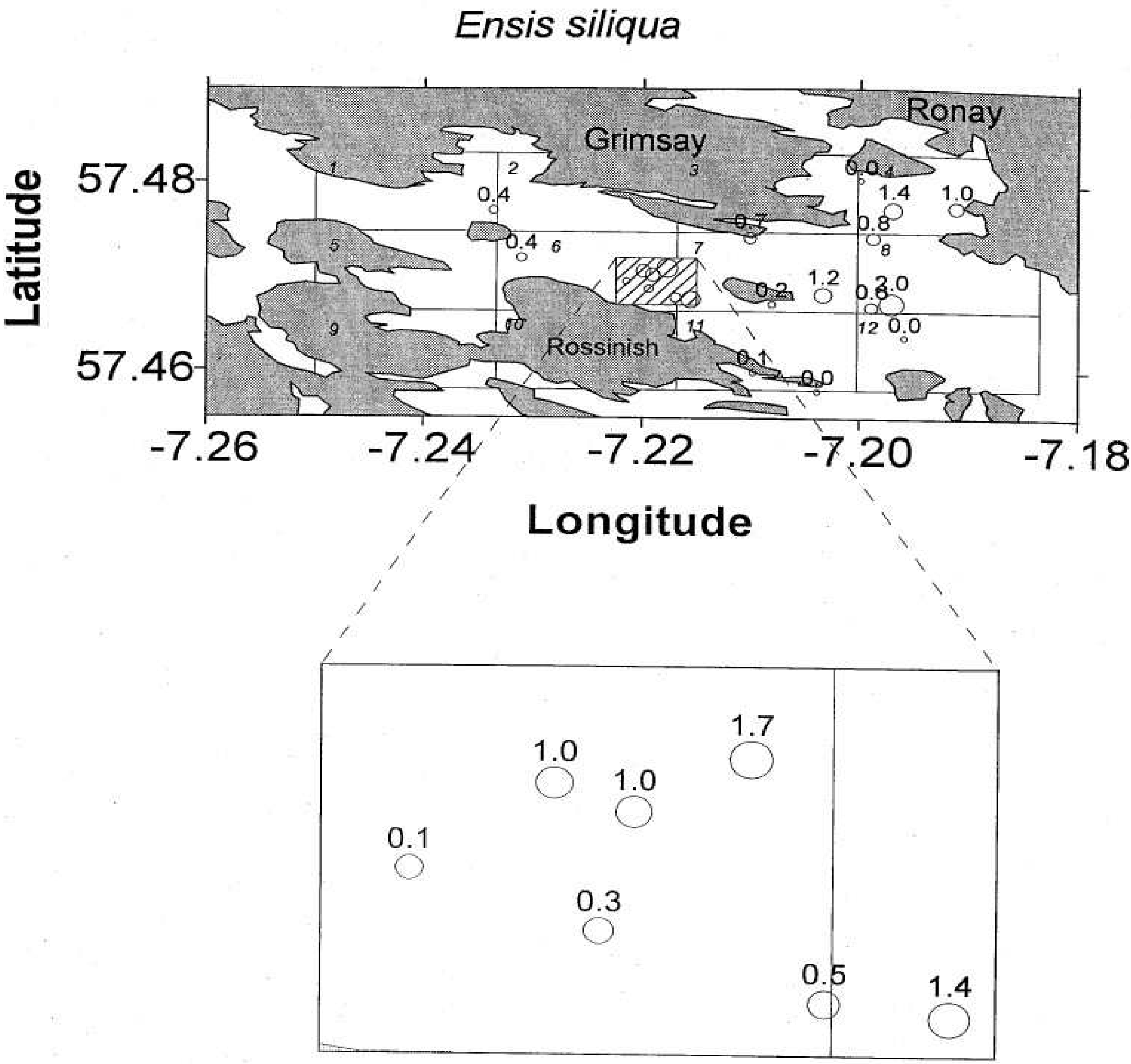



Fig. 3.2.1bii. Survey catch rates at Grimsay (kg/10 min)

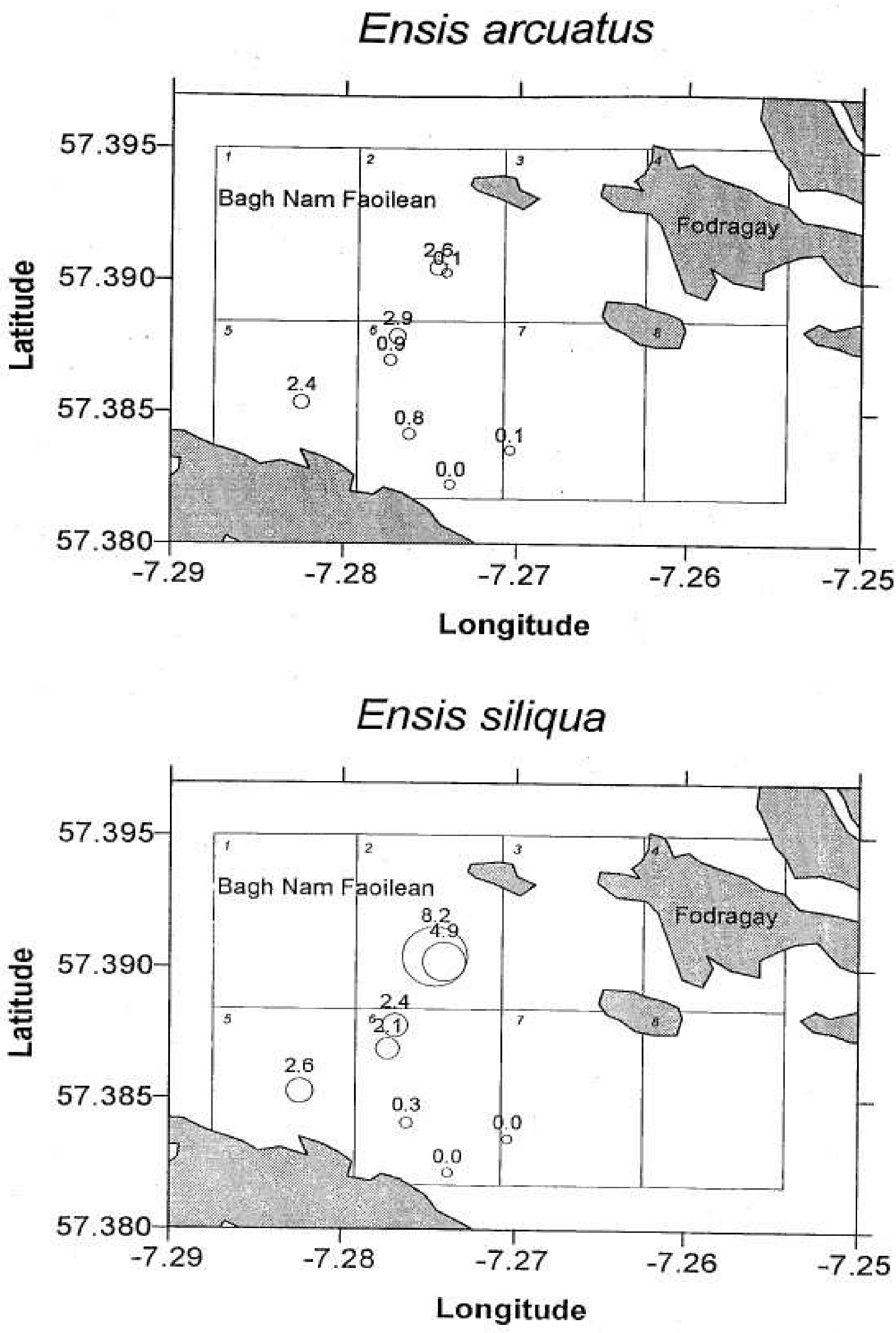
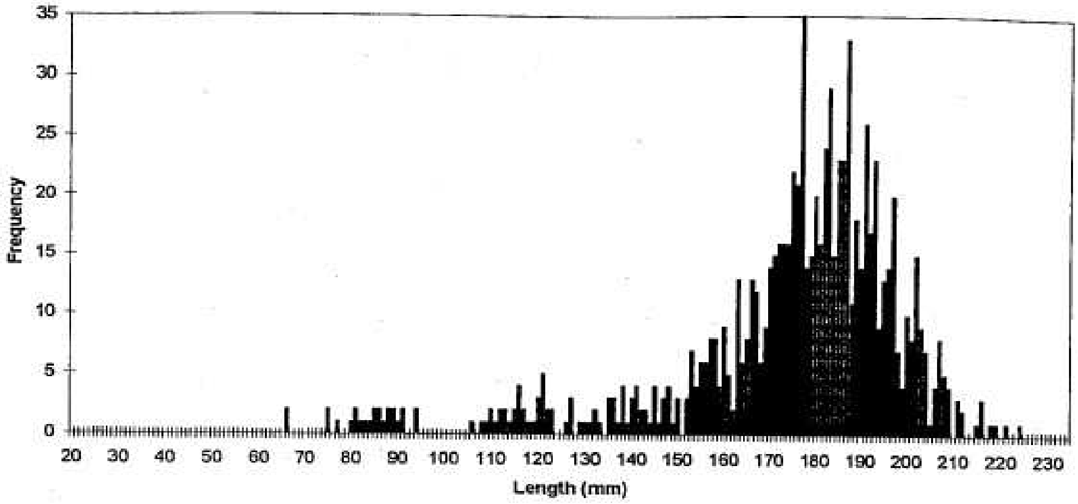



**Fig. 3.2.1c. Survey catch rates at Loch Carnan (kg/10 min)**

**Ensis siliqua, Broad Bay**




**Ensis arcuatus, Grimsay**

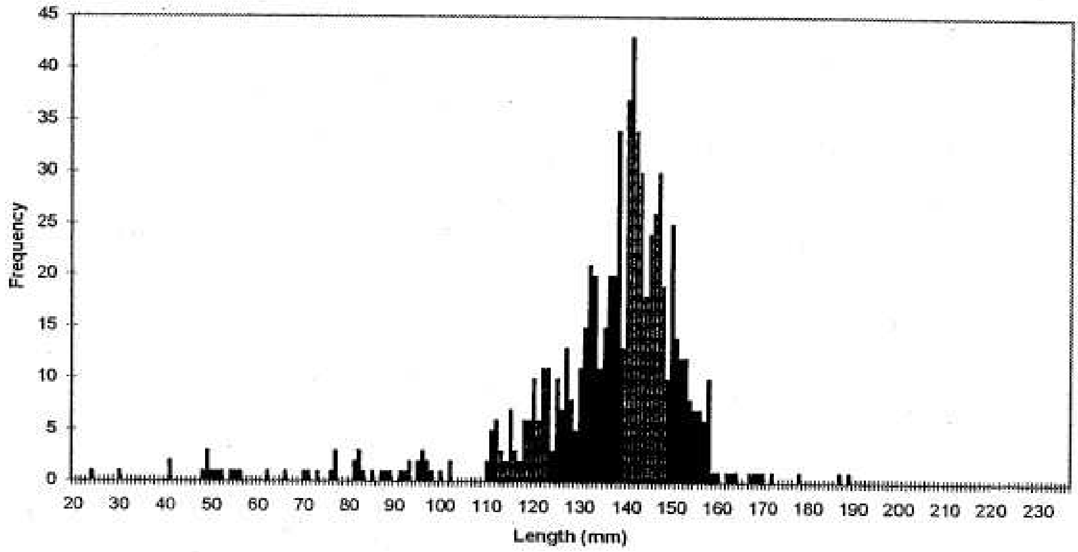



Fig. 3.2.2. Example length frequency distributions of dredge catches used for Multifan analysis. *E. siliqua* distribution was summed for all stations in Broad Bay, while *E. arcuatus* distribution was from a single station (22).

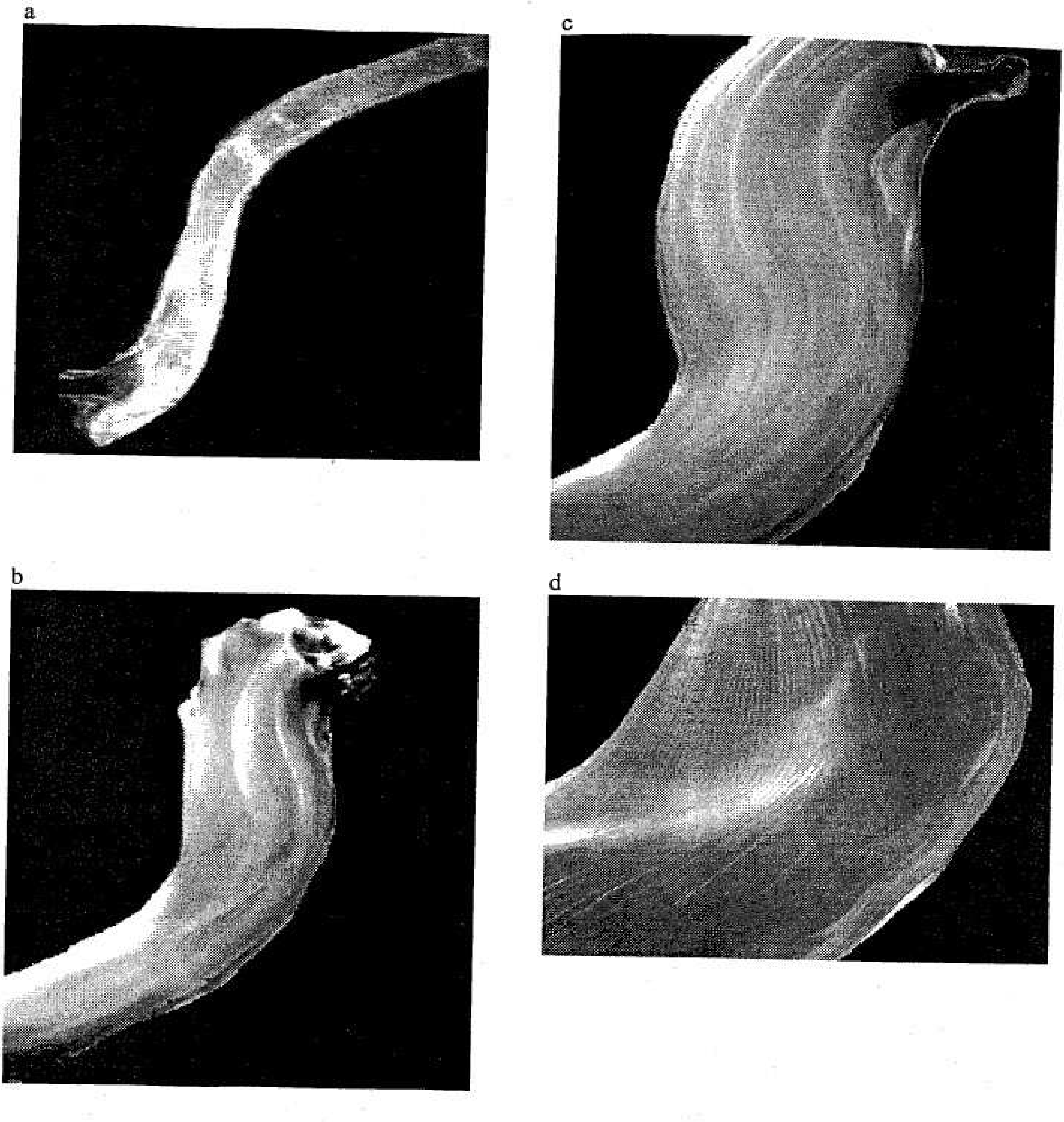



Fig. 3.2.3. Captured images of distinct banding shown in the macrostructure of the sectioned shells a) *Ensis arcuatus* - 1 year old, 61mm, b) 3 year old, 100mm, c) 7 year old, 140 mm and d) *Ensis siliqua* - 46 year old, 215mm

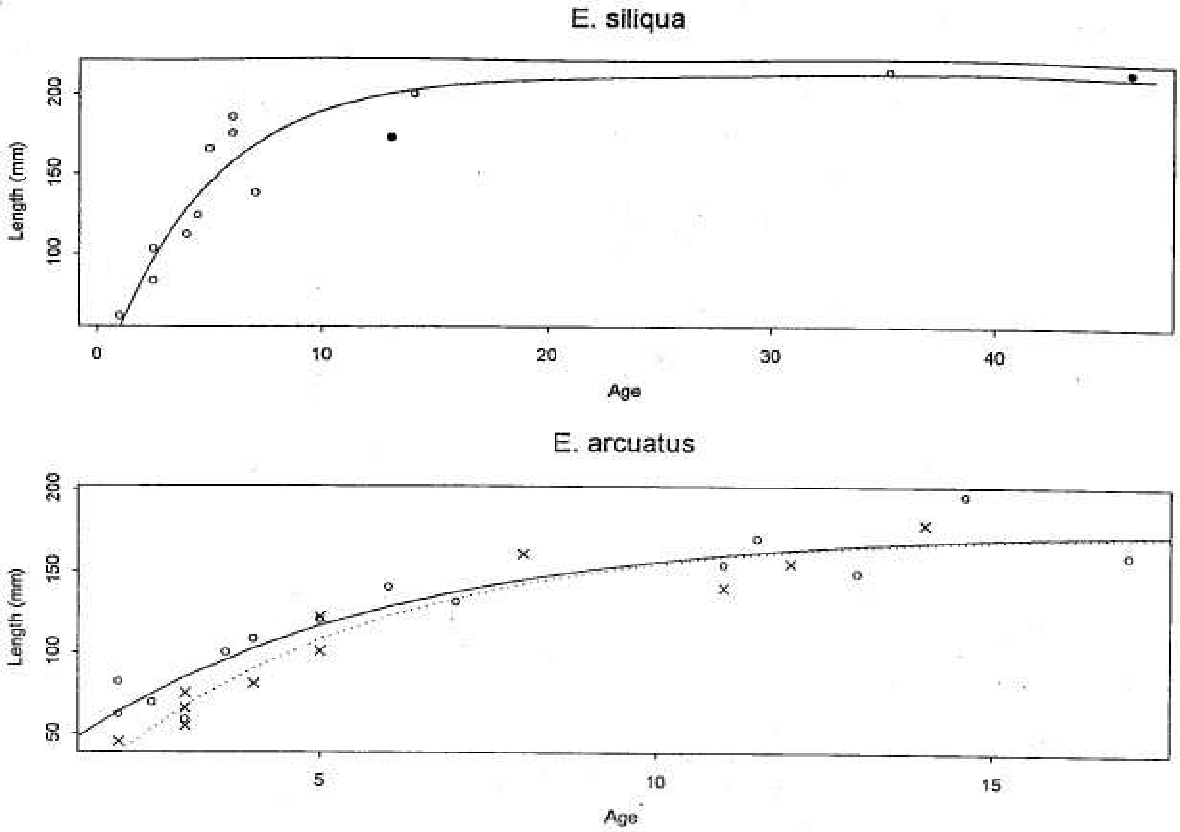



Fig. 3.2.4. Age - length data from direct ageing, and curves derived from this data. Open circles and solid line - Loch Carnan, filled circles - Broad Bay (no curve), crosses and dotted line - Grimsay.

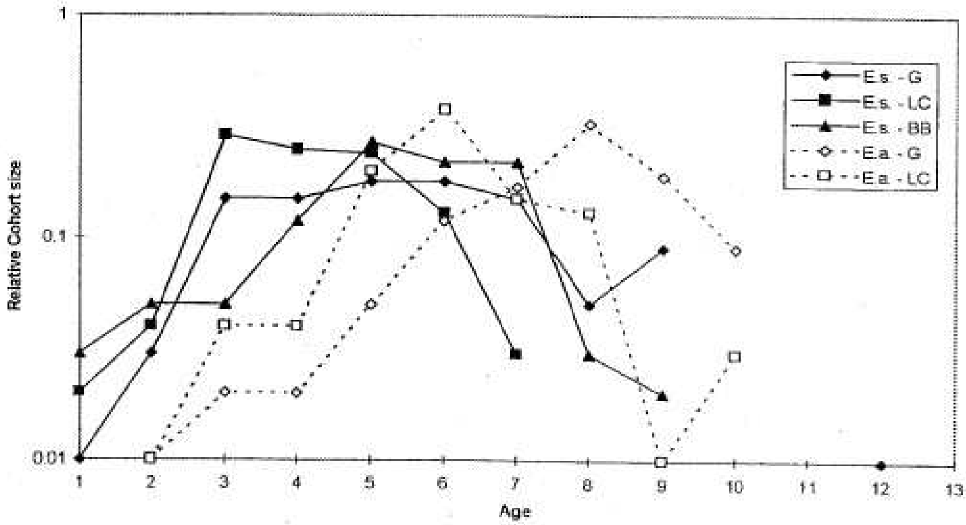



Fig. 3.2.5. Catch curves for *Ensis* dredge catches. E.s. Ensis siliqua, E.a. Ensis arcuatus, BB - Broad Bay, G - Grimsay, LC - Loch Carnan.

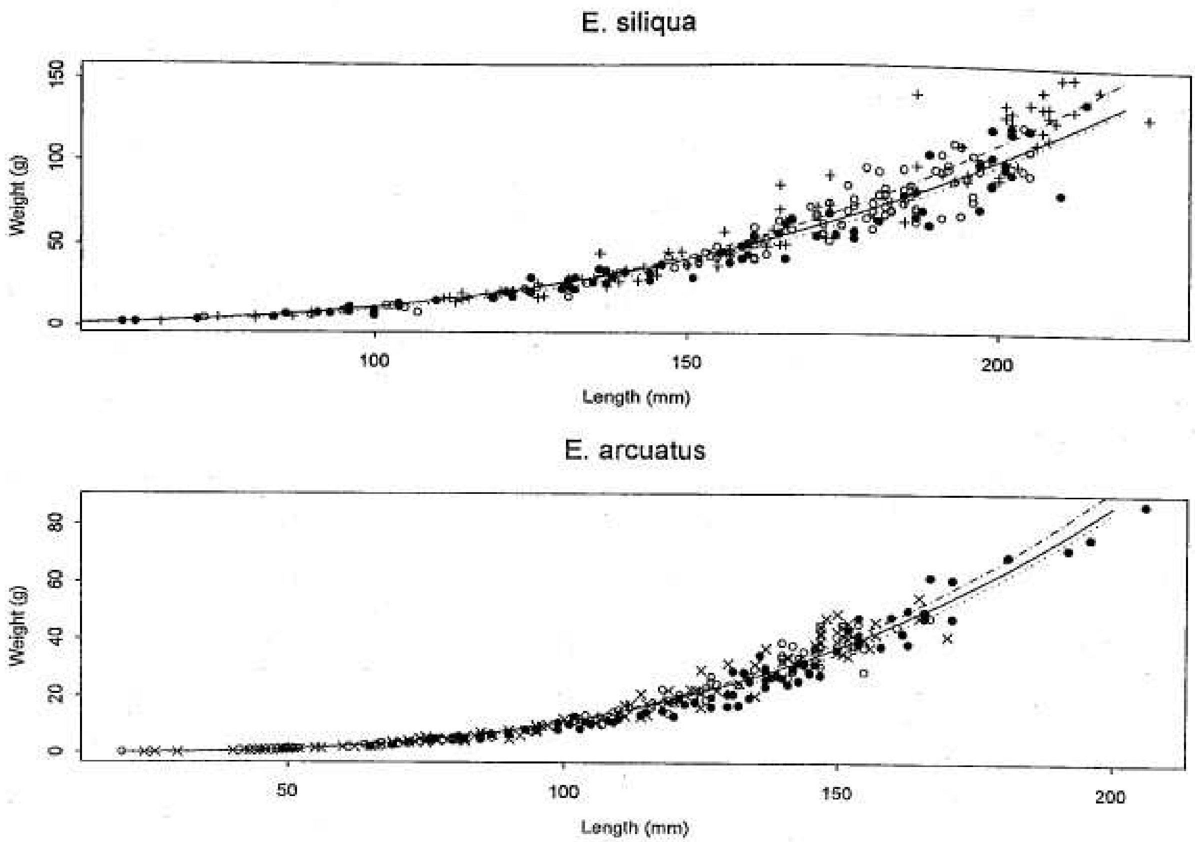



Fig. 3.2.6. Length weight realtionships for *E. siliqua* and *E. arcuatus*. Open circles and solid line - Berneray, filled circles and dotted line - Loch Carnan, plus's dashed line (*E. siliqua*) - Broad Bay, crosses and dashed line (*E. arcuatus*) - Grimsay.

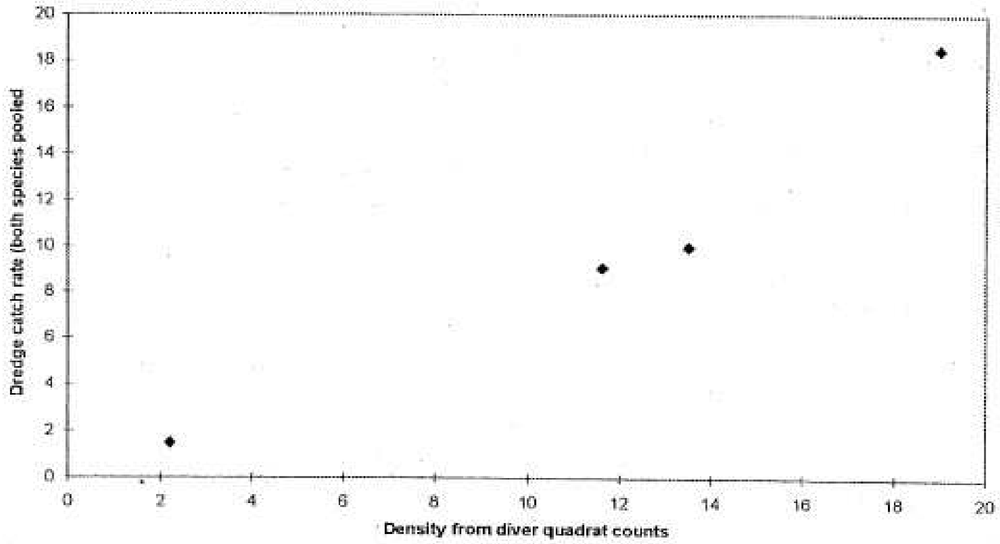
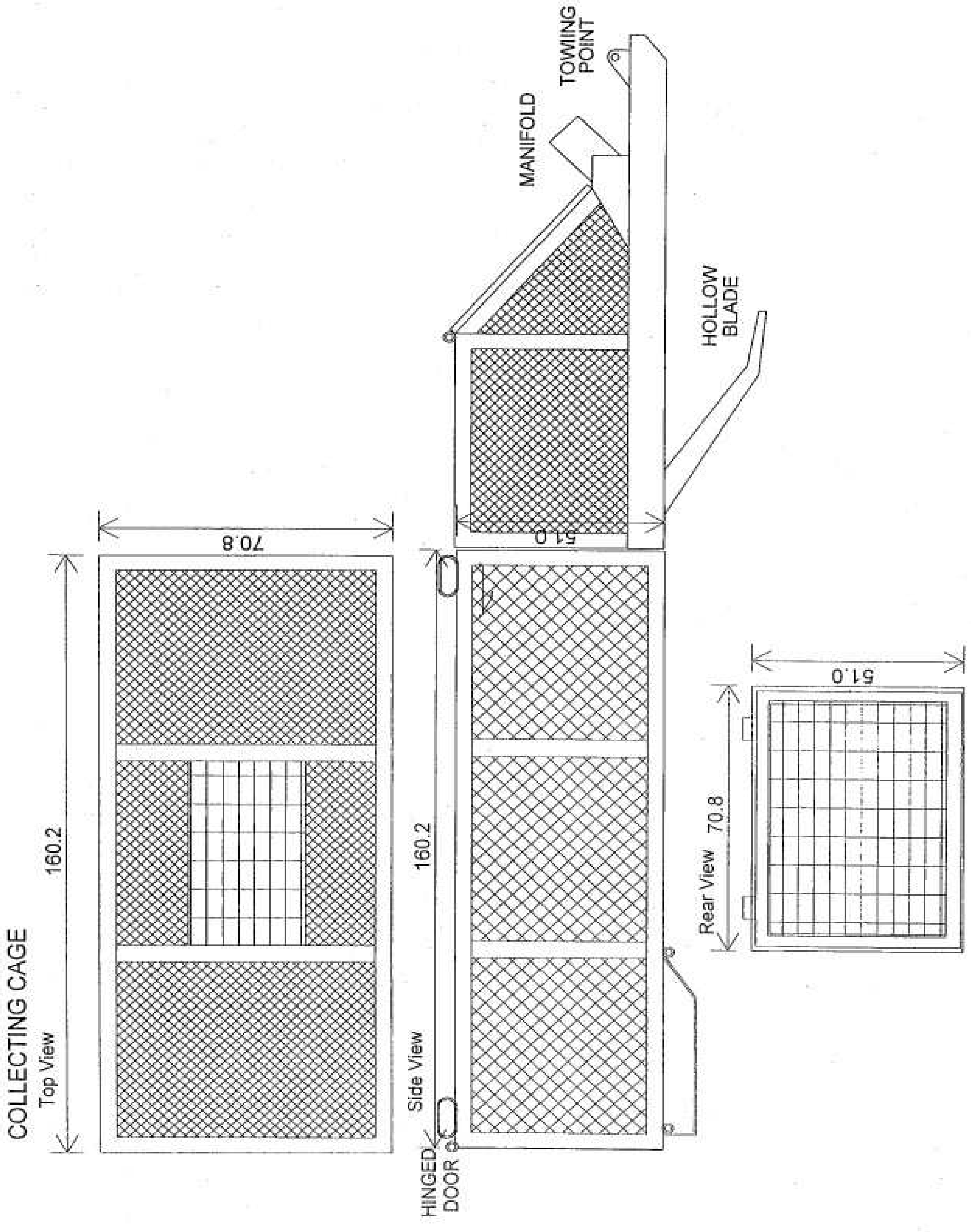



Fig. 3.2.7. Scatterplot of *Ensis* density estimated from diver quadrat counts and dredge catch rate.

## APPENDIX 1

Scale drawing of hydraulic dredge



# APPENDIX 2

Infaunal species recorded from each of the experimentally fished tracks. C- porifera, P- polychaete, R - lower crustacean, S - amphipod, W - mollusc. Numbers recorded at each site throughout study, * - 1-9, ** - 10-99, *** >100.

| Species | | 12 | 13 | 18 | 19 | 22 | 23 |
|---|---|---|---|---|---|---|---|
| *Microciona macrochela* | C | * | | | | | |
| *Parapionosyllis minuta* | P | | | | | * | |
| *Harmothoe ljungmani* | P | | | | * | | |
| *Harmothoe marphysae* | P | | | | * | | |
| *Pholoe inornata* | P | | | * | * | | |
| *Eteone flava* | P | | | | * | | |
| *Eteone longa* | P | * | * | * | * | * | * |
| *Mysta picta* | P | | | | | | * |
| *Pseudomystides limbata* | P | | | | | | * |
| *Anaitides groenlandica* | P | | * | | | | |
| *Anaitides mucosa* | P | | | * | | * | |
| *Anaitides rosea* | P | * | | | | | |
| *Glycera alba* | P | | | | * | * | * |
| *Glycera celtica* | P | | | | | * | |
| *Glycera dayi* | P | | | | | | * |
| *Glycera tesselata* | P | | | | | * | * |
| *Goniadella bobretzkii* | P | * | | | | | |
| *Hesionidae sp.* | P | | | | | | * |
| *Keferstainia cirrata* | P | | | * | * | | |
| *Microphthalmus similis* | P | | | * | * | | * |
| *Streptosyllis bidentata* | P | | * | | | | |
| *Streptosyllis websteri* | P | * | * | ** | ** | ** | *** |
| *Syllides benedicti* | P | | | | | * | |
| *Brania clavata* | P | | * | | | | |
| *Exogone hebes* | P | * | * | ** | ** | *** | ** |
| *Exogone naidina* | P | | | * | | ** | * |
| *Exogone verugera* | P | | | * | | * | |
| *Sphaerosyllis sp.* | P | | | | | * | * |
| *Sphaerosyllis bulbosa* | P | | | | | * | |
| *Sphaerosyllis tetralix* | P | | * | | | | |
| *Lycastis brevicornis* | P | | | | | | * |
| *Nephtys hombergii* | P | | | | | | * |
| *Nephtys longosetosa* | P | ** | ** | ** | ** | ** | ** |

| Species | | 12 | 13 | 18 | 19 | 22 | 23 |
|---|---|---|---|---|---|---|---|
| *Scolelepis squamata* | P | | | | | * | |
| *Scolelepis tridentata* | P | | | | * | | |
| *Spio sp.* | P | | | | | * | |
| *Spio armata* | P | | | | | | * |
| *Spio decorata* | P | | | | | | * |
| *Spio filicornis* | P | * | * | | * | * | * |
| *Spio martinensis* | P | * | | | | | * |
| *Spiophanes bombyx* | P | * | * | * | * | * | * |
| *Magelona alleni* | P | * | * | | | | |
| *Magelona filiformis* | P | ** | * | * | * | ** | ** |
| *Magelona mirabilis* | P | ** | * | | | * | |
| *Magelona wilsoni* | P | | * | | | | |
| *Chaetozone setosa* | P | ** | ** | ** | ** | *** | *** |
| *Cirratulus cirratus* | P | | * | | | | |
| *Flabelligeridae sp.* | P | | | | | * | |
| *Capitella sp.* | P | * | * | * | * | ** | *** |
| *Mediomastus sp.* | P | | | | | * | * |
| *Notomastus sp.* | P | * | * | * | * | * | * |
| *Baldia johnstoni* | P | | | * | | | |
| *Praxillura longissima* | P | * | | | | * | |
| *Euclymene droebachiensis* | P | * | * | | | * | * |
| *Praxillella praetermissa* | P | * | | | | | |
| *Scalibregma inflatum* | P | * | | | | | * |
| *Owenia fusiformis* | P | | | | * | | * |
| *Amage auricula* | P | | | | | * | |
| *Terebellides sp.* | P | | | | * | | |
| *Amphitritinae sp.* | P | | | | * | | |
| *Eupolymnia nebulosa* | P | | * | | | | |
| *Lanice conchilega* | P | | | * | * | * | * |
| *Phisidia aurea* | P | | | | | * | |
| *Polycirrus medusa* | P | | | | * | ** | * |
| *COPEPODA sp.* | R | | * | * | | * | * |
| *OSTRACODA sp.* | R | * | | | | | |

| Species | | 12 | 13 | 18 | 19 | 22 | 23 |
|---|---|---|---|---|---|---|---|
| *Bathyporeia pilosa* | S | ** | ** | * | ** | * | |
| *Bathyporeia sarsi* | S | * | | | | | * |
| *Megaluropus agilis* | S | ** | ** | ** | ** | ** | * |
| *Cheirocratus assimilis* | S | | | | * | | |
| *Microprotopus maculatus* | S | | | | * | | |
| *Corophium sp.* | S | | * | | | | |
| *Siphonoecetes kroyeranus* | S | | | | * | * | * |
| *Parvipalpus capillaceus* | S | | | | * | | |
| *Idotea pelagica* | S | | * | | | * | * |
| *Cumopsis goodsiri* | S | | * | | | * | * |
| *Cumopsis longipes* | S | * | * | | | | |
| *Bodotria arenosa arenosa* | S | | * | | | | |
| *Iphinoe trispinosa* | S | * | | * | * | * | |
| *Cumella pygmaea* | S | | * | | | | |
| *Pseudocuma gilsoni* | S | | * | | | | |
| *Pseudocuma longicornis* | S | * | ** | * | * | * | * |
| *Lamprops fasciata* | S | | * | | | | |
| *Diastylis laevis* | S | | | | | * | |
| *Retusa sp.* | W | | | * | | | |
| *Retusa truncatula* | W | | | | | | * |
| *Nuculoma tenuis* | W | | | | * | | * |
| *Thyasira flexuosa* | W | | | | | | * |
| *Lasaea sp.* | W | | | | | * | |
| *Semierycina nitida* | W | | | | | * | |
| *Mysella bidentata* | W | | | | | * | |
| *Tellimya ferruginosa* | W | | * | | * | * | * |
| *Astarte sulcata* | W | * | * | * | | * | |
| *Cerastoderma edule* | W | | | | | * | |
| *Spisula solida* | W | | | | * | | |
| *Lutraria lutraria* | W | | | | * | | |
| *Ensis arcuatus* | W | | | * | * | * | * |
| *Angulus tenuis* | W | * | * | * | * | * | * |
| *Fabulina fabula* | W | ** | | | | * | * |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| *Lumbrineris latreilli* | P | | | | * | * | * |
| *Lumbrineris tetraura* | P | | | | | * | |
| *Protodorvillea kefersteini* | P | | | * | | | * |
| *Scoloplos armiger* | P | | * | * | * | * | ** |
| *Aricides minuta* | P | * | * | *** | *** | *** | *** |
| *Aricidea catherinae* | P | * | * | | | | |
| *Poecilochaetus serpens* | P | | | | * | * | * |
| *Spionidae sp.* | P | | | * | | | |
| *Aonides oxycephala* | P | | | | | | * |
| *Aonides paucibranchiata* | P | * | | | | * | ** |
| *Malacoceros tetracerus* | P | * | * | * | * | * | * |
| *Minuspio cirrifera* | P | * | | | | * | * |
| *Prionospio ehlersi* | P | | | | | | * |
| *Pygospio elegans* | P | * | | | | * | * |
| *Scolelepis bonnieri* | P | * | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| *Periculodes longimanus* | S | * | | | * | | |
| *Pontocrates arenarius* | S | ** | ** | ** | ** | ** | ** |
| *Synchelidium maculatum* | S | | * | | | | |
| *Parapleustes bicuspis* | S | | | | * | | |
| *Leucothoe spinicarpa* | S | | * | | | | |
| *Urothoe elegans* | S | | | | * | * | * |
| *Metaphoxus fultoni* | S | | | | * | | |
| *Tryphosites longipes* | S | | | | * | | |
| *Dexamine spinosa* | S | | * | | | | |
| *Dexamine thea* | S | | * | | | | * |
| *Ampelisca diadema* | S | | | | | | * |
| *Ampelisca gibba* | S | | | | | | * |
| *Ampelisca macrocephala* | S | | | * | * | | |
| *Bathyporeia guilliamsoniana* | S | * | * | | | | |
| *Bathyporeia nana* | S | * | * | * | * | * | * |
| *Bathyporeia pelagica* | S | ** | ** | ** | * | * | * |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| *Moerella donacina* | W | | | | | | * |
| *Gari tellinella* | W | | | | | * | * |
| *Gari depressa* | W | | | | | | * |
| *Abra alba* | W | | | | | * | |
| *Abra prismatica* | W | | | | | * | * |
| *Circomphalus casina* | W | | | | | * | |
| *Dosinia exoleta* | W | | * | | | * | * |
| *Clausinella fasciata* | W | ** | * | * | * | ** | ** |
| *Mysia undata* | W | | | | | * | * |
| *Turtonia minuta* | W | | | * | * | * | |
| *Thracia pubescens* | W | | | | | * | * |
| *Cochlodesma praetenue* | W | | | | * | * | * |
| *Amphiura chiajei* | ZB | * | | | | | |
| *Amphiura filiformis* | ZB | | | | * | | |
| *Echinocardium cordatum* | ZB | * | | | * | * | |
| *ASCIDIACEA sp.* | ZD | * | | | | | |

## APPENDIX 3

Material collected by Underwater Video Camera and available on Video Tape

In the course of the fieldwork part of this study, various recordings were made by a Sony underwater camera in video 8 format. Two such video tapes were used during the observation and monitoring phase of the impact study, providing underwater observations of the gear and of the tracks produced on the bottom after the gear had passed over a piece of ground. The following Tables list, for each of the six monitored tracks, various events and species observed against the tape counter readout.

Since this video format is not widely available, and since a camera fault produced an "interrupted" output, the laboratory has also prepared an edited synthesis of the material in VHS format. This tape, available from Duncan McInness, Western Isles Fishermen's Association and the Marine Laboratory, should make it possible for interested parties to observe the action and initial physical effects of the gear.

APPENDIX 3 (cont)

**Haul** 12 **Date** 12-Mar **Track length (m)** 59 **Tape 1**

| Tape counter From | To | Event | Razors Unrecessed | Razors Part recess. | Razors Damaged | Crabs Carcinus | Crabs Liocarcinus | Bivalves Venus/Dosinia | Bivalves Lutraria | Fish Flat | Fish Round | Others Echinocard. | Camera fault |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 447 | Dredge in operation no epifuana observed | | | | | | | | | | | |
| 524 | | Start of track | | | | | | | | | | | |
| 581 | | good shot of track profile | | | | | | | | | | | |
| 663 | | diver embedding weight - shows tide | | | | | | | | | | | |
| 688 | | | | | | | | | | | | | |
| 703 | | weight into sediment | | | | | | | | | 1 | | |
| 758 | | | | | | | 1 | | | | | | |
| 786 | | | | 1 | | | | | | | | | |
| 809 | | | | | 1 | | | | | | | | |
| 825 | | | | | | | 1 | | | | | | |
| 832 | | | | | | 1 | | | | | | | |
| 841 | | | 1 | | | | | | | | | | |
| 857 | | | | | | | | | | | 1 | | |
| 871 | | | | | | 1 | | | | | | | |
| 913 | 40 | | 2 | | | | | | | | | | |
| 985 | | divers hand into track | | | | | | | | | | | |
| 1026 | | | 1 | | | | | | | | | | |
| 1111 | | | 4 | | | | | | | | | | |
| 1161 | | | 1 | | | | | | | | | | |
| 1177 | | | 3 | 1 | | | | 1 | | | | | |
| 1291 | | | 2 | | | | | | 1 | | | | |
| 1330 | | | 3 | | | | | | | | | | |
| 1369 | | | 3 | | | | | | | | | | |
| 1383 | | | | | 2 | | | | | | | | |
| 1359 | 1425 | | 8 | | | | | | | | | | |
| 1439 | | | 3 | | | | | | | | | | |
| 1442 | | | | | 1 | | | | | | | | |
| 1446 | | | 4 | | | | | | | | | | |
| 1456 | | | 8 | | | 1 | | | | | | | |
| 1459 | | | | | | | | | 1 | | | | |
| 1515 | | | | | 2 | | | | | | | | |
| 1550 | | | 1 | | | | | | | | | | |
| 1583 | | diver swimming in track | | | | | | | | | | | |
| 1603 | | | | | | | | | | | | | |
| 1619 | | End of track | | | | | | | | | | | |

**Haul** 13 **Date** 12-Mar **Track length (m)** 55 **Tape 1**

| Tape counter From | To | Event | Razors Unrecessed | Razors Part recess. | Razors Damaged | Crabs Carcinus | Crabs Liocarcinus | Bivalves Venus/Dosinia | Bivalves Lutraria | Fish Flat | Fish Round | Others Echinocard. | Camera fault |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1619 | 1811 | Surface | | | | | | | | | | | |
| 1811 | | Start of track | | | | | | | | | | | |
| 1860 | | | | | | 1 | | | | | | | |
| 1876 | | diver picks up broken razor | | | 1 | | | 1 | | | | | |
| 1891 | | | | | | 1 | | | | | | | |
| 1971 | | | | | | | | | | | | | |
| 2020 | | White marker twine | | | | | | | | | | | |
| 2035 | | | | | | | | 15 | | | | | |
| 2063 | | | | | | | | 1 | | | | | |
| 2064 | | | | | | 1 | | | | | | | |
| 2088 | | | 1 | | | | | | | | | | |
| 2099 | | | 1 | | | | | | | | | | |
| 2126 | 2140 | | | | | | | 12 | | | | | |
| 2166 | | End marker | | | | | | | | | | | |
| 2191 | | diver swims up to marker | | | | | | | | | | | |
| 2233 | | diver puts "curve" into sand | | | | | | | | | | | |

APPENDIX 3 (cont)

| Haul | Date | Track length (m) | Tape 1 |
|---|---|---|---|
| 18 | 13-Mar | 60 | |

| Tape counter From | To | Event | Razors Unrecessed | Razors Part recess. | Razors Damaged | Crabs Carcinus | Crabs Liocarcinus | Bivalves Venus/Dosini | Bivalves Lutraria | Fish Flat | Fish Round | Others Echinocard. | Camera fault |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2256 | 2299 | diver with twine marker | | | | | | | | | | | |
| 2317 | | | | | | | | | | | | | |
| 2362 | | | | | | | | 1 | | | | | |
| 2389 | | | | | | | | 1 | | | | | |
| 2457 | | | | | | 1 | | | | | | | |
| 2493 | | | | | 1 | | | | | | | | |
| 2502 | | | | | 1 | | | | | | | | |
| 2525 | | diver | | | | | | 1 | | | | | |
| 2548 | | | | | | | | | | | | | |
| 2563 | | | | | | 1 | | | | | | | |
| 2560 | | | 1 | | | | | | | | | | |
| 2594 | | | | | | 1 | | | | | | | |
| 2634 | | End marker | | | 1 | | | | | | | | |
| 2646 | | | | | | | | | | | | | |
| 2731 | | diver ties twine to weight | | | | 1 | | | | | | | |

| Haul | Date | Track length (m) | Tape 1 |
|---|---|---|---|
| 19 | 13-Mar | 26 | |

| Tape counter From | To | Event | Razors Unrecessed | Razors Part recess. | Razors Damaged | Crabs Carcinus | Crabs Liocarcinus | Bivalves Venus/Dosini | Bivalves Lutraria | Fish Flat | Fish Round | Others | Camera fault |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2757 | | Dredge shots | | | | | | | | | | | |
| 2758 | 2841 | side shots of dredge | | | | | | | | | | | |
| 2841 | | activity behind blade | | | | | | | | | | | |
| 2878 | | Carcinus disturbed by dredge | | | | | | | | | | | |
| 3010 | | sandeel escapes | | | | | | | | | | | |
| 3069 | 3119 | dredge burys into sediment | | | | | | | | | | | |
| 3150 | | Carcinus in dredge | | | | | | | | | | | |
| 3200 | 3214 | On track -Carcinus with | | | 1 | 1 | | | | | | | |
| 3234 | | damaged razor | 8 | 1 | | 1 | | | | | | | |
| 3259 | | | 1 | | | | | | | | | Echinocard. | ] |
| 3264 | | Carcinus attacking razor | | | | | | | | | | | ] good |
| 3272 | | second Carcinus joins above | | | | 1 | | | | | | | ] sequence |
| 3292 | | diver gathers unrecessed razors | 5 | | | | | | | | | | ] no |
| 3302 | | | | | | | | | | | | | ] camera |
| 3317 | | | 1 | | | 1 | | | | | | hermit crab | ] fault |
| 3325 | | End marker | | | | | | | | | | | |
| Note - At this point there were sorme surface shots followed by | | | | | | | | | | | | | |
| 3333 | | End marker | | | | | | | | | | | |
| 3394 | 95 | Carcinus tracked by camera | | | | 3 | | | | | | | |
| 3424 | 118 | diver gathers unrecessed razors | 8 | | | | | | | | | | |
| 3461 | | | 2 | | | 1 | | | | | | | |
| 3485 | | Carcinus with piece of razor | | | | 1 | | | | | | | |

APPENDIX 3 (cont)

| Haul | Date | Track length (m) | Tape 2 |
|---|---|---|---|
| 22 | 14-Mar | 123 | |

| Tape counter From | To | Event | Razors: Unrecessed | Razors: Part recess. | Razors: Damaged | Crabs: Carcinus | Crabs: Liocarcinus | Bivalves: Venus/Dosin | Bivalves: Lutraria | Fish: Flat | Fish: Round | Others | Camera fault |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 54 | surface shots | | | | | | | | | | | |
| 55 | 278 | on dredge - murky | | | | | | | | | | | |
| 278 | | start - attaching white line | | | | | | | | | | | |
| 336 | | | | 1 | | | | | | | | | |
| 381 | | | 1 | | | | | | | | | | |
| 415 | | Carcinus with razor | 1 | | | 1 | | | | | | | |
| 420 | | | 1 | | | | | | | | | | |
| 424 | | | | | | | 1 | | | | | | |
| 432 | | | | | | | | | | 1 | | | |
| 433 | | | | | | | | 3 | | | | | |
| 449 | | | | | | 1 | | | | | | | |
| 467 | | | | | | | | | | 1 | | | |
| 483 | | | | | | | | 2 | 2 | | | | |
| 488 | | | | | | | | 1 | | | | | |
| 508 | | | | 1 | | | | | | | | | |
| 525 | | | 3 | | | | | | | | | | |
| 537 | | | 5 | | | | | | | | | | |
| 558 | | | | | | 1 | | | | | | | |
| 590 | | | | | | | | 1 | | | | | |
| 601 | | | 1 | | | | | | | | | | |
| 611 | | | 1 | | | | | | | | | | |
| 617 | | | | 1 | | | | 1 | | | | | |
| 632 | | | 1 | | | | | | | | | | |
| 650 | | | 3 | | | | | | | | | | |
| 655 | | | 3 | | | | | | | | | | |
| 667 | | | | | | 1 | | | | | | | |
| 681 | | | | | 1 | | | | | | | | |
| 690 | | | 1 | | | | | | | | | | |
| 698 | | | | | | 1 | | | | | | | |
| 720 | | | | | 1 | | | | | | | | |
| 731 | | | | 2 | | | | 3 | | | | | |
| 739 | | | 2 | 1 | | 1 | | | | | | | |
| 767 | | | | | | 1 | | | | | | | |
| 776 | | | 4 | | 1 | | | | | | | | |
| 781 | | | 8 | 2 | 1 | | | | | | | | |
| 800 | | | | 2 | | | | | | | | | |
| 813 | | | | 2 | | | | | | | | | |
| 824 | | | | | | | | 2 | | | | | |
| 834 | | | | | 1 | | | | | | | | |
| 845 | | | 1 | 1 | 1 | | | | | | | | |
| 867 | | | | | 1 | | | | | | | | |
| 871 | | | 1 | | | | | | | | | | |
| 879 | | | | | 1 | 1 | | | | | | | |
| 891 | | | 1 | | 1 | | | | | | | | |
| 910 | | | | 1 | | 1 | | | | | | | |
| 926 | | | 1 | | | | | | | | | | |
| 937 | | | | | 2 | 1 | | | | | | | |
| 953 | | | | | | 1 | | | | | | | |
| 960 | | | 1 | | 1 | | | | | | | | |
| 969 | | Carcinus + damaged razor | 3 | 1 | 1 | 2 | | | | | | | |
| 989 | | | | | 1 | 1 | | | | | | | |
| 992 | | | 2 | 2 | | | | | | | | | |
| 1022 | | | 4 | | 1 | | | | | | | | |
| 1032 | | | | | | | | | | 1 | | | |
| 1043 | | | 3 | | 1 | | | | | | | | |
| 1060 | | | 3 | | | | | | | | | | |
| 1066 | | | 1 | | | | | | | | | | |
| 1074 | | | | | | 2 | | | | | | | |
| 1087 | | | 1 | 3 | 2 | | | | | | | | |
| 1093 | | | | | | 1 | | | | | | | |
| 1103 | | | | | | 1 | | | | | | | |
| 1126 | | End weight | | | | | | | | | | | |

| Haul | Date | Track length (m) | Tape 2 |
|---|---|---|---|
| 23 | 14-Mar | 87 | |

| Tape counter From | To | Event | Razors: Unrecessed | Razors: Part recess. | Razors: Damaged | Crabs: Carcinus | Crabs: Liocarcinus | Bivalves: Venus/Dosin | Bivalves: Lutraria | Fish: Flat | Fish: Round | Others | Camera fault |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1138 | | Start weight | | | | | | | | | | | |
| 1173 | | razor moves into sediment | | 1 | | | | | | | | | |
| 1209 | | | | | | 1 | | | | | | | |
| 1236 | | Echinocardium recessing | | | | | | | | | | Echinocard. | |
| 1248 | | | | | 1 | | | | | | | | |
| 1259 | | | 1 | | | 1 | | | | | | | |
| 1270 | | | | | 1 | | | | | | | | |
| 1312 | | | 1 | | | | | | | | | | |
| 1320 | | Carcinus + damaged razor | | | 1 | 1 | | | | | | | |
| 1349 | | | 2 | | 3 | | | | | | | 5 Echinoca. | |
| 1365 | | | 6 | | 2 | | | | | | | | |
| 1371 | | razor attemps to swim | 1 | | | | | | | | | | |
| 1393 | | | | | | 1 | | | | | | | |
| 1444 | | | 5 | 1 | 4 | | | | | | | | |
| 1470 | | | | 2 | | | | | | | | | |
| 1493 | | | | | | 1 | | | | | | | |
| 1507 | | | 1 | | | | | | | | | | |
| 1521 | | Carcinus + undamaged razor | 1 | | | 1 | | | | | | | |
| 1536 | | | 2 | | | | | | | | | | |
| 1553 | | | 1 | | 1 | | | | | | | | |
| 1578 | | | 1 | 3 | | | 1 | | | | | | |
| 1609 | | | 3 | | 1 | | | | | | | | |
| 1631 | | Carcinus with razor | 1 | | | 1 | | | | | | | |
| 1686 | | | | | 1 | | | | | | | | |
| 1702 | | | 1 | 2 | | | | | | | | | |
| 1711 | | | 1 | | | | | | | | | | |
| 1743 | | | 4 | 3 | | | | | | | | | |
| 1807 | | | 1 | | | | | | | | | | |
| 1816 | | | 1 | | | | | | | | | | |
| 1830 | | | | | | 1 | | | | | | | |
| 1844 | | | | | | 1 | | | | | | | |
| 1859 | | | 1 | | 1 | | | | | | | | |
| 1899 | | | | 1 | | | | | | | | | |
| 1904 | | | 1 | | 1 | | | | | | | | |
| 1924 | | | 1 | | | | | | | | | | |
| 1929 | | | 2 | | | | | | | | | | |
| 1944 | | | 1 | | 1 | | | | | | | | |
| 1962 | | | 1 | | | | | | | | | | |
| 1983 | | | 2 | | 1 | | | | | | | | |
| 1986 | | Carcinus with razor | 1 | | | 1 | | | | | | | |
| 2020 | | | 1 | | | | | | | | | | |
| 2027 | | | | 2 | | | | | | | | | |
| 2036 | | | | | | 1 | | | | | | | |
| 2062 | | Carcinus with razor | 1 | | | 1 | | | | | | | |
| 2090 | | | 1 | | | | | | | | | | |
| 2095 | | | | | 1 | | | | | | | | |
| 2107 | | | 3 | | | 1 | | | | | | | |
| 2120 | | Carcinus with razor | 1 | | | 1 | | | | | | | |
| 2126 | | | | | 1 | | | | | | | | |
| 2152 | | | 1 | | | 2 | | | | | | | |
| 2191 | | | | | | 2 | | | | | | | |
| 2213 | | | | | | 4 | | | | | | | |
| 2234 | | 2 Lutraria - 1 damaged | | | | | | | 2 | | | | |
| 2238 | | | | | | 4 | | | | | | | |
| 2251 | | End weight | | | | | | | | | | | |

**APPENDIX 8**

# UK SCALLOP INDUSTRY GOOD PRACTICE GUIDE

Dr Andrew Woolmer
February 2010

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Revision 6th May 2010

Shellfish Association of Great Britain

**Scallop Association**

SEAFISH the authority on seafood

**Preamble**

Recent years have seen important changes in the management of marine resources, in which environmental, ecological and sustainability issues have become of increasing importance. The EU habitats directive and the UK Marine Act have increased the imperative to improve marine spatial management and planning. Customers are becoming increasingly aware of the need for sustainability and this has given rise to the MSC and other certification schemes. Scallop dredge fisheries can have an effect on biodiversity, particularly when interacting with habitats and species that are sensitive to physical disturbance. There is also a need to understand better the dynamics of scallop stocks and fisheries enabling improved sustainability. The challenge is to set out a an operational approach which will lead to an acceptable environmental footprint for the scallop dredge fishery and enhance fisheries management through better scientific knowledge.

This good practice guide was created because there is a need for the scallop dredge fishery to define and operationalise good practice for scallop fishers in the in relation to environmental, fishery management and fisheries science. The aim is to create an operational environment where all available information and expertise is focussed on minimising that the environmental effects of scallop dredging, whilst maximising the fishing opportunities and sustainability. A key element of this is negotiation and partnership with conservation and science interests.

**Benefits** Widespread adoption and use of the good practice outlined in this guide is intended to result in the following benefits;

For **fishermen** it will provide operational standards and a basis for negotiation and partnership with environmental and marine conservation interests in relation to marine spatial management, enabling fishermen to operate in a way that minimises interaction with nature conservation and enhances environmental and stock sustainability.

For **processors** it will provide the basis for describing to retail customers the operating practices and standards in relation to environmental management and sustainability, within which their scallops are harvested. This is of increasing importance where there is scrutiny of the environmental effects and sustainability of fishing operations from customers.

**Consumers** are becoming increasingly aware of the need to source from fisheries which whose practices are sustainable and environmentally sound. This code of conduct is designed to provide assurance that the vessel operators and processors are taking all feasible steps within the current management framework to minimise environmental effects of scallop dredging and enhance sustainability.

The main unit of operation is the scallop dredging vessel, and the code is expected to become a part of the Responsible Fishing Scheme. However, there is an explicit requirement for partnership at an appropriate scale. Actions under this guide would be expected to be compatible with certification under the Marine Stewardship Council scheme.

## Summary of Principles and Articles, Scallop Industry Good Practice Guide

Partnership agreements should be drawn up at the appropriate scale, local, regional or national, between fishermen, conservation organisations, scientists and managers covering recognition that scallop fisheries and conservation both have their place and formal recognition of the important environment and fishery issues. These agreements should include an action plan jointly produced between the parties on how the partnership will approach each of the principles and appropriate articles.

**Principle 1. Operate in partnership with environmental managers and other marine users**.

Fishermen shall work in partnership with , fishery and conservation managers, and the Statutory Nature Conservation Agencies (SNCAs) to ensure that their fishing activities avoid damage and / or disturbance to sensitive seabed habitats and protected sites.

**Articles**

1. *Fishermen shall work with fishery and conservation managers, and the SNCAs to recommend management measures that will afford protection to sensitive seabed habitats and protected sites and will adhere to management practices that are put in place*
2. *Fishermen shall provide data through their acoustic systems or local knowledge to better understand seabed habitats which would better inform decisions to protect sensitive habitats*
3. *Fishermen shall work with fishery managers and Statutory Nature Conservation Agencies (SNCAs) to develop spatial management plans to ensure the protection of designated sites*
4. *Fishermen shall work with the relevant organisations and researchers collecting fishing activity information which will ensure that the industry is sufficiently considered in the development of –designated sites and other marine developments*
5. *Fishermen shall report, avoid and maintain a protection zone around areas of reef or hard ground conforming with the technical definition of reef habitat but not covered by formal legal protection, where sensitive species are encountered .*
6. *Fishermen shall work in partnership with relevant bodies' research to assess fishing gears and promote and utilize new fishing gears and practices which minimise environmental impacts*
7. *Where economically viable and practicable alternative harvest methods are available fishermen shall adopt them in preference to traditional scallop dredges*
8. *Fishermen shall recognise and respect the needs of other users of the marine environment and take reasonable measures to ensure that direct conflict does not occur through constructive engagement in the marine planning process.*

**Principle 2. Compliance with voluntary and statutory regulations controlling access to fisheries**

Fishermen shall comply with voluntary and statutory agreements and regulations and will work to promote compliance across the industry.

**Articles**

1. *Fishermen shall fit Vessel Monitoring Systems to their vessels, where necessary, to ensure compliance with the spatial plans and regulation*
2. *The buyer and processor members of the industry commit to refuse to purchase from vessels bringing the scallop industry into disrepute by infringing voluntary agreements and statutory regulations*

3. *Scallop fishermen should respect other marine users and inform fishermen's associations, SNCA's, Inshore Fisheries Conservation Authorities (IFCA's) and Inshore Fisheries Groups (IFG's) of intended activities in or adjacent to their area of remit*

**Principle 3. Contribute to Science Knowledge base and to assist in the long term maintenance of sustainable scallop stocks**

Fishermen shall engage with managers and scientists to promote research and best practice in the management of scallop stocks

**Articles**

1. *Fishermen shall be prepared to cooperate and participate with research institutions and in specialist Scallop Science partnership projects to improve the scientific understanding of UK scallop stocks, this may include:*
    a. *in the provision of activity and effort information that would inform statistical analysis*
    b. *participation in at sea recording of stock data and enhanced log book recording*
    c. *fitting environmental data loggers on gear/vessels*
2. *Fishermen shall, where the opportunity arises, participate in local, regional and national management fora with the intention of promoting best practice in the management of the scallop fishery*
3. *Fishermen - should aim to propose behaviours, activities or areas that will result in the maintenance and improvement of scallop stocks throughout the UK*