

Summary of results and findings of the
Orkney shellfish research study 2010/11.
Part funded by EU Fisheries Fund and
Orkney Island Council

Orkney Sustainable Fisheries

2010/2011 Project Review



Sarah Lamb

Executive Summary

Orkney's inshore fisheries play an important economic and social role, with beneficiaries spread throughout the island group. The co-operatively owned crab processing factories in Westray and Stromness are significant employers in their own right and purchase some £5.5M of shellfish annually from local suppliers. Both factories have expanded in recent years on the back of increased supplies, new boats coming into the fishery and highly pro-active marketing. This successful marketing strategy has largely involved placing added-value Orkney branded products in high-end retail markets in both the UK and abroad.

These markets are increasingly seeking confirmation that seafood supplies are from sustainably managed fisheries, the key "badge" being Marine Stewardship Council certification. A pre-assessment of the Orkney fisheries in 2006 highlighted considerable weaknesses in the local fishery in terms of both knowledge of stocks and management practices. In an attempt to begin to address these short-comings, Orkney Sustainable Fisheries Ltd successfully raised funds and employed a full-time shellfish research officer on a 2 year project.

With the support and active involvement of a wide range of local creel fishermen Sarah Lamb (and in the second year her assistant Kate Walker) has made considerable progress. The input from fishermen was particularly important in creating both engagement and ownership of the project. Throughout the study Sarah liaised closely with, and followed procedures established by, Marine Science Scotland and their personnel at the marine laboratory in Aberdeen. We are very grateful for their support and hope that this relationship can be built on in the future.

This report highlights the work undertaken during the study and makes recommendations as to future research priorities. While work to date has been very much "industry led", there is a growing recognition that such research would benefit from more robust scientific input and direction at a management level. To this end discussions are currently taking place with ICIT (Heriot-Watt University) regarding a potential future 3 year project which would follow on from this study.

Stewart Crichton, Chairman, Orkney Sustainable Fisheries Ltd

October 2011

Introduction

Orkney Sustainable Fisheries LTD was set up in 2006 with the aim running of the local lobster hatchery. OSF is industry-led with the company board represented by local fishermen, merchants and processors with the common aim of taking forward various initiatives relating to the sustainability of the local shellfisheries. In 2008 OSF put forward an application for funding for a two year research programme and was successful in securing European Fisheries Fund and OIC grants to carry out the following work:

- Establish, maintain and monitor a shellfish stock assessment programme
- Carry out brown crab tagging trials.
- Take forward MSC accreditation of our crab fishery
- Set up a web-site to publicise this work
- Employ a shellfish research co-ordinator to oversee the programme.

Background to Project

Importance of inshore fisheries to Orkney

The Orkney fishing fleet comprises 146 registered vessels (103 vessels 10m and under) employing 277 full time fishermen and 132 part time. Scottish islands of Eilean Siar, Orkney and Shetland collectively employ 1,297 individuals accounting for 4 % of their total work force, emphasising the crucial role of the industry in the socio-economic stability of island communities. Recent Scottish Sea Fisheries Statistics (2010) show Orkney's shellfish fishery valued at £7,464, 000 in 2010 with the three main species brown crab, velvet crab and lobster accounting for £6,572,000 of this total. The importance of Orkney's shellfish fishery is also highlighted on a Scotland wide scale with velvet crab landings from the county contributing 33% of the Scottish total, brown crab 20% and lobster 12%. Two local brown crab processing factories give Orkney a unique advantage in a competitive export industry, processing around 2,000 tonnes in supply to several UK supermarkets; those not processed at the factory are exported whole along with velvet crab and lobster throughout Europe where market demand remains high.

*All values taken from Scottish Sea Fisheries Statistics 2010 Landings Tables, published September 2011.

MSC pre-assessment

The Marine Stewardship Council (MSC) is an independent, global, non-profit organisation whose role is to recognise, via a certification programme, well-managed and sustainable fisheries and to harness consumer preference for seafood products bearing the MSC label of approval, or eco-label. (MSC, 2005)

In acknowledging the benefits of the eco-label for Orkneys shellfish fishery, OSF put forward Orkney inshore brown crab, velvet crab and lobster fisheries for MSC pre-assessment in April 2006. The pre-assessment evaluated the fishery against the MSC criterion taking account sustainability,

environmental impact and management. Pre-assessors rated the fishery would fail to meet MSC accreditation standards due to:

- the extent of the stock not being properly defined, possibly extending significant distances offshore;
- the lack of objectives set for the fisheries, and of a mechanism to control effort within this fishery should overall stock levels decline to a degree that threatened the sustainability of the stock;
- a need for improved recording of the composition of the catch (sex, size etc), together with accurate spatial recording of data on LPUE etc.;
- a need for improved recording of by-catch.

OSF sought the opportunity to address the data deficiency within the fishery highlighted by the pre-assessment report by applying for research funding from the EU Fisheries Fund and Orkney Island Council.

Need for research

In addressing the data deficiency highlighted by the MSC pre-assessment one of the key needs is to demonstrate feasibility of more industry involvement in collecting fisheries data. This form of co-operative scientific research relies heavily on the participation of fishermen and support of industry stakeholders collaborating with scientists. OSF as a non-profit organisation led by industry stakeholders offers a unique opportunity to provide a key link between science and industry.

Marine Scotland currently collects shellfish stock assessment data for Scottish waters including Orkney. Data collection consists of bi-annual market sampling visits gathering data on the size- and sex-composition of landings. These data are used in length cohort analyses to provide an appreciation of exploitation levels in relation to possible criteria for sustainable management, although at present these results of these assessments are not applied in any formal management context. The employment of a full-time shellfish research co-ordinator by OSF allows regular market sampling accounting for seasonal variations while at the same time increasing sample size, thus improving quality of data upon which any stock assessment would be based.

Key Project Strands

Crab tagging

Tagging trials of commercial crustaceans date back to the 1900's, providing the first demonstration of extensive migration of brown crab moving distances excess of 100 km (Williamson, 1900; Meek, 1913). A tagging study was set up to further understand the migratory and life history pattern of brown crab around Orkney waters while aiming to establishing the identity of Orkney stocks in terms of a wider stock distribution.

Length cohort/Market sampling

Length cohort analysis is a stock assessment method for fish and shellfish based on the length composition of fishery removals together with information about growth rates. Using length composition data from market sampling and landings data and, providing there are no strong trends in catch rates or fishing effort (i.e. it can be assumed that recent fishing mortality and levels of recruitment of juveniles to the stock are relatively stable, or at least varying without trend), can provide an indication of whether or not populations are subject to overfishing in relation to thresholds for optimising fishery yield and protecting spawning potential. Data collected by OSF are intended to be shared with Marine Scotland as part of their on-going stock assessment programme.

Discard Sampling

Discards are the portion of the total catch which is unintentionally caught and returned to the sea, and consists of species with no commercial value and undersized or damaged target species. Discarding from passive methods such as creel fishing have received little research attention in comparison to active gears such as trawling and dredging. An objective of this work is to describe and quantify the total catch composition and discarding patterns while addressing issues of sustainability for stocks of both target and by-catch species.

Website

As part of the project, a website was created to raise awareness of the work of OSF, providing an interactive format for those interested and also to promote OSF out-with Orkney. Belgica design were contracted to set up the domain name (www.orkneysustainablefisheries.co.uk) and the layout design, all content, text and images were then added by the project co-ordinator. Website content includes background to OSF, information on current research and promotion of the work of the lobster hatchery. Since going 'online' in April 2011, feedback indicates that the website has been well received and has been reaching 300+ hits per month. Interactive

Methodology

Crab Tagging

The project aim is to comparing locations of catches and releases to provide information on the scale and pattern of crab movements. Various marker tags available were considered and evaluated for the purpose of the study, it was determined a coloured cable tie to the chelae (claw) would be the most effective method in providing individually identifiable marks that will be easily visible to fisherman, allowing them to return information on catch locations. The cable tie will be lost when the shell is cast during moulting but the inter-moult durations are expected to be of sufficient duration to provide useful information on within-season movements. The cable ties would be sequentially numbered along with a contact telephone number for return of capture information.

Fishermen's meeting were held around Orkney to raise awareness and interest in the project. Those attending meetings were generally forthcoming with their involvement, agreeing to participate in the tagging trips and to return tags. Tagging was carried out by the shellfish co-ordinator opportunistically onboard the fishing vessels. Only discarded (soft, undersized, crippled, black shell disease) crabs were to be tagged to avoid making an impact on the fisherman's marketable catch. The exclusive tagging of discards is unlikely to be representative of the population as a whole and may cause bias towards size class or condition, this will have to be considered in analysis of res. Details of carapace length, sex and condition were recorded along with corresponding tag number and release location (determined by GPS). Different coloured cable ties were used for individual boats, allowing the

fishermen to determine the general areas of release without requiring the individual tag number details. Fishermen were issued capture log books to record information on recaptures, this was to include tag number, date and location of capture.

Market Sampling

Routine market sampling was carried out weekly at various merchants' premises. Information recorded included carapace length, sex and vessel. During year 1 this was recorded by hand using digital callipers and waterproof dive slate, at the beginning of year 2 Marine Scotland kindly donated a electronic PDA calliper system alleviating the manual recording of details and allowing a greater volume to be sampled in a shorter time period.

Discard sampling

Discard sampling was carried out opportunistically onboard fishing vessels. A representative sample of each string of creels was recorded, or where possible the complete discarded catch. Details of carapace length, sex and reason for discards of target species were recorded, along with string GPS location. By-catch of non-target species was also noted on a SACFOR scale, e.g *Ophiothrix fragilis* (common brittlestar) Abundant. The scale is based on that devised by the Joint Nature Conservancy Council (JNCC) (Hiscock, 1996) where depending on the nature of the organism, abundance estimates are made for either percentage cover or numerical abundance. This is then related to the scale to convert to SACFOR (S = Superabundant, A = Abundant, C = Common, F = Frequent, O = Occasional, R = Rare)

Results

Crab tagging

2010 Season Review

A total of 1,096 individuals was tagged during the first year of the project (637 males, 459 females). As of August 2011 an overall return rate 9.6%, (101 tags returned) has been accomplished, a notable increase in comparison to some earlier studies including a previous tagging exercise in Orkney reporting 1.3% (Jones *et al.*, 2010). The majority of returns were less than two weeks at liberty moving less than one mile from their release points. All females were seen to move westerly/south-westerly offshore in direction with the greatest distance recorded 125 miles having been released North of Westray and captured off the Hebridean Isles at the Butt of Lewis. Males were seen to be more variable in movement direction, with several moving distances of between 3-8 miles but remaining largely within the inshore 6 miles limit. However, a single male tagged in deeper water north of Westray moved a distance of 28 miles towards shallower inshore waters of Sanday. A summary of significant movements is provided in Table 1.

Table 1: Summary of significant brown crab movements

Tag Number	Sex/Size	Days at liberty	Distance Moved
18	Male 137mm	135	3.7 miles
110	Male 134mm	84	3.5 miles
127	Male 130mm	69	8.5 miles
165	Male 147mm	6	3 Miles
225	Male 145mm	69	7.8 miles
1881	Female *	329	21 miles
14423	Female 176mm	369	50 miles
14643	Male 177mm	97	28 miles
15409	Female 153mm	341	55 miles
15466	Female 157mm	353	125 miles
*Size not available			

Market sampling/Length cohort analysis

The data collected will contribute to the on-going efforts of Marine Scotland data collection and length cohort analysis will be carried out by Marine Scotland as part of their Scotland wide fisheries stock assessments. Average landing size of brown crab of the 35 vessels sampled varied between 146-170mm carapace width with an overall average of 162mm over the two year sampling period (Table 2). Yearly averages vary slightly increasing from 160mm to 164mm in 2011 with males comprising 69% of landings in 2010 decreasing to 53% in 2011. Average landing size of velvet crabs is consistent between the 12 vessels sampled, varying in the range 71-74mm carapace width with overall average of 73mm. Sex composition of the velvet crab landings was similar between years with males accounting for 72% of landings in 2010 and 75% 2011. Average lobster size landed between 15 sampled ranged between 90-103mm carapace length with the average size landed 98mm. Males accounted for 46% and 45% of the landings in 2010 and 2011 respectively.

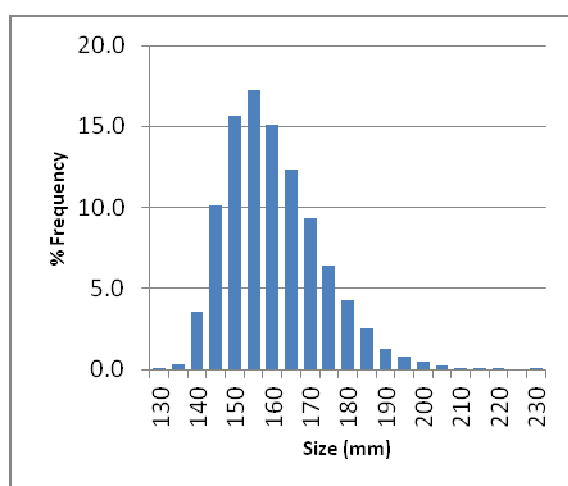


Figure 2: Male brown crab length frequency distribution landed 2010

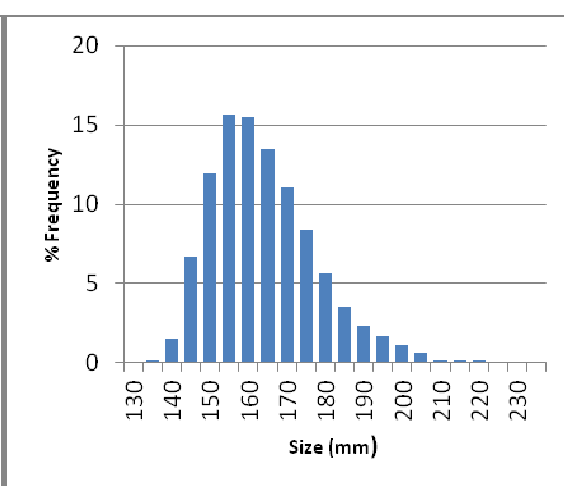


Figure 1: Male brown crab length frequency distribution landed 2011

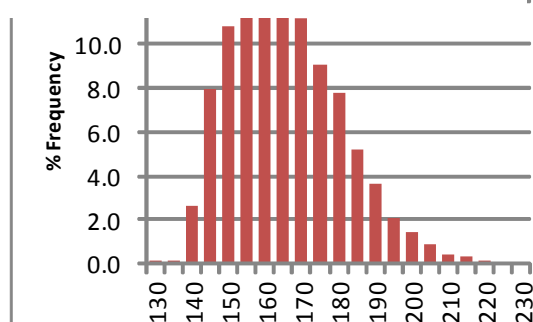


Figure 3: Female brown crab length frequency distribution landed 2010

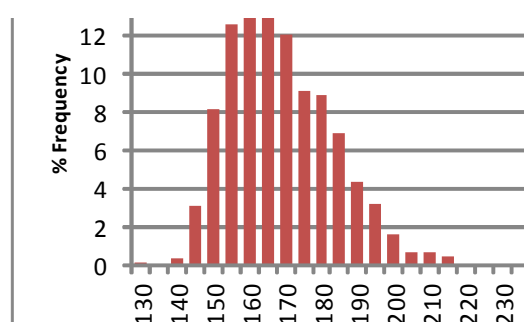


Figure 4: Female brown crab length frequency distribution landed 2011

Table 2: Summary of yearly market sampling figures for and average sizes for inshore vessels.

		Boats sampled	Individuals sampled	Number Male	Male Average Size (mm)	Number Female	Female Average Size (mm)	Overall Average Size (mm)
2010	Brown Crab	26	7,836	5,421	158	2,405	164	160
	Velvet	5	1,847	1,330	74	517	71	74
	Lobster	7	435	200	99	235	98	98
2011	Brown Crab	20	7,808	4,124	162	3,684	166	164
	Velvet	8	5,023	3,783	73	1,240	71	73
	Lobster	12	1,471	665	99	806	98	98

Market sample data for brown crabs obtained from offshore vivier vessels landing into Orkney were separated from the inshore fishery to allow comparison to be made between the two sectors. The average size landed from offshore grounds remained stable between years (Table 3). Females comprised 91% and 90% of these offshore landings in 2010 and 2011 respectively.

Table 3: Summary of yearly market sample data and average sizes for offshore vessels

		Individuals sampled	Number Male*	Male Average Size (mm)	Number Female	Female Average Size (mm)	Average
2010	Brown Crab	2517	220	167	2296	167	167
2011	Brown Crab	3021	312	167	2709	168	168

*Note that larger male crabs were selectively graded and retained in container that were not always available for sampling, therefore estimated average male size landed offshore may be biased.

Discard Sampling

As discard sampling was carried out opportunistically at the convenience of the fishermen it was not possible to standardise several variables (soak time, bait, gear type, target species) which may influence catch rates and composition to an unknown degree. For the purpose of this report only a single catch composition case study will be discussed in detail. The sampling vessel was chosen to represent a mixed target species fishery on the East side of Orkney. A day catch summary is

provided in Table 4. Nine strings were hauled on the day of sampling totalling 310 individual traditional creels. Of the individuals caught 80% of brown crab catch was returned and 20% retained for market, of which 97% was male. 83% of the discards were legally undersized, 1% crippled and 2% diseased, the remaining 14% being returned due to market preference for larger crab >155mm.

Table 4: Total catch summary, sampling trip May 2010

		Male	Female	Berried
Brown Crab	Discard	366	219	
	Landed	147	4	
Velvet	Discard	1	4	99
	Landed	309	221	
Lobster	Discard	13	11	
	Landed	12	10	3
No. creels hauled		310		

84% of the velvet crab catch was landed while discards of berried females represented 15.5% of the catch and a single discarded male representing the remaining 0.5%. Male to female split of marketable catch was divided 58% male to 42% female. Lobster landings/discards were more evenly split with 44% landed and 56% discarded, 100% of discards being legally undersized. Both discards and landings of lobsters were similar in sex ratio, 54% male 46% female for discards and 55% male and 45% female for landings, with 30% of females landed being berried. By-catch was quantified using the SACFOR scale (Table 5). By-catch composition tallied 11 individual species comprising 3 species of crustacea, 5 of chordata, 1 mollusc and 2 echinoderm species. Most abundant species were *Buccinum undatum* (whelk) and *Pagurus bernhardus* (hermit crab). All species recorded are common by-catch species within the creel fishery.

Table 5: Bycatch species summary, sampling trip May 2010

Latin Name	Common Name	SACFOR scale
<i>Buccinum undatum</i>	Whelk	Abundant
<i>Echinus esculentus</i>	Sea Urchin	Frequent
<i>Galathea squamifera</i>	Squat lobster	Occasional
<i>Pagurus bernhardus</i>	Hermit crab	Abundant
<i>Crossaster papposus</i>	Sun Star	Rare
<i>Liocarcinus depurator</i>	Harbour Crab	Rare
<i>Gadus morhua</i>	Cod	Rare
<i>Cyclopterus lumpus</i>	Lumpsucker	Rare
<i>Labrus mixtus</i>	Cuckoo wrasse	Rare
<i>Conger conger</i>	Conger eel	Rare
<i>Scyliorhinus canicula</i>	Dog fish	Rare

Conclusions & recommendations

Tagging trials

The tagging results reiterated previous studies having observed females undertaking seasonal migrations while males generally stayed inshore. The female crab migratory movement is thought to be as part of their breeding cycle, moving inshore to moult and mate with resident males then travelling into deeper water and preferred softer sediment where they may burrow, usually counter-current, positioning themselves to enable the planktonic larvae to float back with the current to inshore settling grounds. Tagging results support this theory with the three furthest travelled females all being recently moulted ('soft') when tagged and then found to have moved in one case westerly the others south-westerly towards deeper water. Jones *et al* (2010) offshore tagging results confirmed an easterly movement of larger females returning towards inshore waters, suggesting the offshore/inshore stock dynamic on the west coast of Orkney extending some 200 miles.

It is important to consider tagging information to support future assessments of the fishery, particularly in the separation of inshore and offshore fishery components. The importance of both areas in the reproductive cycle requires consideration in expansion within the fishery, more notably in the offshore sector with the advancement of vivier vessels exploiting predominant female spawning stocks in offshore areas.

Only through the continuation of the tagging project will we gain further insight on movements and patterns. The success of the tagging research is not only justified in its scientific value but also in actively involving fishermen in a project of mutual interest building and reinforcing relations within the industry. As the cable ties will be lost on moult, recently moulted crabs were targeted to maximise the tag re-capture period. The volume of discards available for tagging was extremely variable making some trips less fruitful than others. In future tagging exercises if it were possible to pay fishermen for a portion of their marketable catch for tagging purposes this would allow greater numbers to be tagged per trip while movements not being biased to 'soft' or undersized discards.

Length cohort/market sampling

The principal mechanism of preventing over exploitation of important crustacean stocks is through the enforcement of a minimum landing size (MLS) under EU regulations. These sizes were decided upon for the species based on scientific advice that protection will allow the population to mate and reproduce at least once in their lifetime before they can be legally landed. Market sampling has provided an important baseline data collection particularly in view of future management decisions that may consider increases in MLS. While the MLS of 140mm serves its purpose in conservation, market pressure for larger crabs (>155mm) holds the greatest influence on the size of crab landed and this is reflected in the average landing size of 162mm. As the market price for lobster is considerably higher there is no evidence of a similar grading process by fishermen or market preference to size, whereby with little exception if a lobster meets MLS (87mm) it is rightfully landed. The average landing size of 98mm was consistent between 2010/11 suggesting a stable fishery between sampling years, although if a decrease is experienced in the following years attributed to increase in fishing pressure management strategies would need to be considered. An increase in MLS would be an effective management strategy for this species, allowing a greater number of females will mature before they can be legally caught, and egg number per female at the legal size to be slightly higher.

While length cohort analysis is the current method of stock assessment for crabs and lobsters carried out by Marine Scotland, this technique relies heavily on equilibrium assumptions about the stock and fishery and biological parameters required are still poorly known for these crustacean species. This means that these assessments should not be used as the sole indicator of the well-being of targeted stocks. Landings per unit effort (LPUE) data can be utilised to provide a 'real time' index of abundance and further understanding of population dynamics. Fishermen currently provide information on fishing activity and landings as a legal requirement, but unfortunately this requires no details on effort (number of creels lifted) per vessel from which LPUE may be derived. This is a national issue with the exception of Shetland where independent logbooks (providing LPUE data) are a compulsory requirement under the Shetland Shellfish Management Order. Future industry and research initiatives should prioritise the collection of this data, whether achievable for Orkney as a whole or for a representative sample of vessels.

Discard sampling

Although crustacean species are particularly vulnerable when recently moulted, given reasonable handling practices by fishermen it may be possible to assume 100% discard survival in the fishery is common, therefore losses to the fishery through discarding is negligible and composition of landings representative of total fishery removals. Due to sampling being at the convenience of the fishermen it was not possible to standardise variables (soak time, bait, gear type, target species) between vessels, thus it is unknown how these factors may influence catch rates and composition and this raises several uncertainties in analysis of data. Data analysis has also been limited due to sampling being restricted to summer months. It is suggested that smaller samples from a larger number of boats would minimise biases owing to between-vessel variations. With sufficient industry support this may be achievable through a fishermen self-sampling scheme whereby fishermen themselves record discard information throughout the year. Fishermen also have extensive anecdotal information, this may be collated by fishery questionnaires (from past exercises this would be more fruitful if possible to engage in person rather than paper based).

Summary of recommendations

- Prioritise the collection of landings per unit effort (LPUE) data, whether achievable for Orkney as a whole or for a representative sample of vessels.
- Seek funding opportunities to allow marketable catch to be included in tagging trials to remove bias towards 'soft' or undersized discards.
- Pursue fishermen discard self-sampling scheme whereby fishermen themselves record discard information throughout the year. Anecdotal information may be collected through fishery questionnaires.
- Continue market sampling to build upon the current data set in support of the on-going length cohort analysis stock assessment

APPENDIX

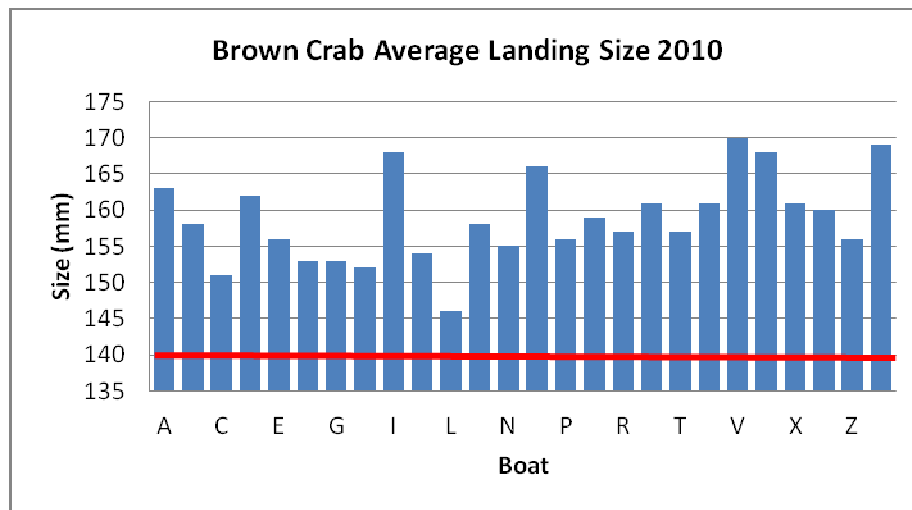
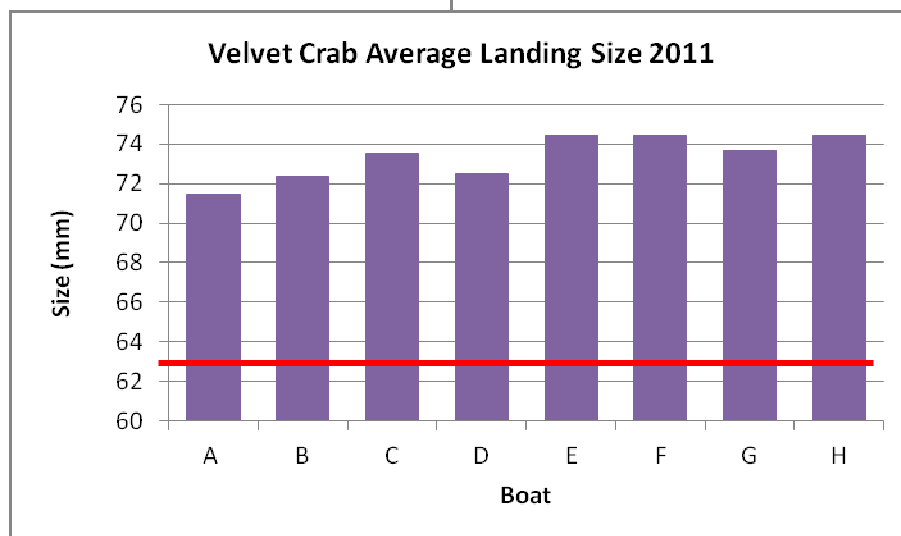
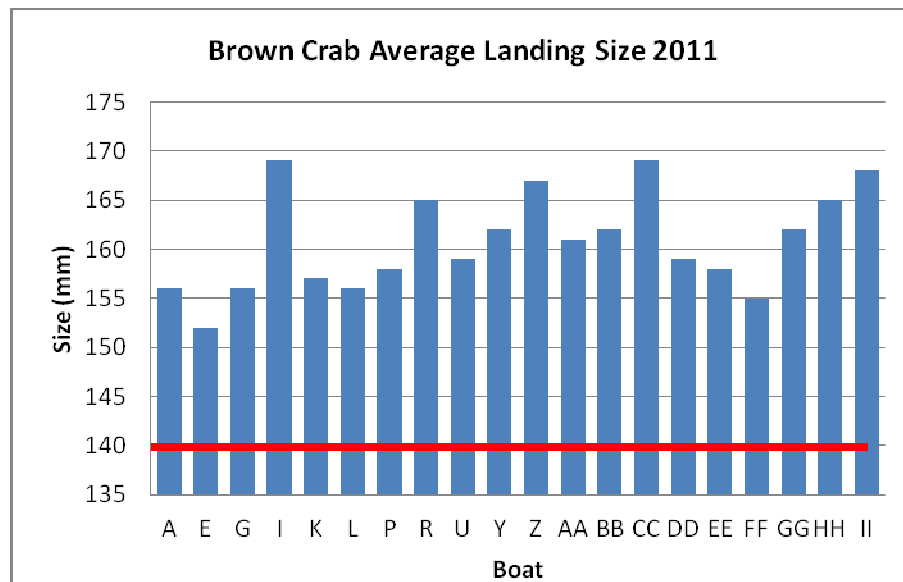


Figure 5:
Inshore brown
crab average
landing size
2010

**Figure 6: Inshore average brown
crab landing size 2011**



**Figure 7: Velvet
crab average
landing size 2011**

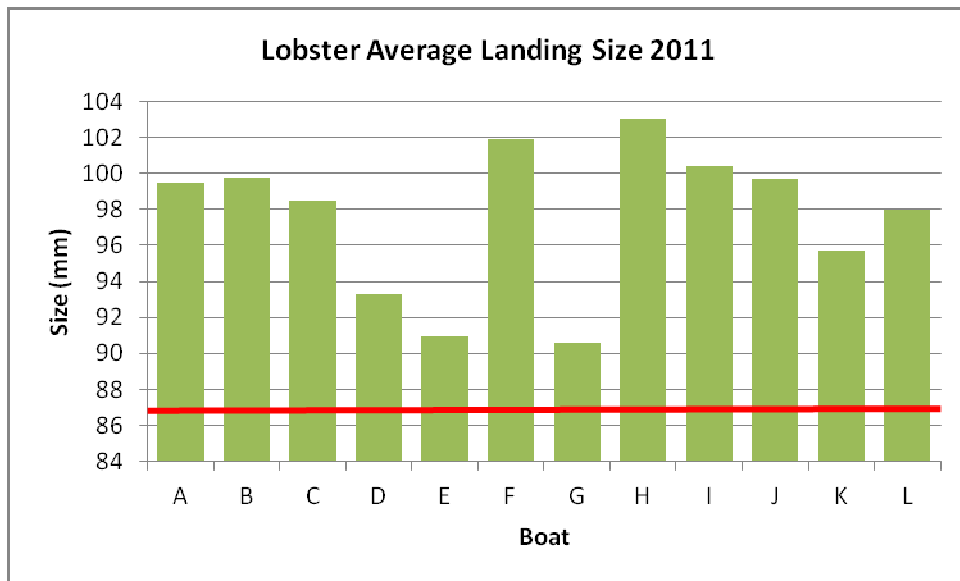


Figure 8:
Lobster average
landing size 2011

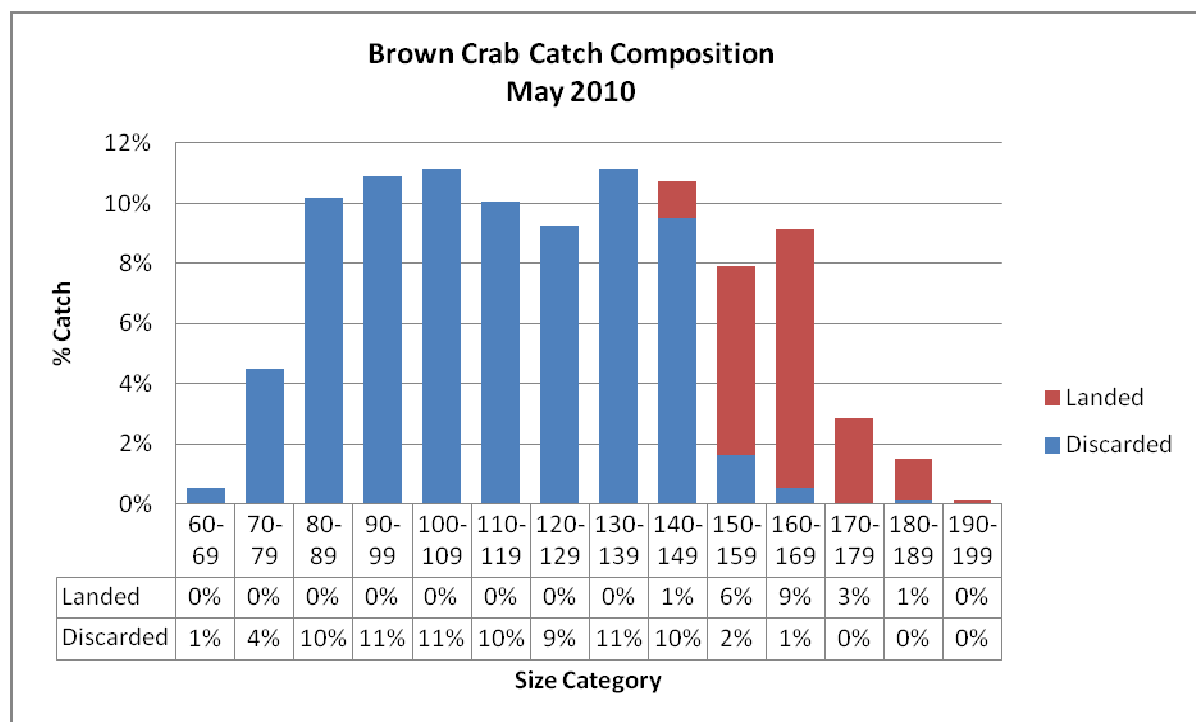


Figure 9: Brown crab catch composition (May 2010 sample trip)

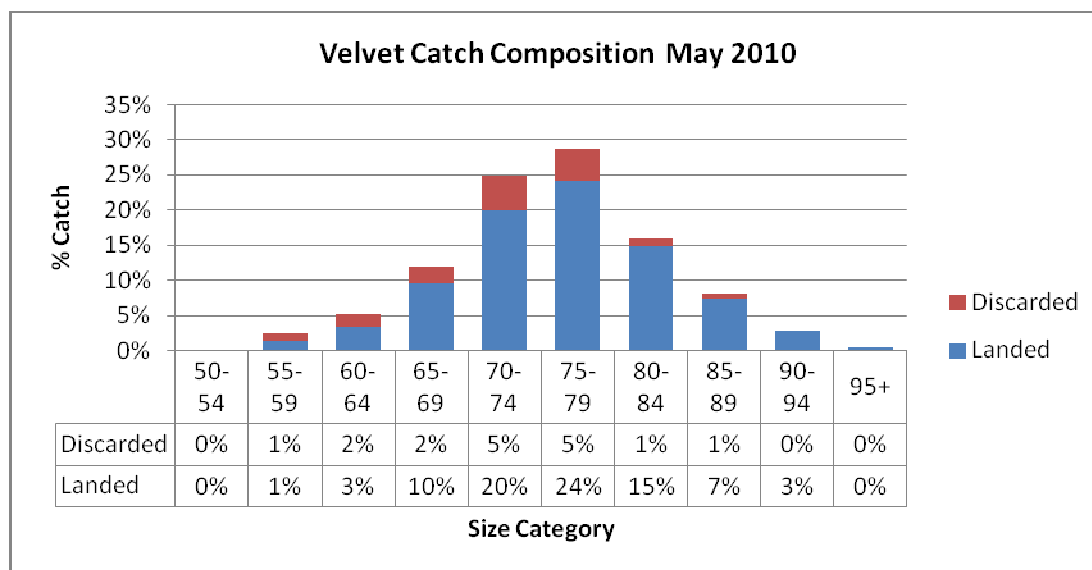


Figure 10: Velvet crab catch composition (May 2010 sample trip)

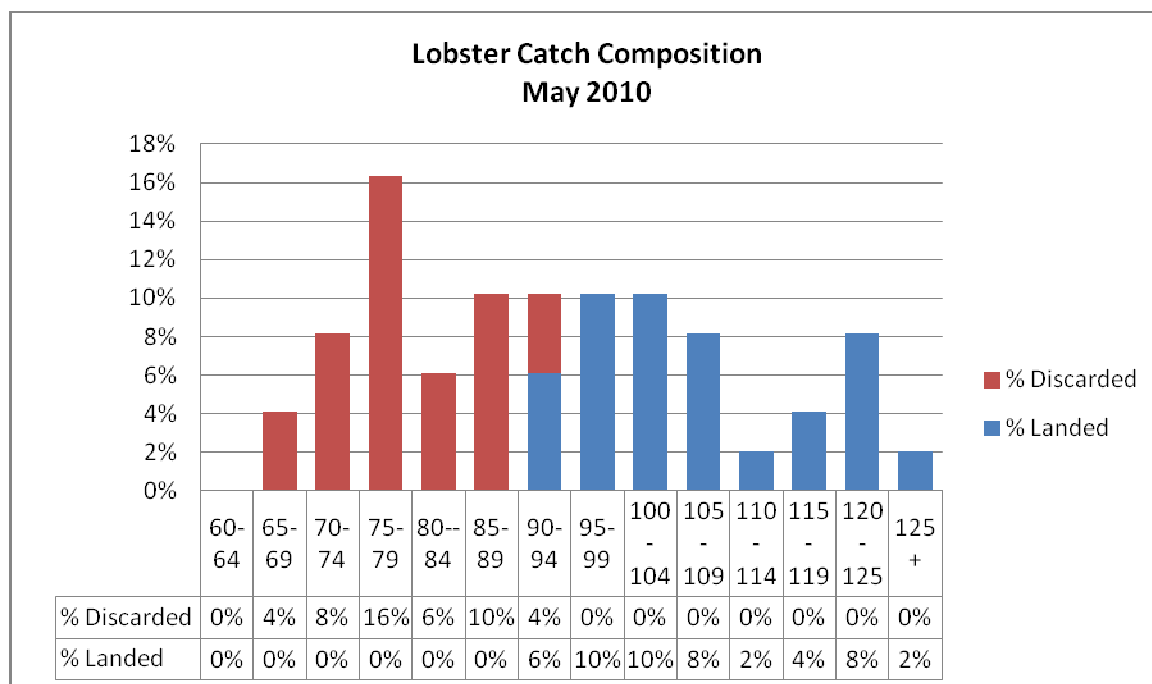


Figure 11: Lobster catch composition (May 2010 sample trip)

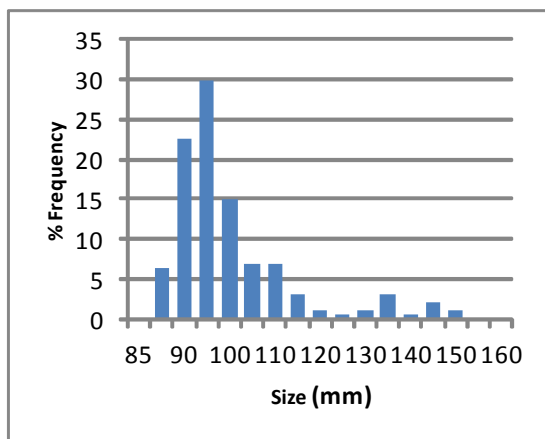


Figure 12: Male lobster length frequency distribution landed 2010

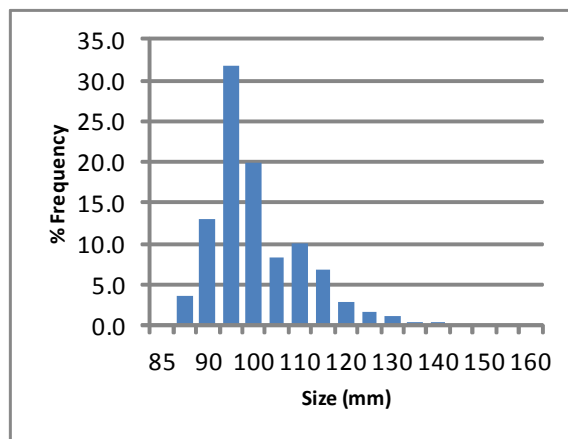


Figure 13: Male lobster length frequency distribution landed 2011

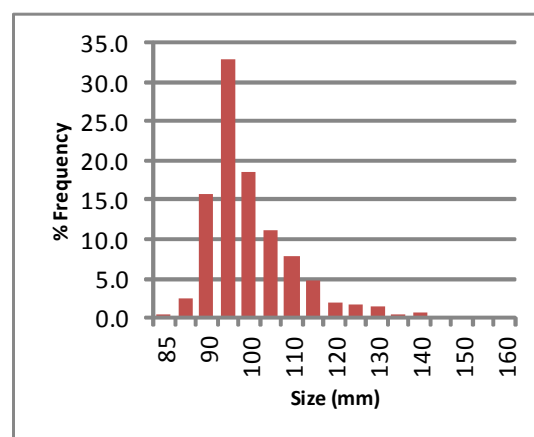
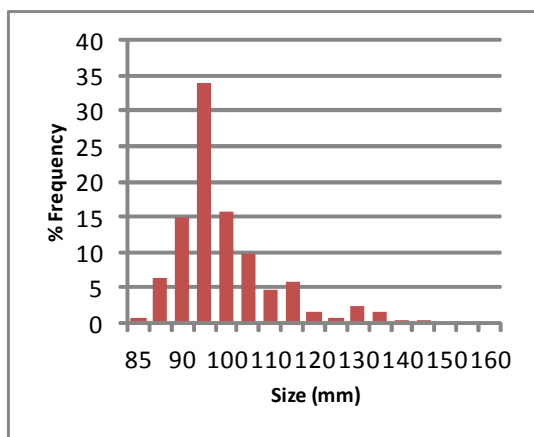


Figure 15: Female lobster length frequency distribution landed 2011

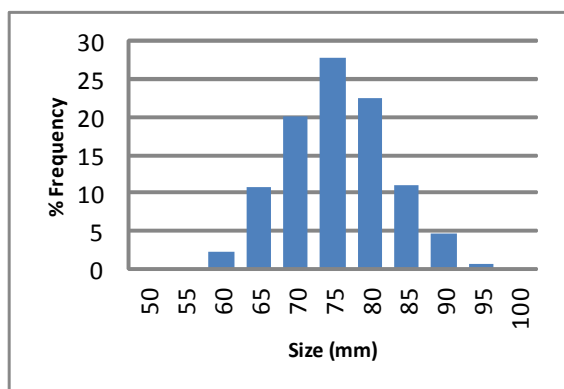


Figure 16: Male velvet crab length frequency distribution landed 2010

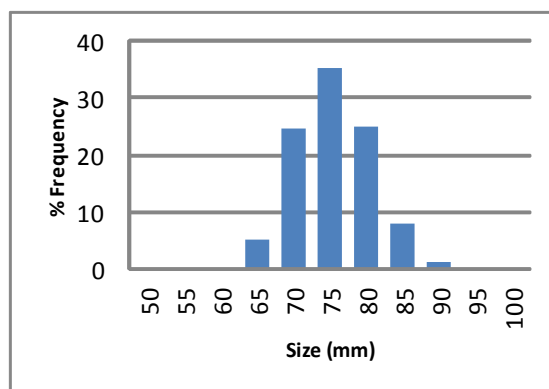


Figure 17: Male velvet crab length frequency distribution landed 2011

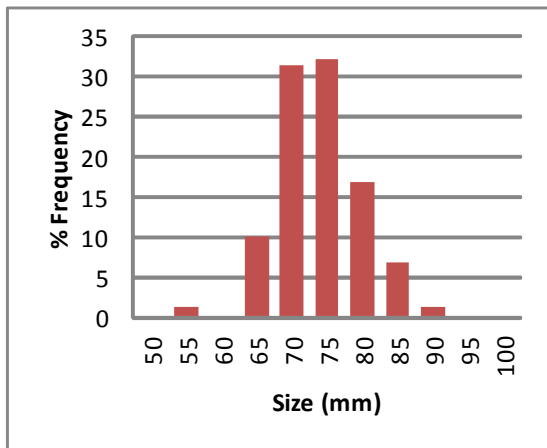


Figure 17: Female velvet crab length frequency distribution landed 2010

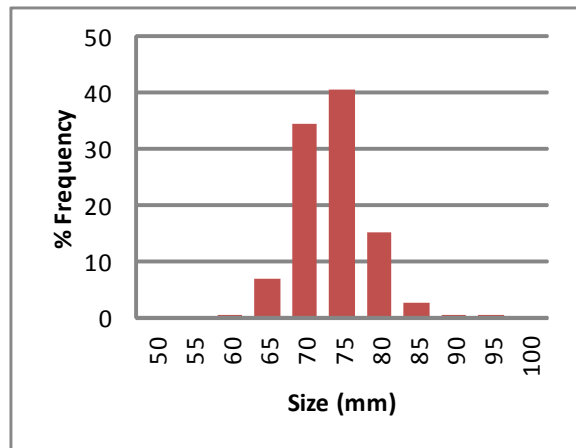


Figure 18: Female velvet crab length frequency distribution landed 2011

Figure 12: Screenshot of Orkney Sustainable Fisheries website



Orkney Sustainable Fisheries

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Orkney Sustainable Fisheries

Orkney Sustainable Fisheries was established as a Company Ltd by Guarantee in 2006 with the aim of taking over the running of the successful Orkney Lobster hatchery. OSF is industry lead with the company board represented by local fishermen, merchants and processor together with the common aim to take forward various initiatives relating to the sustainability of the local shellfisheries.



Sarah Lamb has been appointed as full-time Co-ordinator for the group and is taking forward a number of research initiatives. With support from the European Fisheries Fund and Orkney Islands Council Sarah's key projects involve tagging and releasing brown crabs around the Orkney Islands, carrying out length cohort analysis on the main shellfish species, and investigating methods for determining and recording release and return of undersize shellfish and by catch species. The aim is to tag up to 30,000 crabs over 2 seasons and to record seasonal migrations, both within the islands and from off-shore areas.

Further work is planned on monitoring and recording releases from the lobster hatchery while a joint project (2010/2011) with the European Marine Energy Centre (EMEC) will examine the effects of marine energy devices on crustacean fisheries and the impacts of hatchery juvenile lobsters being released into waters where such devices are being tested.

News

Hatching Lobsters

To understand the process in hatching lobsters and the stages of growth visit the 'Hatching Lobsters' page.
[Read more](#)

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