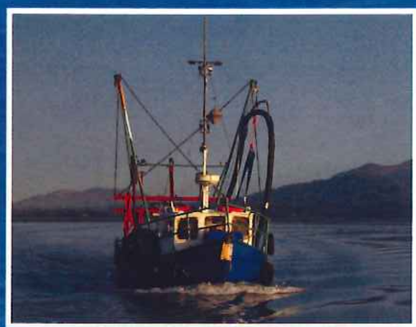
Shellfish Stocks and Fisheries Review

December 2012






BIM
Bord Iascaigh Mhara
Irish Sea Fisheries Board

Marine Institute
Foras na Mara

Shellfish Stocks and Fisheries

Review 2012

An assessment of selected stocks

The Marine Institute and Bord Iascaigh Mhara

Bord Iascaigh Mhara
Irish Sea Fisheries Board

Marine Institute
Foras na Mara

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Photographs on cover by J. White (Lobster), I. Lawlor (Scallop dredge), S. Clarke (Cockle Boat), E. Fahy (Stern of fishing boats and Brown Crab) and D. Walsh (Lobster in fishbox)

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1 Introduction

This review presents information on the status of selected shellfish stocks in Ireland. In addition, data on the fleet (<13 m) and landings for all species of shellfish (excluding *Nephrops* and mussels) are presented. The intention of this annual review is to present stock assessment and scientific advice for shellfisheries which may be subject to new management proposals or where scientific advice is required in relation to assessing the environmental impact of shellfisheries especially in conservation areas designated under European Directives. The review reflects the recent work of the Marine Institute (MI) and An Bord Iascaigh Mhara (BIM) in the biological and economic assessment of shellfish fisheries.

The information and advice presented here for shellfish is complementary to that presented in the MI Stock Book on demersal and pelagic fisheries. Separate treatment of shellfish is warranted as their biology and distribution, the assessment methods that can be applied to them and the system under which they are managed, all differ substantially to demersal and pelagic stocks.

Shellfish stocks are not generally assessed by The International Council for the Exploration of the Sea (ICES) (with the exception of crab and scallop) and although they come under the competency of the Common Fisheries Policy they are generally not regulated by TAC and in the main, and other than crab and scallop, are distributed inside the national 12 nm territorial limit. Management of these fisheries, by the Department of Agriculture, Food and Marine (DAFM), is based mainly on minimum landing sizes and generally, but with exception, there are no input or output controls. A co-operative management framework introduced by the Governing Department and BIM in 2005 (Anon 2005) is now in abeyance and management proposals developed by the various advisory groups during the period 2005-2008 have not been implemented. Management of oyster fisheries is the responsibility of The Department of Communications, Energy and Natural Resources (DCENR) implemented through Inland Fisheries Ireland (IFI). In many cases, however, management responsibility for oysters is devolved through Fishery Orders or 10 year Aquaculture licences to local co-operatives.

The main customers for this review are DAFM, DCENR, IFI and the fishing industry and its representative organisations.

2 Shellfish Fleet

The Irish fishing fleet is, for the purpose of licensing, divided into a number of segments. Vessels in the polyvalent segment, which contains the majority of vessels, have general access to all stocks although access to a number of stocks may be further restricted and require a specific authorisation. Vessels in the specific segment can only fish for bivalves while vessels in the potting segment can only fish with pots. All vessels in the aquaculture and specific segments target bivalves and vary from small oyster dredgers working inshore to offshore seed mussel and scallop dredgers.

Practically all vessels <13 m in length in the polyvalent segment, target shellfish. In 2012 there were 39 polyvalent vessels between 13-15 m. Although some of these may fish for shellfish they are more likely to trawl for finfish. Polyvalent vessels over 15 m, other than crab vivier vessels, target finfish. Polyvalent potting vessels, by definition as they can only fish with pots, can only target crustaceans and whelk and are all less than 12 m in length and less than 20Gt in capacity. These gear and size restrictions were conditions of incorporating these vessels into the registered fleet in the period 2004-2007.

The shellfish fleet, as defined above, numbered 1,981 vessels as indicated on the National Register of Sea Fishing Vessels on December 2012 (Table 1). In addition 3 polyvalent vessels over 18 m in length fish for crab offshore. An unknown number of vessels registered in Northern Ireland (on the UK fleet register) and not included in Table 1, also fish shellfish stocks in Irish territorial waters.

The number of vessels in the Shellfish fleet increased by 64% between 2006 and 2012. This was predominantly due to regularisation of the potting fleet which were operating outside of the registered fleet prior to 2006 and to the registration of existing vessels operating dredges in fishery order and aquaculture licensed areas. The number of vessels in the Aquaculture and Polyvalent segments have increased year on year since 2006 (Table 1). The number of vessels in the polyvalent potting segment is declining slowly, due to de-registration or transfer from this restricted segment, which limits fishing entitlement, to the polyvalent general segment. The specific segment has fluctuated; following significant increases in 2007-2009 the numbers of vessels declined in 2009-2011. This segment increased by three vessels in 2012.

The average length and capacity of vessels in the specific and aquaculture segments declined between 2006 and 2012. There has also been a general decline in the length and capacity of vessels in the polyvalent segment.

Polyvalent potting vessels have higher engine capacities in proportion to their gross tonnage than polyvalent general vessels (Table 1). Aquaculture and specific vessels have lower engine capacities compared to polyvalent or potting vessels.

Table 1. Length and capacity profile of the Irish Shellfish fleet 2006-2012 (<13 m polyvalent, all polyvalent potting, all vessels in bi-valve segment, all aquaculture vessels). Three >18 m crab vivier vessels not included.

Segment	2006	2007	2008	2009	2010	2011	2012
Aquaculture	16	21	39	73	86	96	104
Polyvalent General <13m	953	950	994	1131	1198	1257	1269
Polyvalent Potting <13m	80	492	490	481	467	461	460
Specific (bi-valve)	157	117	128	154	150	145	148
Grand Total	1206	1580	1651	1839	1901	1959	1981
Average length of vessels							
Aquaculture	31.62	30.00	21.51	14.75	13.33	12.78	12.46
Polyvalent General	7.95	7.89	7.82	7.67	7.57	7.63	7.51
Polyvalent Potting	7.32	6.74	6.76	6.71	6.67	6.64	6.62
Specific (bi-valve)	14.70	13.40	13.22	12.09	12.06	11.71	11.58
Average Gross Tonnage of vessels							
Aquaculture	212.05	197.86	117.30	64.18	54.12	48.87	45.64
Polyvalent General	4.68	4.61	4.38	4.14	3.96	4.30	3.85
Polyvalent Potting	2.96	2.28	2.30	2.22	2.16	2.12	2.10
Specific (bi-valve)	38.62	27.34	25.93	20.54	20.29	18.55	18.25
Average kilowattage of vessels							
Aquaculture	468.55	433.79	284.45	166.11	142.51	132.04	126.74
Polyvalent General	35.49	36.46	34.05	31.77	30.43	31.73	29.79
Polyvalent Potting	44.50	29.60	30.29	29.70	28.93	28.28	28.03
Specific (bi-valve)	162.81	124.53	113.26	96.36	94.26	90.32	90.28
Kilowatts per GT							
Aquaculture	2.21	2.19	2.42	2.59	2.63	2.70	2.78
Polyvalent General	7.58	7.91	7.77	7.68	7.69	7.38	7.73
Polyvalent Potting	15.03	12.99	13.20	13.39	13.41	13.32	13.35
Specific (bi-valve)	4.22	4.56	4.37	4.69	4.65	4.87	4.95

Table 2. Annual percentage change in numbers of vessels per fleet segment in the Shellfish fleet 2006-2012.

Fleet Segment	2006	2006-2007	2007-2008	2008-2009	2009-2010	2010-2011	2011-2012
Aquaculture	16	5	18	34	13	10	8
Polyvalent General	953	-3	44	137	67	59	12
Polyvalent Potting	80	412	-2	-9	-14	-6	-1
Specific	157	-40	11	26	-4	-5	3

3 Landings 2004-2012

Annual landings of crustaceans and bivalves, excluding *Nephrops* and wild blue mussel (*Mytilus*) seed, which is re-laid for on-growing, during the period 2004-2012, varied from 29,533 tonnes in 2004 to approximately 14,000 tonnes in 2008. The main decline in volume occurred in edible crab and whelk. Landings of scallop declined from a high in 2004 to a low in 2006 but recovered during 2007-2012 due to increased fishing activity in the eastern Celtic Sea and southern Irish Sea. Lobster landings declined from a high of 856 tonnes in 2004 to 249 tonnes in 2012 but recovered to 430-490 tonnes in 2008-2010 (Table 3). Edible crab and king scallop are generally the most valuable species. The value of crustacean and bivalve fisheries (excluding *Nephrops* and mussels) was €42.4m in 2012.

Landings data for some species (lobster, periwinkle) in recent years show unexplained changes in volumes relative to say 2004 levels. Spider crab in 2012 was substantially higher than in any previous years. Brown crab landings in 2012 were less than half of their value in 2004. Lobster landings in 2012 were approximately 30% of 2011 landings. Although landings can obviously increase or decline due to changes in effort or catch rates the scale of change in some species, the fisheries for which are known to have stable or increasing effort and where catch rate indicators are stable, is contradictory. Other sources of information from industry questionnaires also indicate significant differences between official landings and landings derived from estimates of catch rates, annual individual vessel landings, days at sea and individual vessel fishing effort. There is also poor correspondence between sales note data and landings reported in EU logs combined with estimates for under 10 m vessels which do not report catch and effort.

A number of species such as lobster, periwinkle, native oyster and shrimp are targeted by vessels under 10 m in length. As these vessels do not report landings capturing these data is difficult due to the large number of vessels and the small daily consignments involved (which may also be derogated from recording in first point of sale notes). Improved tracking of landings by vessels under 10 m would significantly improve data on total landings for a number of species and give a more accurate picture of the economic value of the shellfisheries sector.

Table 3. Estimates of annual landings (tonnes) and value (€) of crustacean and bivalve shellfish (excl. prawns and mussels) into Ireland 2004-2012 (source: SFPA, logbooks). Unit value (per kilo) is from 2012 sales note data or other sources. 2010 and 2011 *Spisula* landings are from BIM logbook data for Waterford only.

Scientific Name	Common name	2004	2005	2006	2007	2008	2009	2010	2011	2012	Unit Price	Value 2012
Cancer pagurus	Edible crab	14,217	9,527	10,827	9,251	7,640	6,614	8,622	6,372	6,691	€1.49	€9,969,590
Pecten maximus	King Scallop	2,471	1,277	742	953	1,322	1,207	1,982	2476	2,703	€5.90	€15,947,700
Homarus gammarus	Lobster	856	635	625	308	498	431	477	735	249	€12.72	€3,167,280
Littorina littorea	Periwinkle	1,674	1,139	1,210	609	1,141	1,103	1,280	64	103	€2.04	€210,120
Buccinum undatum	Whelk	7,589	4,151	3,144	3,635	1,947	2,239	2,976	2,828	3,440	€1.20	€4,128,000
Palaemon serratus	Shrimp	405	151	319	325	180	228	135	111	152	€16.43	€2,497,360
Ostrea edulis	Native oyster	543	94	233	291	88	327	349	100	*100*	*€4.50*	€450,000
Aequipecten opercularis	Queen scallop	110	75	172	26	4		748	1,002	1,479	€1.70	€2,514,300
Necora puber	Velvet crab	291	245	281	142	268	205	342	160	168	€1.99	€334,320
Spisula	Surf clam	28		26	14	55	150	*162*	*73*	15	€3.00	€45,000
Maja brachydactyla	Spider crab	180	141	153	70	153	443	415	290	818	€1.08	€883,440
Palinurus elephas	Crayfish	80	30	34	16	18	28	30	25	33	€35.00	€1,155,000
Ensis	Razor clams	400	404	547	356	451	293	131	598	118	€2.64	€311,520
Chaceon affinis	Red crab	214	294	152	83	44	105	91	106	0	€1.08	€0
Carcinus maenas	Shore crab	268	27	46	91	72	244	129	74	253	€0.62	€156,860
Cerastoderma edule	Cockle	207	107	7	643	9	173	5	401	400	€1.70	€680,000
Veneridae	Venus clam		217	4								€0
Total		**29,533**	**18,514**	**18,522**	**16,813**	**13,890**	**13,790**	**17,874**	**15,415**	**16,722**		**€42,450,490**

4 Economic performance of inshore vessels

The Sentinel Vessel Programme (SVP), operating as a pilot project under the Data Collection Framework (DCF) provides 3 main sets of data; catch and effort data (equivalent to the transversal data required under the data collection framework), biological data (fish measurements) and economic data on capital and operating costs and annual landings and earnings.

Data presented here is based on verified economic data from the 2010 to 2012 SV programme. Provisional data for 2012 is presented but consists of only 45 logbooks out of 86 vessels for 2012. Whereas the majority of these vessels are under 10 m LOA a small number of 10-12 m LOA vessels are included (Figure 1, Table 4).

Given the incomplete data set, summary economic data for 2012 is presented rather than comprehensively analysed.

In 2010 the SVP underwent a review which resulted in a new logbook and the addition of several parameters to the economic survey. Data prior to 2010 has been excluded from the following analysis as this needs to be reanalysed to harmonise it with the data collected under the new data collection scheme.

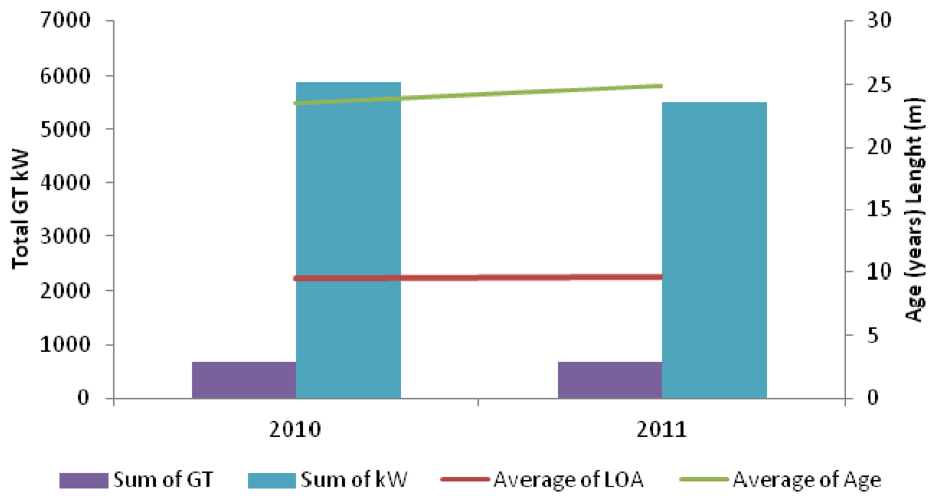


Figure 1. **Summary of vessels sampled in 2010 (n=89) and 2011 (n=82) with total GT and total kW and average LOA and age.**

Table 4. **Summary of sampled vessels by segment and year**

Segment	n	Average of LOA	Total GT	Total kW	Mean Age
VI Crustacean Potter					
2010	15	10	148	965	32
2011	12	10	129	699	36
VII Crustacean Potter					
2010	47	9	290	2,644	23
2011	41	9	270	2,385	24
VIIa Mollusc Dredger					
2010	12	10	102	935	23
2011	14	10	128	1,080	23
VIIa Mollusc Potter					
2010	8	10	58	656	19

2011	7	10	51	564	23
VIIf-k Gillnetter					
2010	7	11	81	680	17
2011	8	11	94	786	21

4.1 Annual Gross Earnings

The annual gross earnings per vessel is the combined value of the catch of all species reported, calculated as follows;

> Annual gross earnings = [the sum of the total volume of all landings by species] * [the average unit price by species].

Some of the shellfish vessels also land small quantities of finfish. These earnings have been reported together with shellfish.

Total earnings from shellfish vary from €35,000 for vessels primarily targeting cockles to over €105,000 for vessels primarily targeting brown crab (Table 5). Earnings per vessel, within fishery, or any aggregation, were highly variable.

Table 5. Annual average gross earnings per vessel in the main shellfish fisheries in 2010-2012 and the percentage and direction of changes in profits from 2010-2011.

Target Species	2010	2011	Provisional 2012 Data	%Δ 2010-2011	
Brown Crab	€166,450.44	€105,875.00	€120,057.58	-36%	↘
Cockles	-	€35,202.77	-	-	-
Lobster	€58,474.26	€45,705.80	€48,550.76	-22%	↘
Razor Clams	€73,102.76	€140,821.04	€88,717.60	93%	↗
Shrimp	€18,676.46	-	-	-	-
Spider Crab	€22,499.46	€39,815.34	€39,406.84	77%	↗
Velvet Crab	€17,056.46	-	-	-	-
Whelk	€98,603.30	€132,985.09	€387,103.98*	35%	↗
Whitefish	€279,346.52	€173,406.84	-	-38%	↘

4.2 Annual operating costs and cost earnings ratio

Variability in annual costs within each fishery is also very high. Bait, fuel, gear replacement and vessel maintenance are significant costs to all fisheries. Some vessels do not report certain expenditure variables. This is problematic in that it is unknown if this non-reporting represents a value of zero or that this variable is not a cost factor for that vessel. It is assumed that the non-reporting of a particular variable represents a zero value for that variable.

Annual net earnings, including payment for partaking in the sentinel programme and lobster v-notching have remained relatively stable for most sectors. The dramatic increase in both total income and subsequently gross profit for VIIa Mollusc Potters in 2012 is considered to be a result of the low numbers included in the 2012 samples. Unit price of whelk also increased. This is compounded by high landings of shrimp for one vessel that increases the average landing income by as much as €310,400. In the absence of this outlier, the total average income is €96,600, which is more in line with previous years.

Table 6. ***Average income and total cost for 2010 and 2011 (provisional data for 2012) by geographic (ICES Area) segmentation. Area VI is essentially Donegal coast, VIIa is Irish Sea, VIIf-k is south, south west and west coasts. * Includes an outlying value for 1 vessel***

Average of Total Income	**2010**	**2011**	**2012**	**%Δ 2010-2011**	
VI Crustacean Potter	€60,979.89	€54,280.23	€79,147.04	-11%	↘
VII Crustacean Potter	€92,766.22	€74,548.32	€83,998.01	-20%	↘
VIIa Mollusc Dredger	€72,250.42	€110,692.42	€72,316.21	53%	↘
VIIa Mollusc Potter	€86,277.47	€117,051.83	***€408,200.96****	36%	↗
VIIf-k Gillnetter	€188,384.01	€121,687.96	€74,987.31	-35%	↘
Average of Total Costs					
VI Crustacean Potter	€24,365.79	€20,751.85	€11,059.30	-15%	↘
VII Crustacean Potter	€19,695.59	€25,483.13	€30,669.22	29%	↗
VIIa Mollusc Dredger	€26,652.50	€31,604.83	€25,496.25	19%	↗
VIIa Mollusc Potter	€31,390.48	€18,801.30	€22,295.45	-40%	↘
VIIf-k Gillnetter	€50,036.15	€41,184.79	€36,873.29	-18%	↘
Average of Gross Profit					
VI Crustacean Potter	€36,614.10	€33,528.38	€68,087.74	-8%	↘
VII Crustacean Potter	€73,070.64	€49,065.19	€53,328.79	-33%	↘
VIIa Mollusc Dredger	€45,597.92	€79,087.60	€46,819.96	73%	↗
VIIa Mollusc Potter	€54,886.99	€98,250.53	€385,905.51	79%	↗
VIIf-k Gillnetter	€138,347.86	€80,503.17	€38,114.02	-42%	↘

4.3 Cost Structure

Cost structures have been broken down by vessel segment and target species (Table 7, Table 8, Table 9). Vessel segments and target species is allocated using dominance criteria, where each vessel is allocated to a segment and target species based on: the number of fishing days used with each gear and the amount of landings by species. If a fishing gear is used by more than the sum of all the others or a species is landed more than the sum of all the others (i.e. a vessel spends more than 50% of its fishing time using that gear or lands 50% or more of one species) the vessel is allocated to that segment and target species. In the small number of cases where the activity, or target species, of a vessel does not constitute 50% or more of the activity, vessel segment and target species are assigned to the highest records for gear usage and landed species of that vessel.

All data, within years, was used for the cost structure. The figures given are averages for all costs within each segment/target species and have been calculated to give an impression of the average cost structures for each category. This results in a generalized picture of costs as variability within each of these categories can be high.

Fuel costs appear to be low as a percentage of total income. This may indeed be the case as many of the target species such as lobster and shrimp receive high prices, resulting in higher than average landing income in respect of fishing effort. However, there is a large amount of variation in fuel costs and there is little correlation between fuel costs and days at sea. To gauge what is driving fuel costs more accurately, estimates of effort, in terms of steaming and fishing times will be needed to improve the resolution of the days at sea data.

At present, gear soak times are collected but not in sufficient and detailed quantity and quality to make accurate calculations of fishing effort (in terms of fuel consumption and vessel activity). Fuel costs for dredgers are higher than other segments and are lower for potters. This would be expected as dredgers have higher fuel consumption rates in comparison with vessels using passive gears.

All target species demonstrate similar cost structures although there are some discrepancies with fuel costs, which are not what would be expected. Total cost as a percentage of total income is above 70% for the majority of species. However, there is one outlier in 2010 for shrimp. This may be the result of an as yet unknown data issue regarding these vessels compounded by the high landings value of this species, which effectively decreases the total costs percentage of total income.

Crew wage as a percentage of total income is high for all target species. Crew wages are rarely specified in surveys, however, and as a result, for most vessels, crew wage has been imputed using total landing income and average crew wage. In reality, crew wage calculated in this manner only represents the total income remaining after all other costs have been removed divided by the number of engaged crew. This assumes that there are no other costs other than those reported and that crew members are given the same crew share. It also does not take into account money that may be reinvested into the vessel.

4.4 Employment

Total fisheries employment in 2011 was estimated at 4,714 jobs, corresponding to 3,168 FTEs. The level of employment increased between 2010 and 2011, with total employed increasing by 7% and the number of FTEs increasing by 12% over the period. The major factors for this increase are due, in part, to the introduction of more vessels in the small scale fisheries. This increase in employment in the small scale fleet is estimated at 31%, from 2010 to 2011, rising from 1,000 to 1,311, which can be explained by the corresponding increase in vessel numbers. The reduction in average wage per FTE for the small scale fleet is not a realistic trend. Wage data for the small scale fishery for 2011 was sparse and total estimates are probably not indicative of the real figure as explained previously.

Table 7. Cost structure by target species and year.

2010													
Target Species	**Landing Value**	**Total Income**	**Crew Wage**	**Repairs**	**Fuel and Oil**	**Fees**	**Insurance**	**Loans**	**Transport/ Travel**	**Ice**	**Bait**	**Other Costs**	**Total Costs**	**Gross Profit**
Brown Crab	€166,450.44	€167,863.97	€103,768.46	€7,309.53	€10,295.03	€3,960.44	€3,812.56	€10,989.00	€3,166.76	€275.07	€4,514.25	€3,028.41	€144,053.27	€23,810.70
Crayfish	€17,250.25	€18,250.25	€0.00	€500.00	€14,000.00	€50.00	€1,263.00		€400.00		€0.00	€530.00	€16,743.00	€1,507.25
Lobster	€58,474.26	€60,001.82	€19,190.43	€1,476.44	€5,523.03	€805.23	€2,303.54	€6,746.00	€1,122.54	€403.33	€1,465.25	€1,177.09	€35,132.09	€24,869.74
Razor Clams	€73,102.76	€74,102.76	€40,444.51	€3,900.00	€7,837.17	€3,967.67	€3,908.67	€8,224.83	€2,552.42	€156.67	€698.89	€2,289.33	€67,621.18	€6,481.58
Scallop	€147,447.91	€152,097.91	€10,000.00	€2,000.00	€12,450.00	€17,570.00	€2,700.00	€2,000.00	€1,600.00			€700.00	€49,020.00	€103,077.91
Shrimp	€18,676.46	€19,743.12	€433.33	€400.00	€353.33	€151.67	€143.50	€0.00	€700.00	€0.00	€696.00	€313.33	€2,911.33	€16,831.79
Spider Crab	€22,499.46	€23,632.80	€10,330.35	€783.33	€1,363.33	€476.67	€2,250.00	€0.00	€557.33		€1,465.00	€474.00	€16,461.69	€7,171.11
Velvet Crab	€17,056.46	€18,211.46	€0.00	€200.00	€895.00	€398.00			€82.50		€2,108.00	€567.50	€3,197.00	€15,014.46
Whelk	€98,603.30	€99,818.30	€44,395.77	€5,639.90	€7,746.10	€1,912.90	€2,881.07	€10,614.71	€2,545.40	€0.00	€7,677.19	€1,787.20	€78,728.35	€21,089.94
Whitefish	€279,346.52	€280,346.52	€140,665.70	€5,000.00	€19,443.33	€3,503.33	€4,200.00	€37,973.60	€4,733.33	€2,560.00	€2,312.71	€4,866.79	€211,747.61	€68,598.91
Cost Profile														
Brown Crab	99%	100%	62%	4%	6%	2%	2%	7%	2%	0%	3%	2%	86%	14%
Crayfish	95%	100%	0%	3%	77%	0%	7%	0%	2%	0%	0%	3%	92%	8%
Lobster	97%	100%	32%	2%	9%	1%	4%	11%	2%	1%	2%	2%	59%	41%
Razor Clams	99%	100%	55%	5%	11%	5%	5%	11%	3%	0%	1%	3%	91%	9%
Scallop	97%	100%	7%	1%	8%	12%	2%	1%	1%	0%	0%	0%	32%	68%
Shrimp	95%	100%	2%	2%	2%	1%	1%	0%	4%	0%	4%	2%	15%	85%
Spider Crab	95%	100%	44%	3%	6%	2%	10%	0%	2%	0%	6%	2%	70%	30%
Velvet Crab	94%	100%	0%	1%	5%	2%	0%	0%	0%	0%	12%	3%	18%	82%
Whelk	99%	100%	44%	6%	8%	2%	3%	11%	3%	0%	8%	2%	79%	21%
Whitefish	100%	100%	50%	2%	7%	1%	1%	14%	2%	1%	1%	2%	76%	24%

Table 8. Cost structure by species, 2011.

2011														
Target Species	Landing Value	Total Income	Crew Wage	Repairs	Fuel and Oil	Fees	Insurance	Loans	Transport/ Travel	Ice	Bait	Other Costs	Total Costs	Gross Profit
Brown Crab	€105,875.00	€107,403.68	€35,244.61	€5,645.02	€10,321.33	€2,040.14	€5,724.79	€7,819.05	€1,896.53	€72.22	€4,692.37	€2,681.71	€74,360.26	€33,043.42
Cockles	€35,202.77	€36,202.77	€9,738.40	€3,176.00	€6,234.90	€2,366.00	€360.00	€3,330.00	€904.00	€0.00	€0.00	€1,552.00	€27,661.30	€8,541.47
Crayfish	€17,868.99	€18,868.99	€4,000.00	€1,700.00	€4,950.00	€400.00	€1,300.00	€0.00	€0.00	€0.00	€320.00	€1,100.00	€14,870.00	-€30,901.01
Lobster	€45,705.80	€47,108.02	€18,571.25	€1,679.07	€4,243.97	€769.04	€1,384.32	€2,576.96	€1,277.29	€60.38	€1,670.25	€1,507.14	€33,583.69	€13,524.33
Razor Clams	€140,821.04	€141,821.04	€84,267.79	€4,028.75	€13,905.05	€2,094.63	€2,186.14	€6,712.00	€2,646.50	€70.83	€0.00	€2,690.00	€117,471.71	€24,349.33
Spider Crab	€39,815.34	€41,038.18	€11,633.81	€1,050.00	€4,745.99	€603.33	€1,466.67	€3,633.33	€1,098.00	€995.00	€1,176.00	€751.67	€27,153.80	€13,884.38
Whelk	€132,985.09	€134,913.66	€59,207.62	€5,514.33	€6,774.14	€1,672.86	€2,423.86	€1,971.43	€3,561.71	€0.00	€7,767.52	€2,012.57	€89,008.64	€45,905.02
Whitefish	€173,406.84	€174,406.84	€84,357.99	€10,727.93	€19,327.19	€3,622.88	€3,787.50	€14,569.07	€2,791.63	€2,098.63	€330.00	€3,917.87	€138,599.27	€35,807.57
Cost Profile														
Brown Crab	99%	100%	33%	5%	10%	2%	5%	7%	2%	0%	4%	2%	69%	31%
Cockles	97%	100%	27%	9%	17%	7%	1%	9%	2%	0%	0%	4%	76%	24%
Crayfish	95%	100%	21%	9%	26%	2%	7%	0%	0%	0%	2%	6%	79%	-164%
Lobster	97%	100%	39%	4%	9%	2%	3%	5%	3%	0%	4%	3%	71%	29%
Razor Clams	99%	100%	59%	3%	10%	1%	2%	5%	2%	0%	0%	2%	83%	17%
Spider Crab	97%	100%	28%	3%	12%	1%	4%	9%	3%	2%	3%	2%	66%	34%
Whelk	99%	100%	44%	4%	5%	1%	2%	1%	3%	0%	6%	1%	66%	34%
Whitefish	99%	100%	48%	6%	11%	2%	2%	8%	2%	1%	0%	2%	79%	21%

Table 9. Cost structure by year and geographic segment.

2010													
Target Species	**Landing Value**	**Total Income**	**Crew Wage**	**Repairs**	**Fuel and Oil**	**Fees**	**Insurance**	**Loans**	**Transport/ Travel**	**Ice**	**Bait**	**Other Costs**	**Total Costs**	**Gross Profit**
VI Crustacean Potter	€56,031.00	€57,114.33	€25,438.19	€1,530.56	€5,955.72	€1,478.33	€2,088.33	€5,700.00	€711.11	€0.00	€5,781.77	€1,883.44	€48,015.96	€9,098.37
VII Crustacean Potter	€72,904.13	€74,548.32	€24,282.18	€4,249.32	€6,966.42	€1,082.86	€3,483.00	€4,224.45	€1,538.88	€146.18	€2,364.12	€1,899.60	€49,853.06	€24,695.26
VIIa Mollusc Dredger	€110,312.62	€111,312.62	€56,075.96	€5,038.84	€11,707.61	€2,327.04	€1,607.92	€6,648.77	€2,194.18	€210.98	€0.00	€2,489.39	€87,680.79	€23,631.84
VIIa Mollusc Potter	€116,051.83	€117,051.83	€59,564.11	€2,100.67	€5,163.85	€1,646.92	€2,370.29	€3,742.86	€2,623.38	€0.00	€7,139.88	€1,142.86	€85,194.72	€31,857.12
VIIf-k Gillnetter	€120,273.83	€121,687.96	€53,584.90	€3,618.57	€13,328.61	€3,075.38	€3,562.50	€6,329.60	€3,281.25	€641.31	€1,289.17	€3,671.25	€90,874.06	€30,813.90
Cost Profile														
VI Crustacean Potter	98%	100%	45%	3%	10%	3%	4%	10%	1%	0%	10%	3%	84%	16%
VII Crustacean Potter	98%	100%	33%	6%	9%	1%	5%	6%	2%	0%	3%	3%	67%	33%
VIIa Mollusc Dredger	99%	100%	50%	5%	11%	2%	1%	6%	2%	0%	0%	2%	79%	21%
VIIa Mollusc Potter	99%	100%	51%	2%	4%	1%	2%	3%	2%	0%	6%	1%	73%	27%
VIIf-k Gillnetter	99%	100%	44%	3%	11%	3%	3%	5%	3%	1%	1%	3%	75%	25%
2011														
VI Crustacean Potter	€105,875.00	€107,403.68	€35,244.61	€5,645.02	€10,321.33	€2,040.14	€5,724.79	€7,819.05	€1,896.53	€72.22	€4,692.37	€2,681.71	€74,360.26	€33,043.42
VII Crustacean Potter	€35,202.77	€36,202.77	€9,738.40	€3,176.00	€6,234.90	€2,366.00	€360.00	€3,330.00	€904.00	€0.00	€0.00	€1,552.00	€27,661.30	€8,541.47
VIIa Mollusc Dredger	€17,868.99	€18,868.99	€4,000.00	€1,700.00	€4,950.00	€400.00	€1,300.00	€0.00	€0.00	€0.00	€320.00	€1,100.00	€14,870.00	- €30,901.01
VIIa Mollusc Potter	€45,705.80	€47,108.02	€18,571.25	€1,679.07	€4,243.97	€769.04	€1,384.32	€2,576.96	€1,277.29	€60.38	€1,670.25	€1,507.14	€33,583.69	€13,524.33
VIIf-k Gillnetter	€140,821.04	€141,821.04	€84,267.79	€4,028.75	€13,905.05	€2,094.63	€2,186.14	€6,712.00	€2,646.50	€70.83	€0.00	€2,690.00	€117,471.71	€24,349.33
Cost Profile														
VI Crustacean Potter	99%	100%	33%	5%	10%	2%	5%	7%	2%	0%	4%	2%	69%	31%
VII Crustacean Potter	97%	100%	27%	9%	17%	7%	1%	9%	2%	0%	0%	4%	76%	24%
VIIa Mollusc Dredger	95%	100%	21%	9%	26%	2%	7%	0%	0%	0%	2%	6%	79%	-164%
VIIa Mollusc Potter	97%	100%	39%	4%	9%	2%	3%	5%	3%	0%	4%	3%	71%	29%
VIIf-k Gillnetter	99%	100%	59%	3%	10%	1%	2%	5%	2%	0%	0%	2%	83%	17%

5 Lobster (*Homarus gammarus*)

5.1 Management advice

Current data shows that catch rates and size composition in the fishery are mostly stable although catch rates are declining in some areas. The catch rate data is limited and may not be reflective of the fleet.

Egg production is estimated to be below generally accepted limit reference points. The prevalence of v-notched lobsters in the stock is at best stable but declining in some areas. Accordingly, given the limited egg production, that the MLS is below the size at maturity, that the catch and effort data is poor and that there is no effort or catch control FEAS recommend the addition of a maximum landing size at 127 mm to enhance recruitment potential. This measure, originally proposed by the Lobster Advisory Group in 2006, would protect large spawning lobsters, which have high fecundity, improve egg production and protect some of the investment that has been made through the national v-notch programme since 2002.

Data on landings need to be improved. Availability of catch and effort data needs to be scaled up, particularly for vessels less than 10 m in length in order to develop suitable and high quality indicators of stock status and fishery performance and to provide higher resolution spatial data on fishing pressures on marine habitats especially in Special Areas of Conservation

5.2 The fishery

Lobster fishing is an important economic activity in coastal fishing communities around Ireland (Tully *et al.* 2006). Up to 1,729 vessels (based on the number of vessels <13 m registered in the Polyvalent segment of the Irish Register of Sea Fishing vessels at the end of 2012) participated in the fishery between April and October 2012 on all Irish coasts. Landings of 853 tonnes, in 2004 were the highest recorded. Recorded landings declined to 308 in 2007 were consistent between 400 and 500 tonnes from 2008 to 2010, increased to > 700 tonnes in 2011 and declined again to 247 tonnes in 2012.

5.3 Issues relevant to the assessment of the lobster fishery

Poorly resolved data on landings, and limited catch and effort information in the lobster fishery makes it difficult to report comprehensively on the status of the stock and the performance of the fishery. Catch and effort information on vessels less than 10 m in length is only available through the sentinel vessels reference fleet programme run by BIM and an observer programme run by the Marine Institute. Effort information in EU logbooks for vessels 10-13 m is poorly recorded. Due to the fact that the catch rate data is from a small reference fleet only, which itself is not consistent over time, there is low precision. Poor accuracy or bias is also potentially a significant problem. Although the limited reference fleet may not be representative of the entire fleet, the data are probably accurate at 'local' scale for the geographic area in which the reference fleet operates. If these are to be the main indicators for assessment of stock status data quality and quantity need to be improved.

5.4 Data sources

Catch and effort data on lobster for 2007 to 2012 are mainly from the sentinel vessels (SV) reference fleet programmes administered by BIM. Some additional data has also been collected through an observer programme operated by the Marine Institute (MI) since 2009. Prior to 2002 data for Wexford and Kerry were compiled by Taighde Mara Teoranta and Trinity College Dublin, respectively. Data for 2002-2006 are from voluntary fishing activity records (FARs) submitted to BIM. Data collected prior to 2002 did not distinguish between targeted catch rates of lobster and by-catch of lobster in the crab fishery and therefore pre and post 2002 data are not directly comparable. Size composition data for catch and landings are generated from MI observers, self sampling by vessel operators involved in the sentinel vessel programme and by periodic sampling of landings at ports or at live holding facilities.

This report includes available data from 2010-2012 for the northwest (Donegal), the west (Sligo, Mayo, Galway and Clare), the southwest (Kerry and Cork) and the southeast (Waterford and Wexford). Comparisons are made with data from 2002-2008 where available and from 1995-2008 for Wexford.

Three catch rate indicators are reported for different components of the catch:

LPUE = the number of legal size lobsters landed per 100 pots hauled

DPUE = the number of undersized lobsters discarded at sea per 100 pots hauled. These lobsters are mainly between 50-87 mm in length and indicates recruitment potential to the fishable stock

VPUE = the number of v-notched lobsters caught and discarded at sea per 100 pots hauled. V-notched lobsters represent a spawning reserve in the stock and the VPUE index reflects both the level of recent v-notching and the potential in the v-notched component of the stock.

The indicators are reported as nominal values and are not standardised for soak time, bait type or other co-variates. Indicators are reported by month and coastal county and as such account for fishing location and time of year which are likely to be very important factors determining catch rate.

Data supplied by industry is referred to as sentinel vessel (SV) data in this report. Marine Institute observer data is referred to as MI data.

5.5 Donegal-Sligo

5.5.1 Catch and effort indicators

In Donegal LPUE in 2010 was about 25 lobsters landed per 100 pot hauls compared to 10 lobsters per 100 pots in 2011 or 2012. Catch of undersized lobsters (DPUE) was generally higher than LPUE throughout 2010-2012. V-notched lobster catches declined from 2010 to 2012. The observed patterns may be due to different vessels reporting in different years (Figure 2).

In Sligo LPUE was generally 10-20 lobsters per 100 pots. MI LPUE data corresponds reasonably with the sentinel vessel (SV) data. Undersized catch rates (DPUE) were significantly higher than catch rates of legal lobsters and were up to 80 lobsters per 100 pots in MI observer data indicating strong recruitment potential in the area.

Catches of v-notched lobsters were particularly low in 2011. There are no data for 2012 (Figure 3).

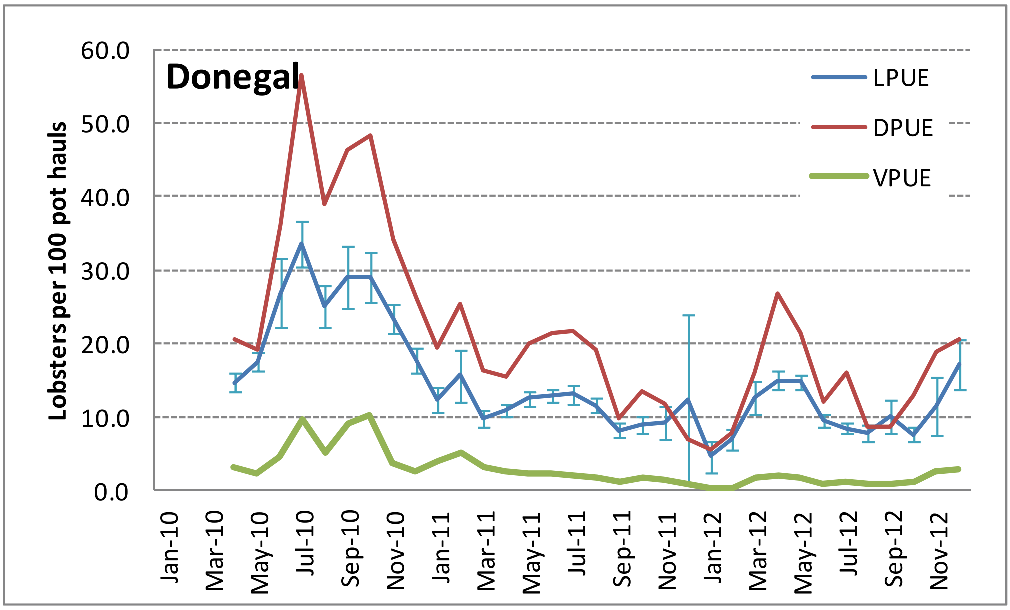


Figure 2. **Catch rates of legal lobsters (LPUE), undersized lobsters (DPUE) and v-notched lobsters (VPUE) in Donegal.**

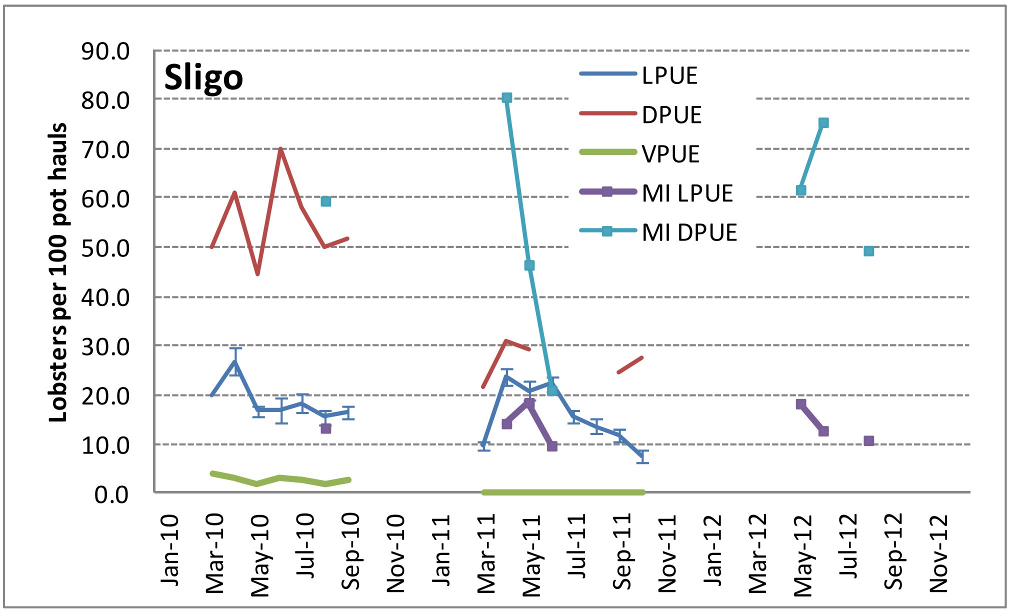


Figure 3. **Catch rates of legal lobsters (LPUE), undersized lobsters (DPUE) and v-notched lobsters (VPUE) in Sligo. MI = Marine Institute observer data. Other data is from the sentinel vessels.**

5.5.2 Size composition

Size composition of lobsters in the catch in Sligo was dominated by lobsters less than 87 mm. In the areas fished by the vessels lobsters less than 87 mm are abundant and large lobsters are rare. The catch composition was stable across the 3 years 2010-2012 (Figure 4).

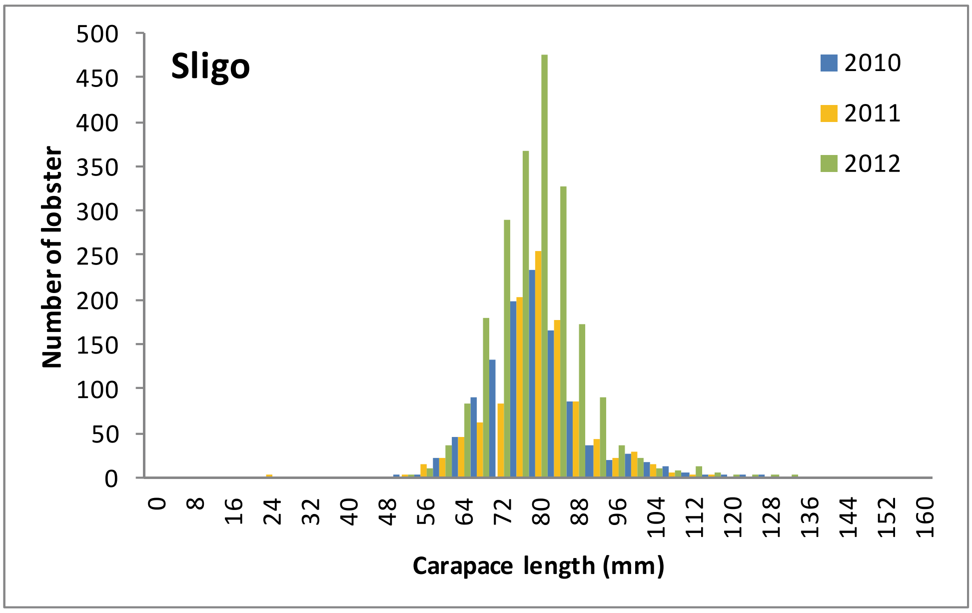


Figure 4. Size distribution of all lobsters in the catch for Sligo 2010-2012 (MI observer data).

5.6 *Mayo-Galway-Clare*

5.6.1 Catch and effort indicators

In Mayo LPUE varied between 10-35 lobsters per 100 pot hauls between 2002 and 2012. DPUE showed a similar range although this index increased to over 45 in the summer of 2011. VPUE varied from 0-10 lobsters per 100 pots although in 2010-2011 this index was less than 5.

In Galway there was a decline in LPUE between 2010 and 2012. LPUE ranged from 20-30 lobsters per 100 pots in 2010, declined linearly during the summer and autumn of 2011 and ranged between 10-25 in 2012. The MI LPUE data was similar to the SV data provided by the fleet. DPUE showed a similar pattern of decline during the period 2010-2012 although the index was higher than LPUE in 2011. MI data on DPUE was generally higher than the SV data. VPUE increased in 2012.

In Clare LPUE peaked during 2004-2006 at 20-30 lobsters per 100 pots but declined thereafter to between 10-20 during the summer of 2010 and 15-25 in 2011. DPUE was highest during 2004-2006 at 40-60 lobsters per 100 pots but declined to 10-30 during 2010-2011. There was strong and consistent seasonality in the DPUE and LPUE indices.

VPUE was higher in the period 2002-2004 than in later years (Figure 5, Figure 6, Figure 7).

5.6.2 Size composition

In Galway the modal size of the catch was 80-88 mm and size ranged from 40-150 mm. The size composition was similar across years 2010-2012. The SV data is similar to MI data for the legal sized catch but undersized lobsters seem to be underrepresented in these data compared to the MI data.

In Clare the modal size of the catch was 76-88 mm and ranged from 40-152 mm. The proportion of larger lobsters (> 96 mm) was higher than in Galway. The size composition was similar across years 2010-2012. Undersized lobsters were underrepresented in the SV data compared to the MI data (Figure 8, Figure 9).

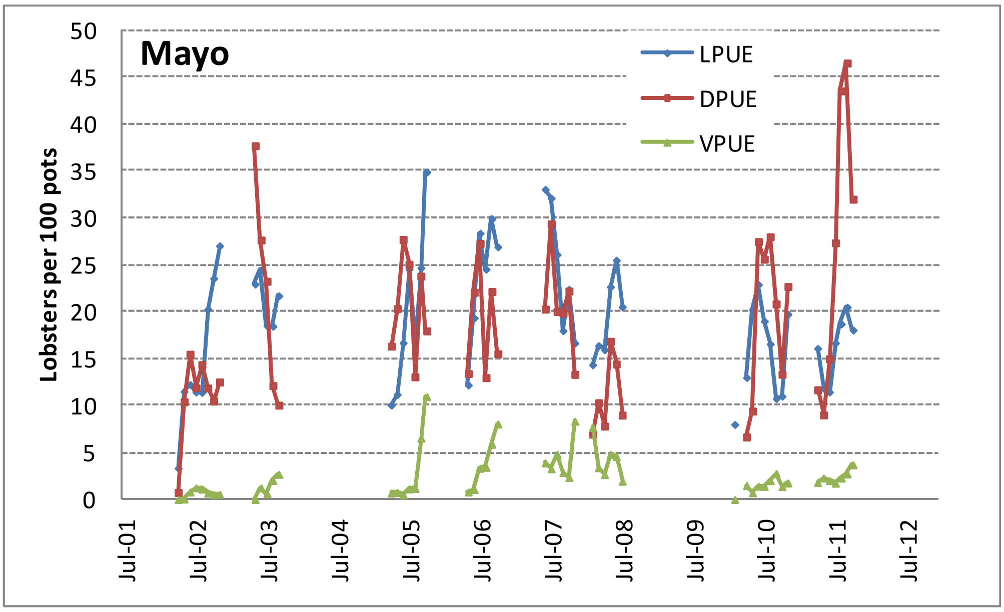


Figure 5. **Catch rates of legal lobsters (LPUE), undersized lobsters (DPUE) and v-notched lobsters (VPUE) in Mayo 2002-2012.**

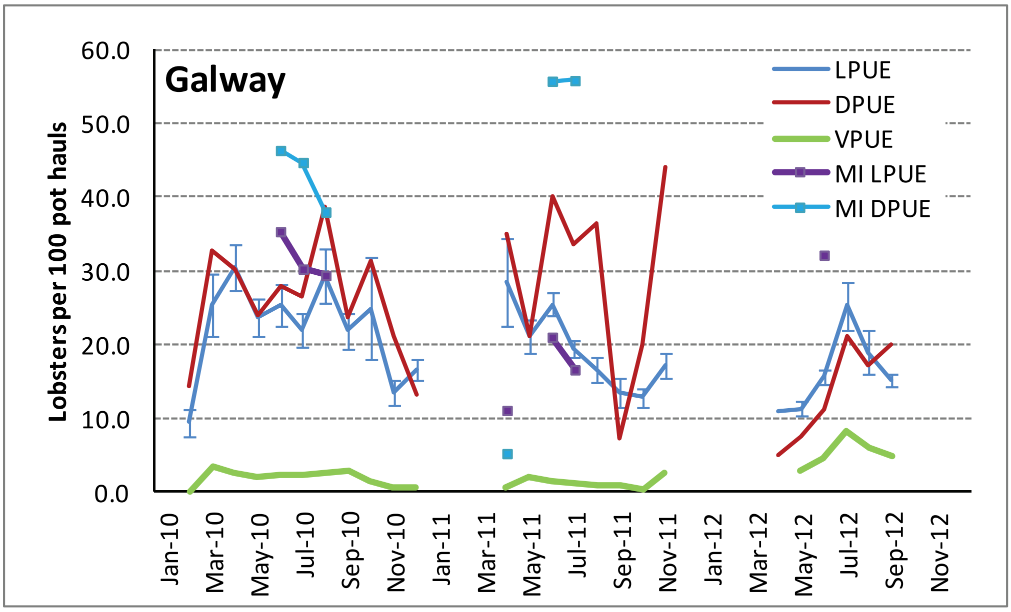


Figure 6. **Catch rates of legal lobsters (LPUE), undersized lobsters (DPUE) and v-notched lobsters (VPUE) in Galway 2010-2012.**

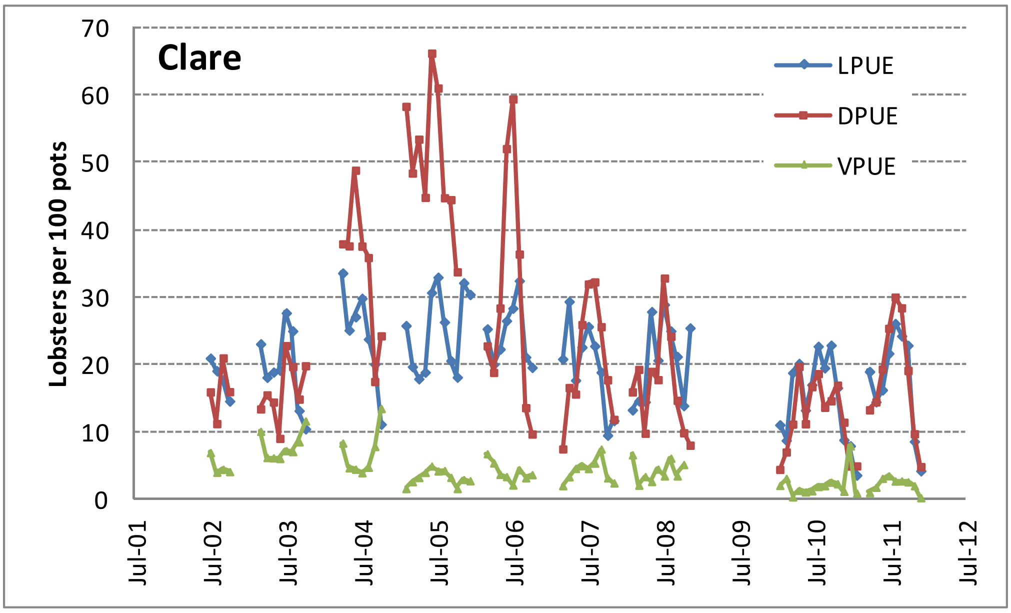


Figure 7. Catch rates of legal lobsters (LPUE), undersized lobsters (DPUE) and v-notched lobsters (VPUE) in Clare 2002-2011.

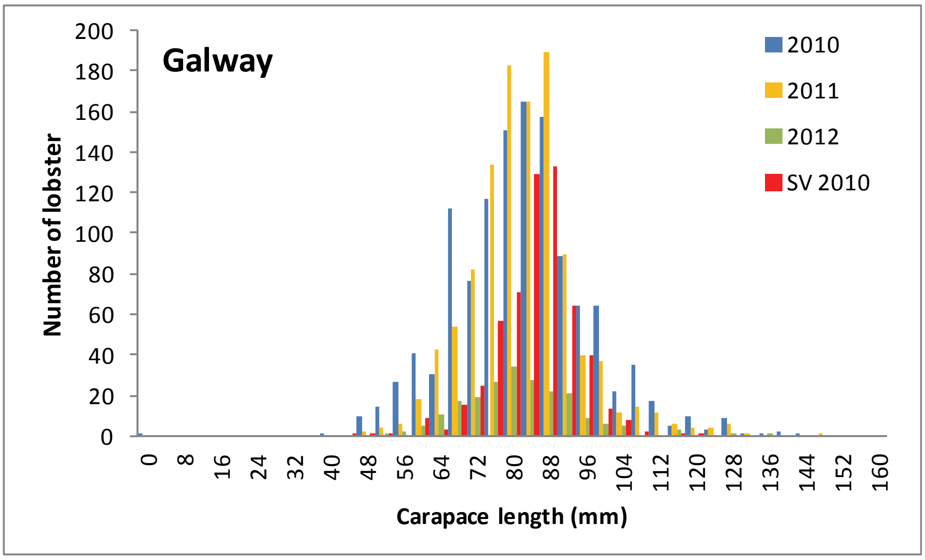


Figure 8. Size distribution of all lobsters in the catch for Galway (MI observer data 2010-2012 and Sentinel Vessel (SV) data 2010).

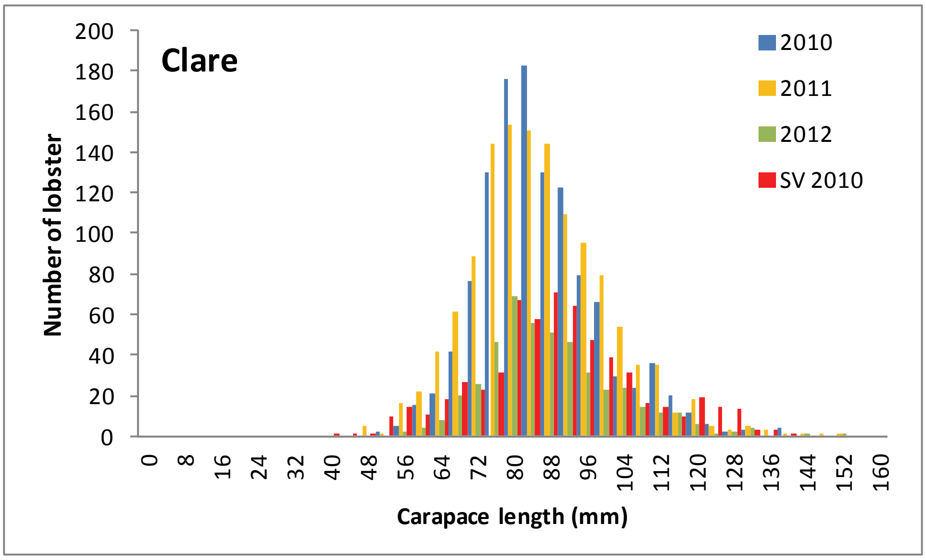


Figure 9. **Size distribution of all lobsters in the catch for Clare (MI observer data 2010-2012 and Sentinel Vessel (SV) data 2010).**

5.7 *Kerry-Cork*

5.7.1 Catch and effort indicators

In Kerry LPUE ranged from 5-15 lobsters per 100 pots in 1996-1999 and up to 25 in the period 2002-2008. LPUE, with strong seasonality, was generally between15-25 during 2010-2012 although lower in winter. DPUE was generally lower than LPUE while VPUE ranged from 0-5 during the period 1996-2008.

In Cork LPUE generally ranged between 10-20 lobsters per 100 pots. DPUE was similar to LPUE in 2002-2007 but lower than LPUE in 2010-2012. VPUE was lower than in other areas at 1-4 lobsters per 100 pots (Figure 10, Figure 11).

5.7.2 Size composition

In Kerry modal size was 80-90 mm and size ranged from 48-160 mm. The size composition was stable over the period 2010-2012. Undersized lobsters are underrepresented in the SV data compared to the MI data (Figure 12).

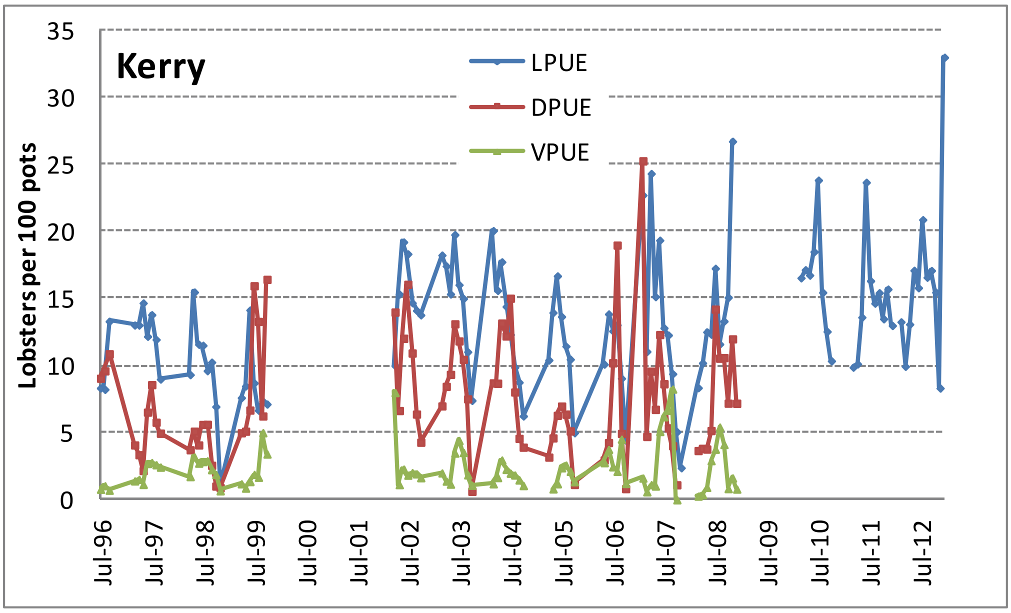


Figure 10. **Catch rates of legal lobsters (LPUE), undersized lobsters (DPUE) and v-notched lobsters (VPUE) in Kerry 1996-2012.**

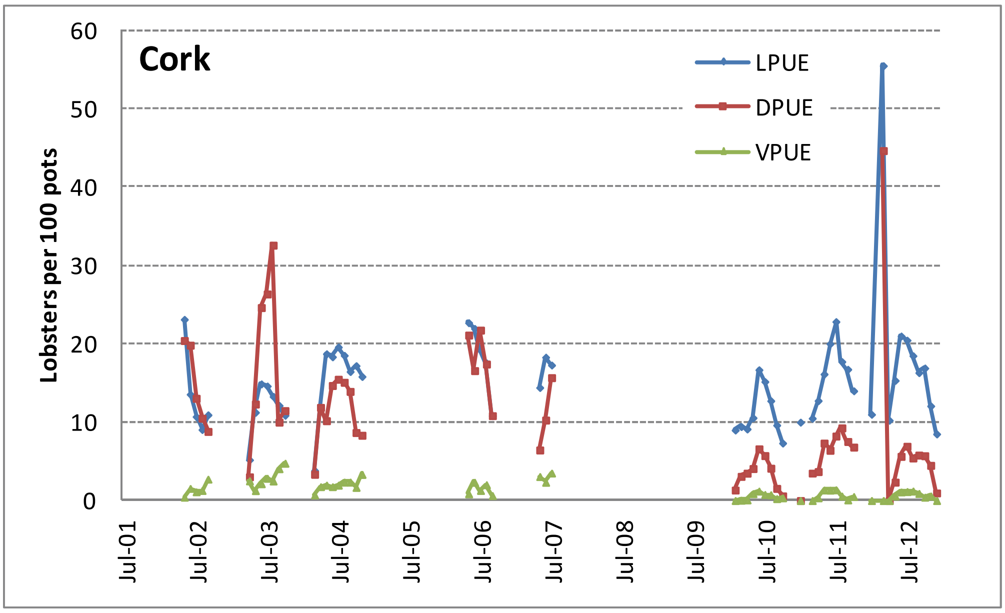


Figure 11. **Catch rates of legal lobsters (LPUE), undersized lobsters (DPUE) and v-notched lobsters (VPUE) in Cork 2002-2012.**

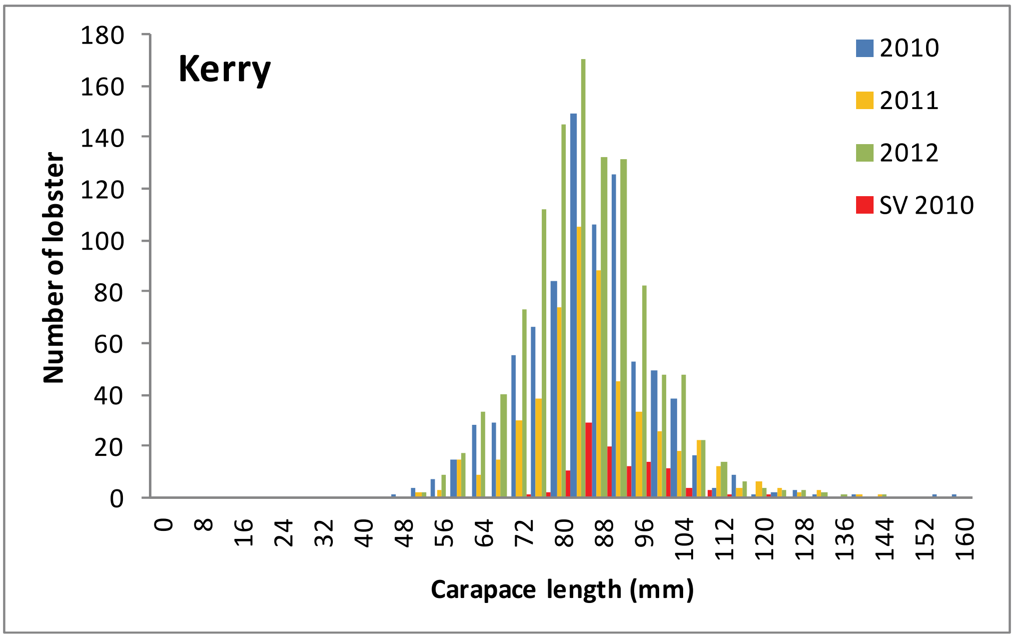


Figure 12. **Size distribution of all lobsters in the catch for Kerry (MI observer data 2010-2012 and Sentinel Vessel (SV) data 2010).**

5.8 Waterford-Wexford

5.8.1 Catch and effort indicators

LPUE in Wexford increased from a low of approximately 7 lobsters per 100 pots in 1995 to 10 during the period 1999-2004 and 10-15 in 2010-2012. The DPUE index was at similar levels and also increased during the 1990s and was generally higher than LPUE in the period 2002-2007. VPUE was lower than in many other areas and generally less than two lobsters per 100 pots.

The data time series is shorter for Waterford. LPUE was in the same range as in Wexford during 2010-2012. (Figure 13, Figure 14).

5.8.2 Size composition

In Waterford modal size was 72-80 mm in 2011but 76-88 mm in 2010 and 2012. Size ranged from 44-156 mm. SV and MI data were similar for commercial sized fish but undersized lobsters may be underrepresented in the SV data (Figure 15).

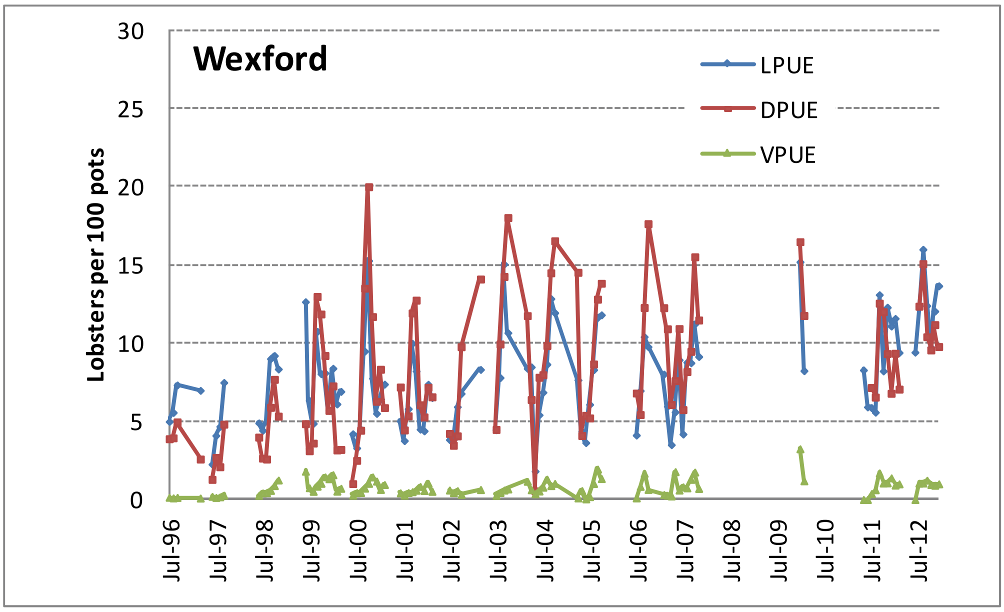


Figure 13. **Catch rates of legal lobsters (LPUE), undersized lobsters (DPUE) and v-notched lobsters (VPUE) in Wexford 1996-2012.**

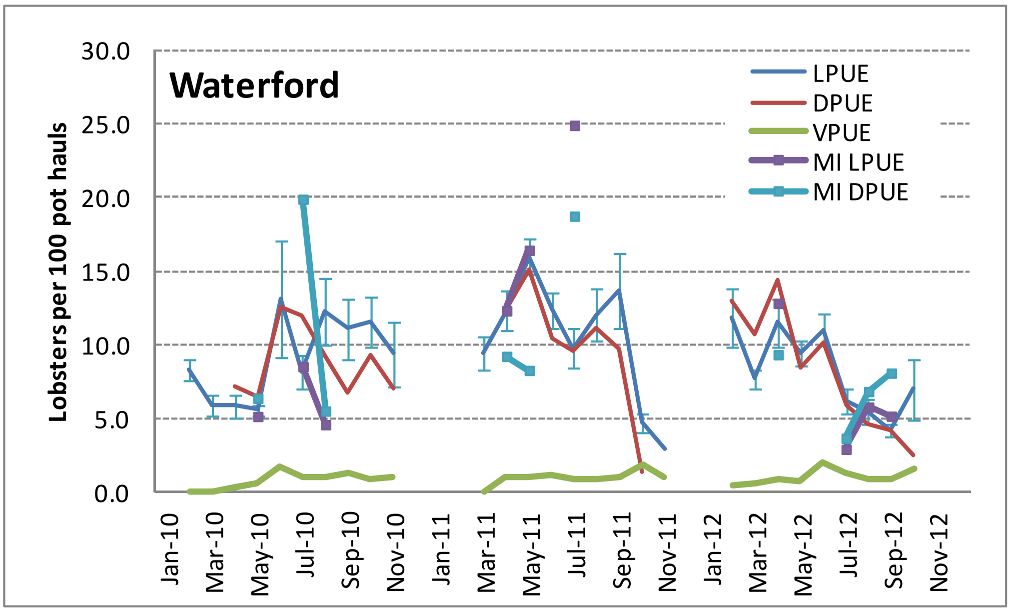


Figure 14. **Catch rates of legal lobsters (LPUE), undersized lobsters (DPUE) and v-notched lobsters (VPUE) in Waterford 2010-2012.**

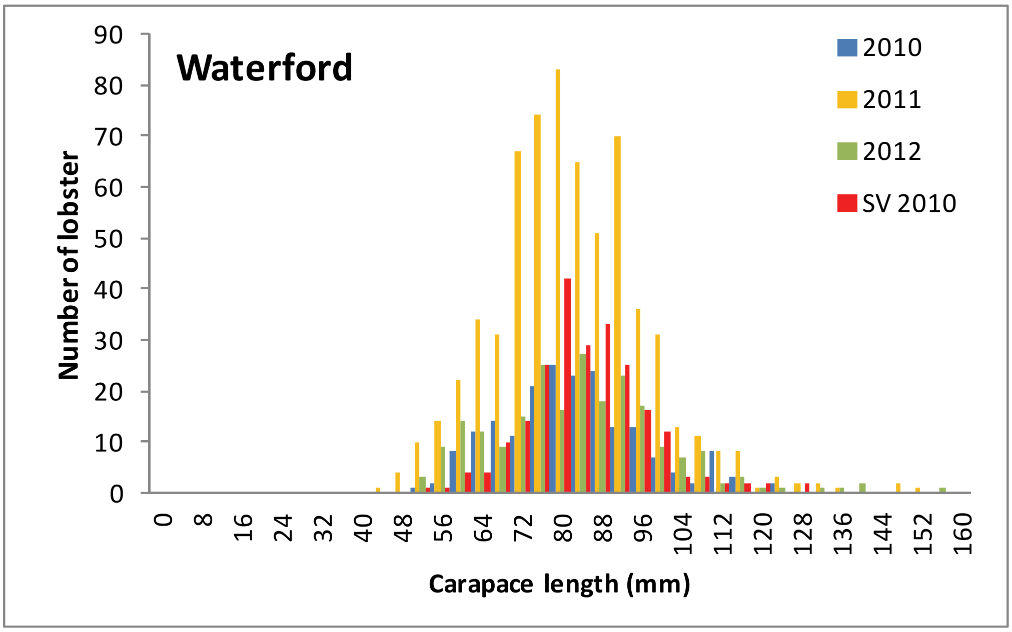


Figure 15. **Size distribution of all lobsters in the catch for Waterford (MI observer data 2010-2012 and Sentinel Vessel (SV) data 2010).**

5.8.3 Size limits

A proposal to introduce a maximum size limit at 127 mm was previously proposed in 2006 by the Lobster Advisory Group. This was subject to egg production assessment in 2009 and is being discussed by the management authority presently. This measure would increase egg production, spawning potential and recruitment as previous assessments had indicated that egg production potential was low and possibly limiting recruitment. The size limit of 127 mm would also afford permanent protection to v-notched lobsters as the notch repairs and they grow above this measure.

V-notched lobsters are generally larger than non-notched lobsters as the notched component of the stock have not been subject to fishing mortality since they were notched (the comparison in effect shows the effect of fishing mortality on size composition in the lobster stock). This difference reflects the balance between introduction of new and generally smaller v-notched lobsters (during the annual v-notch programme), growth of v-notched lobsters and then the repair of the notch and subsequent removal of such lobsters from the stock by fishing. Modal size of non-notched lobsters in the catch is 76-80 mm but is 96-112 mm in notched lobsters (Figure 16). The mean size of commercial sized non v-notched lobsters varied from 95-99 mm in 2009-2012 (MI observer data) while the mean sized of v-notched lobsters varied from 106-113 mm during the same period (Table 10).

The proportion of commercial sized lobsters over 127 mm varied from 0.9-2.3% in the period 2009-2012 (MI observer data) and by County from 0.32% (Sligo) to 8.6% (Wexford). SV data shows similar figures varying from 0% (Sligo) to 6% (Waterford) although Kerry SV data shows 38% of lobsters to be over 127 mm. MI data collected at ports or live exporters showed 9% of commercial sized lobsters were over 127 mm in Donegal, 1.4% in Mayo and 0% in Galway (Table 11, Table 12).

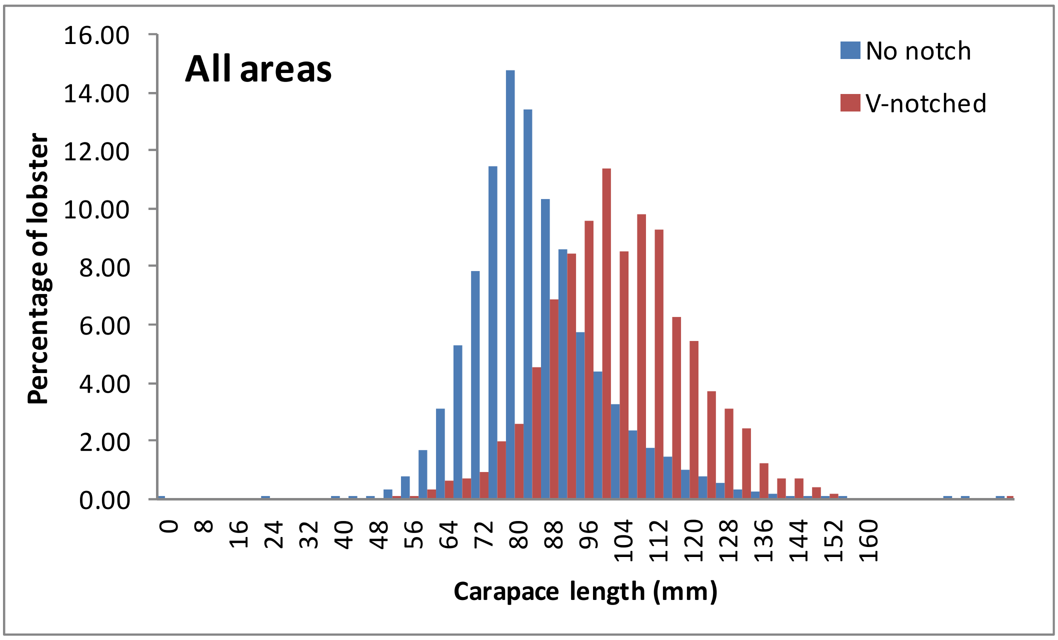


Figure 16. Size distribution of v-notched and non-v-notched lobsters in the catch. All areas and years (2009-2012) combined (MI Observer data).

Table 10. Mean size of commercial sized lobsters with v-notches and no v-notches .

Year	No notch			V-notch		
	N	Mean	S.d.	N	Mean	S.d.
2009	407	99.3	11.2	166	113.7	14.8
2010	1,319	96.7	9.4	180	106.6	12.6
2011	969	97.2	9.9	173	109.4	14.3
2012	1,420	95.5	8.7	104	110.1	14.5

Table 11. Percentage of commercial sized v-notched and non-v-notched lobsters that were under and over 127 mm in the period 2009-2012 (MI observer data).

Year	No notch			V-notch		
	N<127	N>127	%>127	N<127	N>127	%>127
2009	398	9	2.3	137	29	21.2
2010	1,298	21	1.6	168	12	7.1
2011	949	20	2.1	153	20	13.1
2012	1,408	12	0.9	88	16	18.2

Table 12. Percentage of commercial sized non-v-notched lobsters that are under and over 127 mm by County based on MI observer data and SV data 2009-2012.

County	MI data 2009-2012			SV data 2009-2012		
	N>127	N<127	%>127	N>127	N<127	%>127
Clare	44	1,577	2.79	26	518	5.02
Cork	25	784	3.19	0	155	0.00
Donegal	15	771	1.95	6	156	3.85
Galway	25	1,272	1.97	0	298	0.00
Kerry	34	1,811	1.88	73	192	38.02
Mayo	17	741	2.29	2	89	2.25
Sligo	3	946	0.32	0	0	0.00
Waterford	27	741	3.64	18	290	6.21
Wexford	15	174	8.62	2	170	1.18

6 Brown crab (*Cancer pagurus*)

6.1 Management advice

Catch rates of commercial crab in the inshore and offshore sector have declined slowly over the past 20 years and average between 0.5-1.5kgs per pot haul in all areas.

Size composition of the catch appears to be stable. There is significant high grading and given that the MLS is also well above the size at maturity there is probably adequate spawning escapement and recruitment is unlikely to be limited.

Operationally the fleet may be under economic pressure at certain times of year when catch rates are at 0.5kgs per pot or less, when crab quality is low and when market price is low.

Although there is significant high grading and discarding of live legal size crab this practice varies regionally and locally. Fishing strategies vary from landing high volume and variable quality crab to high grading and landing low volume of higher quality crab. High grading for good meat quality is incentivised by some processors but may be insufficient for all operators to adopt a high grading strategy that would further reduce fishing mortality.

Consideration should be given to closed seasons during periods of low catch rate and profitability and of incentivising high grading and good on board handling to optimise discard survival and reducing fishing mortality.

In addition, in order to increase profitability, effort reduction, which would reduce gear competition for catch and lead to increased catch rates and lower costs should be discussed at a regional level for each stock.

6.2 The fishery

Targeted fisheries for brown crab, also known as edible crab, in Ireland developed during the 1960s. Brown Crab fishing developed off Malin Head in Donegal and along the Donegal coast and, to a lesser extent, on the south coast during the 1970s. The Malin Head fishery accounted for 25% of national landings during the 1980s. The offshore fishery developed in 1990 and by the mid 1990s had fully explored the distribution of brown crab on the Malin Shelf. This stock, which extends from Donegal to the edge of the continental shelf, is the largest stock fished by Irish vessels. Crab stocks off the southwest and southeast coasts are exploited mainly by Irish vessels <13 m in length.

Landings increased exponentially between 1992 and 2004 and amounted to over 13,000 tonnes in 2004. Landings have since declined to approximately 7,500 although there is some doubt about recent landings data. Offshore effort has declined.

6.3 Issues relevant to the assessment of the brown crab fishery

Catch and effort data for some areas around the Irish coast is limited. The landings per unit effort time series are sensitive to changes in grading practice, independently of changes in stock status. Although additional variables on grade and percentage waste (crab that are unsuitable for processing due to low meat content) at factories could possibly be used to standardise the series this has not been tested. Catch per unit effort can be derived from a summation of the landings and discards. Discards are reported in the sentinel vessel data although the accuracy of this discard data is unknown; it is difficult to estimate during normal fishing operations.

Length based assessments have been undertaken but changes in size composition, resulting from different levels of fishing mortality are very difficult to detect and seem independent of annual trends in fishing effort and landings.

6.4 Data sources

6.4.1 Landings per unit effort

From 1993-2006 landings per unit effort data (LPUE) were obtained from private diaries of crab fishermen off the northwest coast. LPUE, and discard data are available from the sentinel vessel fleet programme. Infrequent MI observer trips have been undertaken since 2010 from which CPUE, LPUE and DPUE indicators are derived.

The private diaries data is known to be accurate and provides precise estimates of LPUE at fine spatial scale and has allowed the distribution of fishing and LPUE to be mapped and the behaviour of the fleet to be monitored in the past. Changes in LPUE can, therefore, by associated with shifts in geographic location of fishing. This index for the offshore fishery was discontinued in 2009 as effort in this fishery declined significantly and data were not available for the remaining effort. The spatial resolution of fishing by the inshore fleet is lower although the fishing grounds used by individual vessels is generally known.

6.4.2 Size composition

Size distribution of the catch was collected during 1996-1997 (Cosgrove 1998) in the northwest fishery. Additional data were collected on board offshore vessels periodically in 2000-2001. In the southeast annual sampling of size composition was undertaken from 2001 to 2004. Currently some size distribution data is collected through the sentinel vessel programme and the MI observer programme.

6.5 Stock structure and assessment units

Stock structure of brown crab is determined by migration of adult crab and dispersal of larvae. Tag return data off the Irish coast indicate that crab undertake extensive migrations. On the basis of tag return data and the distribution of fishing and landings four stocks may exist. These 4 assessment units are a subset of a larger number of assessment units in northern Europe identified by ICES in 2012 (Figure 17).

Brown crabs on the northwest coast, from west and north of Mayo to the Inishowen peninsula and west and northwest to the edge of the continental shelf, are part of a single stock. This stock is contiguous with crab fisheries off the west coast of Scotland and Hebrides and is known as the Malin Shelf Stock. It is the largest stock fished by the Irish fleet. Tag return data shows extensive return migrations from north Donegal to Mayo and between inshore coastal waters northwest to the 200 m depth contour (Tully *et al.* 2006). These data also show some connection between west of Mayo and the Clare coast.

The south west stock occurs mainly in inshore waters out to the 12 nm limit. Surveys in 2006-2007 between 6-20 nm offshore did not find any significant stocks in offshore waters to the south west. Small scale inshore-offshore migrations occur in this area on a seasonal basis.

Boundaries between the south west coast stock and the Celtic Sea stock to the east are unknown. Larval dispersal is probably in the south west direction along the south Irish coast. There is a limited inshore-offshore migration and a westward migration of female crab from the Wexford coast (Fahy *et al.* 2004). Migration from the Irish south coast may extend as far south as the Scilly Isles, however, fishing effort in offshore waters in the Celtic Sea is low suggesting the main stock occurs in waters inside 20 nm.

Landings in the western Irish Sea increased in the mid 2000s especially into ports in Northern Ireland. The North West Irish Sea is a retention area which may retain crab larvae spawned along the north east coast. However, there is no data on the migration of adult crabs in this area.

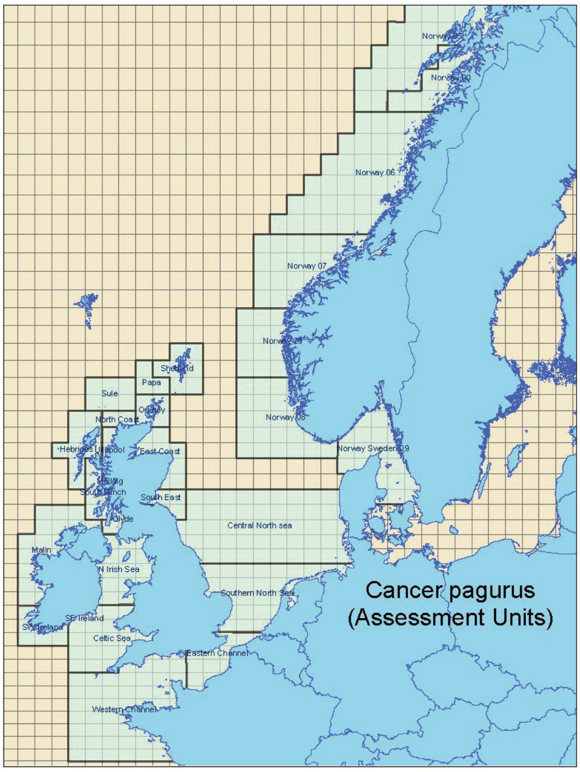


Figure 17. Crab stock assessment units in northern Europe (source: ICES WGCrab 2012).

6.6 *Northwest*

6.6.1 Trends in distribution of effort

Fishing for crab occurs west and north of Mayo where the inshore fleet fish in waters up to 80 km north of Erris (Figure 18). In addition vessels fishing from south Donegal fish in Donegal Bay and west and south of Aranmore. A number of vessels target crab north of Horn Head to Malin Head. Offshore, the over 18 m vivier fleet fish west and north west of Mayo and west of Donegal. Effort has declined in recent years (Figure 18) as some of the fleet has moved to the southern North Sea.

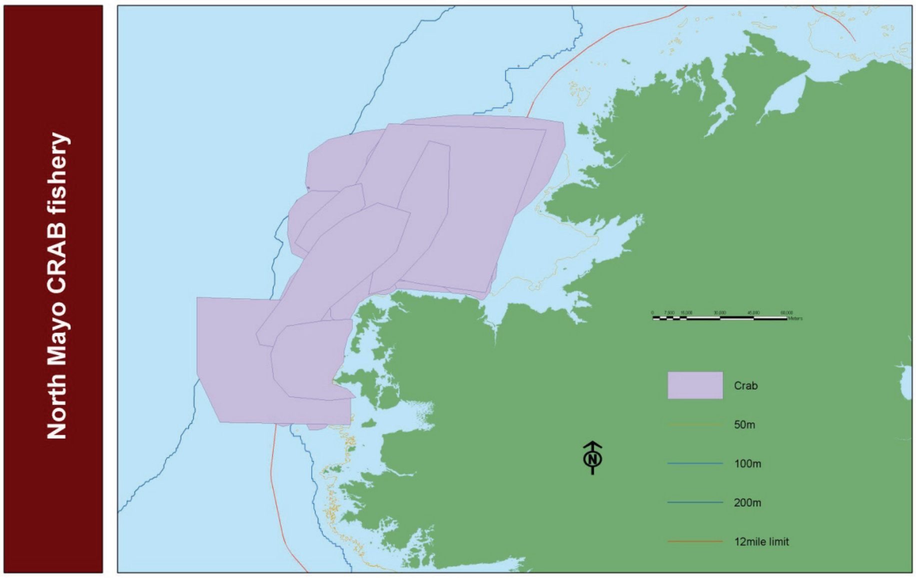


Figure 18. **Distribution of fishing for crab by the north Mayo fleet in 2010-2011 (source: questionnaire data provided by vessel owners).**

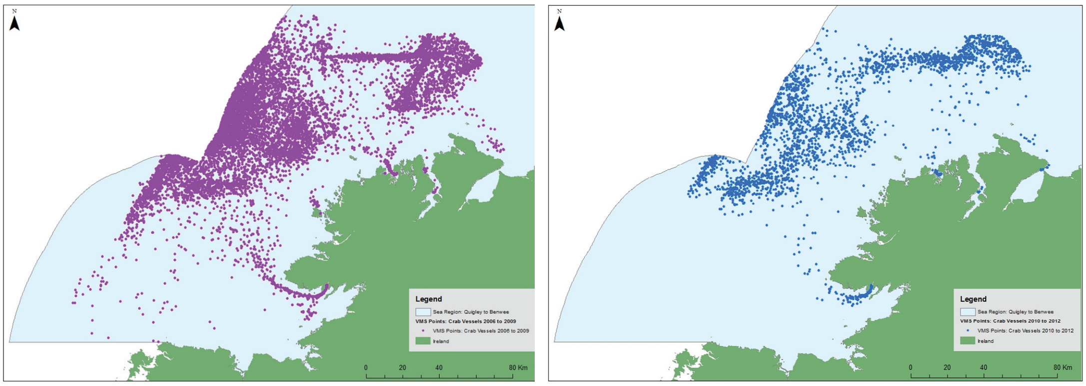


Figure 19. **Distribution and intensity of VMS point data, seaward to 100 km, for vessels >18 m targeting crab in the Malin Shelf from 2006-2009 (left) and 2009-2012 (right).**

6.6.2 Landings

Landings may be under recorded in official figures. In the period 2008-2011 annual landings of crab into County Mayo were reported to be 431, 576, 987 and 730 tonnes per annum respectively. Landings derived from questionnaire data which provides information on landings, annual days and sea, daily effort combined with catch rate data suggests landings into North Mayo are at least 1,700 tonnes, probably in the region of 2,300 tonnes and in very good years may be over 3,000 tonnes. Landings into Malin head amounted to some 1,800 tonnes per annum during the 1990s but may be somewhat lower now. In addition there are vessels landing significant quantities of crab into other piers in north and north west Donegal and to a lesser extent into Killybegs. Total landings peaked at approximately 14,000 tonnes in 2004.

6.6.3 Catch rate indicators

The offshore LPUE index declined from 1991, at the start of the offshore fishery, to 1994 and remained stable between 1994-2000. A further decline occurred in 2001. LPUE was stable at approximately 1.5 kgs per pot during the period 2001-

2009 (Figure 20). Annual LPUE is very closely and negatively correlated with annual effort.

In the inshore fleet seasonal peaks in LPUE occurred mainly in October/November, however peaks in July/August have also been recorded in certain years since 1993 and a peak in March 2010, of 3 kg of brown crab per pot haul, was evident.

Annual LPUE between 1993 and 2007 ranged between 1.2-2.0 kg per pot haul. In 2008 the annual LPUE declined to 0.7 kg per pot haul. From 2009-2012 the annual LPUE ranged from 1.1-1.9 kg. The lowest level occurred in 2012.

Monthly LPUE shows strong seasonal variation presumably due to changes in catchability related to crab reproduction and moulting cycles and seawater temperatures. LPUE generally ranges between 1.0-1.5 kgs per pot but is as low as 0.4 kg per pot in some months.

Annual DPUE ranged between 0.42-0.85 kg of brown crab per pot haul from 2002-2007. From 2008 DPUE decreased to 0.51 kg per pot haul in 2012.

Monthly DPUE shows strong seasonal variability as might be expected due to changes in crab quality due to moulting. However, the seasonal pattern is similar to that of LPUE indicating overall changes in CPUE and that discarding patterns may be correlated with overall crab abundance in addition to expected changes in crab quality. DPUE peaked during late summer or July-September in the majority of years between 2002 and 2012, with the exception of a peak in June 2009 and in December 2012. DPUE was usually at its lowest in April and May, with the exception of 2002 and 2006 where the minimum occurred in December and in 2009 where the minimum occurred in January. Very low discarding rates occurred in some months in the period 2009-2012.

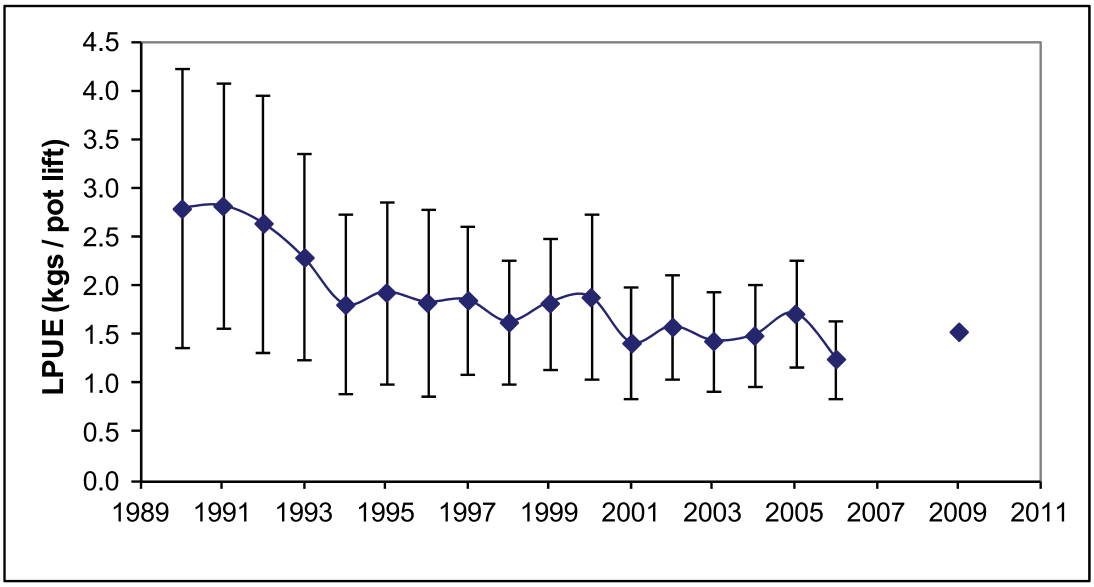


Figure 20. **Annual LPUE (S.e.) for the offshore (>18 m) crab fleet 1990-2006 and 2009. Data for 2010-2012 not available.**

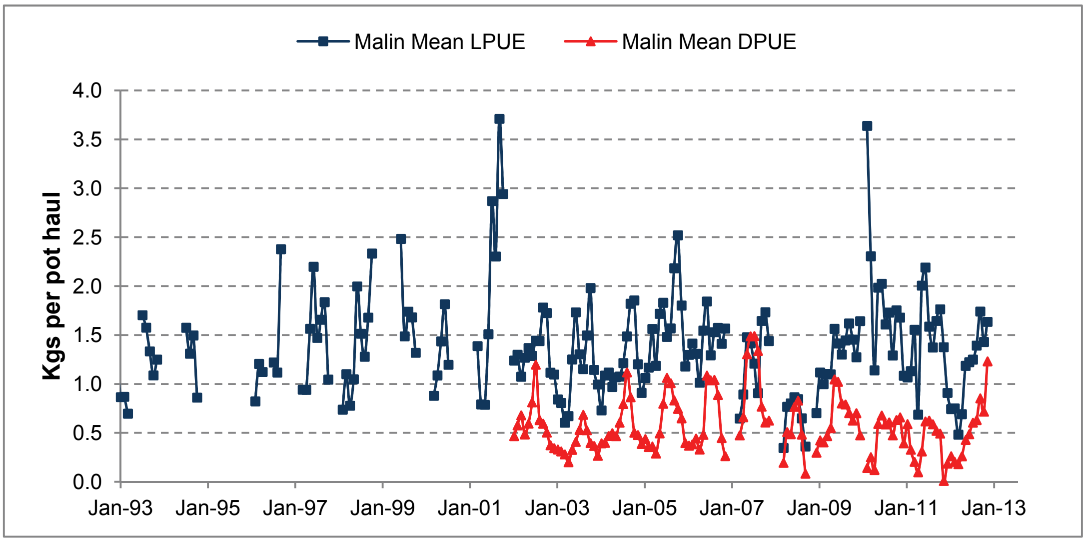


Figure 21. **Monthly LPUE and DPUE in the <13 m crab fishery in the Malin Stock (Donegal and north Mayo), 1993-2012.**

Table 13. **Annual LPUE and DPUE (±SE) in the <13 m crab fishery off the northwest coast. Data from 1993-2007 is off the Donegal coast only, whereas data from 2008-2012 consists of data from Donegal and North Mayo. N=number of vessel days.**

	LPUE			DPUE			
Year	N	Mean	SE	N	Mean	SE	Pot Hauls
1993	87	1.25	0.06				56,895
1994	29	1.42	0.13				31,725
1995							
1996	85	1.21	0.05				43,650
1997	91	1.47	0.06				51,000
1998	84	1.35	0.07				40,650
1999	99	1.75	0.07				46,050
2000	62	1.37	0.06				32,550
2001	131	2.08	0.12				45,550
2002	448	1.45	0.03	182	0.67	0.03	232,650
2003	1,274	1.26	0.02	128	0.42	0.02	317,797
2004	339	1.24	0.03	161	0.64	0.02	212,510
2005	1,414	1.84	0.02	1,143	0.85	0.02	742,152
2006	872	1.40	0.02	604	0.66	0.02	481,902
2007	373	1.52	0.03	373	0.80	0.03	207,300
2008	137	0.74	0.05	117	0.61	0.04	78,905
2009	497	1.39	0.02	465	0.77	0.02	311,595
2010	444	1.81	0.05	444	0.53	0.01	268,280
2011	620	1.92	0.09	620	0.62	0.04	341,905
2012	813	1.15	0.04	813	0.51	0.04	438,270

6.7 South west

6.7.1 Trends in distribution of effort

The geographic distribution of crab fishing by the <13 m fleet in the southwest extends along the coasts of Kerry and Cork. Various surveys were undertaken in this area during 1999-2007, however in recent years the distribution of the fleet is known mainly through the sentinel vessel reference fleet data. There is no significant fishery outside 12 nm.

6.7.2 Catch rate indicators

Annual LPUE declined from 2.29 kgs per pot in 2000 to 1.42 in 2006 and varied from 1.41 to 1.82 kgs per pot in the period 2010-2012. The number of data records available for 2008 and 2009 was low (Figure 22, Table 14).

Data from 2000 indicated monthly peaks in July-September (Figure 22). In 2003 and 2010 the monthly peak occurred in May and in 2005 the highest LPUE was recorded in November. For the majority of years the LPUE was lowest from December to March. Annual LPUE declined from 2.29 kg of brown crab per pot haul in 2000 to 1.49 kg per pot haul in 2004.

Discard rates in the southwest were lower, in proportion to LPUE, than the northwest fishery from 2004-2008 ranging from 0.01-0.04 kg of discarded brown crab per pot haul. However, DPUE increased to approximately 0.4 kg per pot haul from 2009 to 2012, which were closer to discard rates in the northwest.

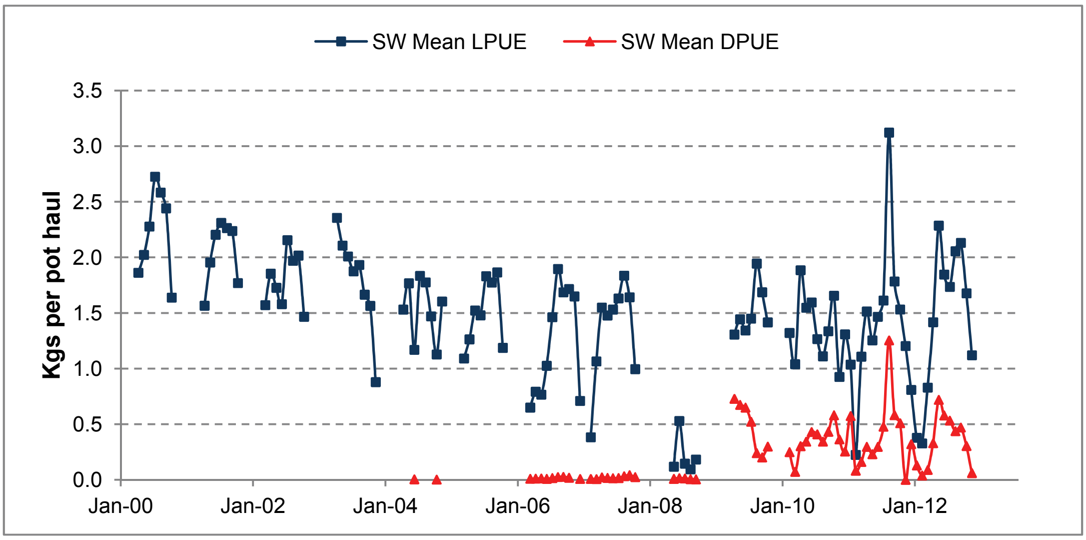


Figure 22. **Monthly LPUE and DPUE in the <13 m crab fishery in the southwest stock (Kerry and Cork), 2000-2012.**

Table 14. **Annual LPUE and DPUE (±SE) in the <13 m crab fishery off the southwest coast. N=number of vessel days.**

	LPUE			DPUE			
Year	N	Mean	SE	N	Mean	SE	Pot Hauls
2000	782	2.29	0.031				54,740
2001	943	2.05	0.026				56,580
2002	857	1.88	0.029				52,120
2003	956	1.87	0.025				57,360
2004	1,021	1.49	0.021	1	0.04		54,590
2005	1,237	1.61	0.017				74,220
2006	2,497	1.42	0.015	213	0.02	0.002	145,808
2007	4,472	1.59	0.010	675	0.02	0.001	265,851
2008	48	0.23	0.041	41	0.01	0.002	25,780
2009	87	1.64	0.084	86	0.40	0.034	34,120
2010	216	1.41	0.076	216	0.37	0.021	75,840
2011	373	1.69	0.179	373	0.49	0.090	119,770
2012	390	1.82	0.068	390	0.45	0.023	137,130

6.8 South east

6.8.1 Trends in distribution of effort

Fishing effort on crab occurs south of Wexford and Waterford seaward to 20 nm. Further offshore French vivier vessels fish for crab although this effort has declined in recent years

6.8.2 Catch rate indicators

The annual LPUE for the southeast was relatively stable from 2002-2004 at approximately 1.0-1.3 kg per pot haul. In the period 2009-2012 annual average LPUE was 1.1 kg per pot with some outlying data in 2010 raising the annual mean to 1.99 kgs in that year (Figure 23, Table 15).

There was no discard per effort data available for 2002-2004. DPUE varied from 0.23-0.84 during the period 2009-2012.

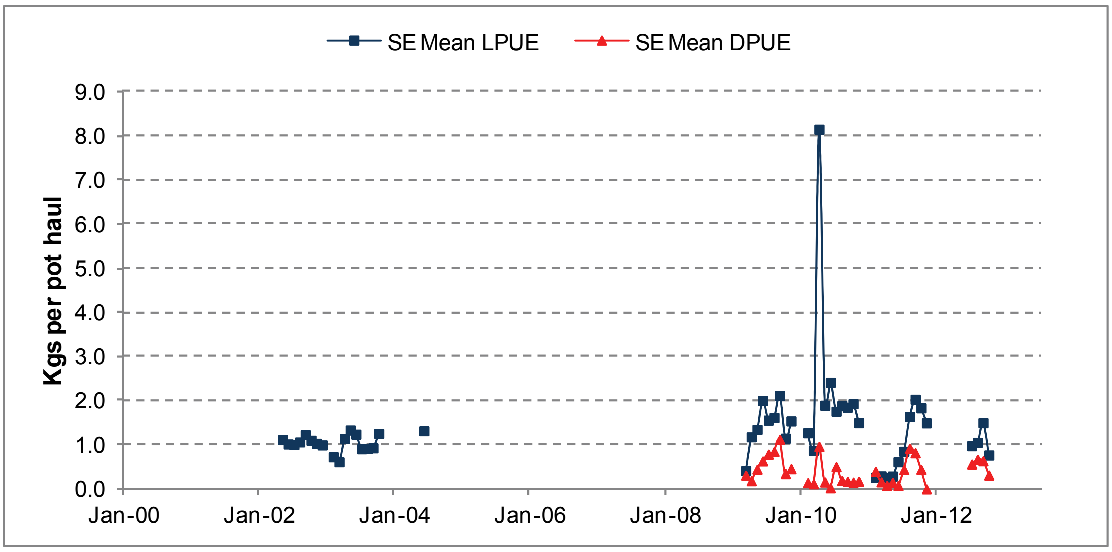


Figure 23. Monthly LPUE and DPUE in the <13 m crab fishery in the southeast stock (Waterford and Wexford), 2000-2012.

Table 15. Annual LPUE and DPUE (±SE) in the <13 m crab fishery off the southeast coast. N=number of vessel days.

	LPUE			DPUE			
Year	N	Mean	SE	N	Mean	SE	Pot Hauls
2000							
2001							
2002	579	1.08	0.024				97,535
2003	211	1.01	0.034				32,860
2004	3	1.32	0.069				320
2005							
2006							
2007							
2008							
2009	255	1.70	0.052	255	0.84	0.058	69,879
2010	201	1.994	0.172	201	0.23	0.029	72,920
2011	222	1.107	0.058	222	0.47	0.048	34,464
2012	61	1.102	0.081	61	0.56	0.035	8,277

6.8.3 Size composition data

Size composition of crab is collected by MI observer catch sampling on inshore vessels and MI sampling at ports and processors. The data shown below is from MI catch sampling aggregated across 2010-2012 and across all counties.

The modal size of crab landed in the fishery is 150-160 mm indicating significant high grading of crab above the minimum legal size of 130 mm (Figure 24). The modal size for discards was 120-130. Few crabs less than 90 mm are captured. Discard rates above the 130 mm legal size is size related; about 60% of the catch between 130-140 mm is discarded. This declines to less than 20% for crab over 150 mm (Figure 25).

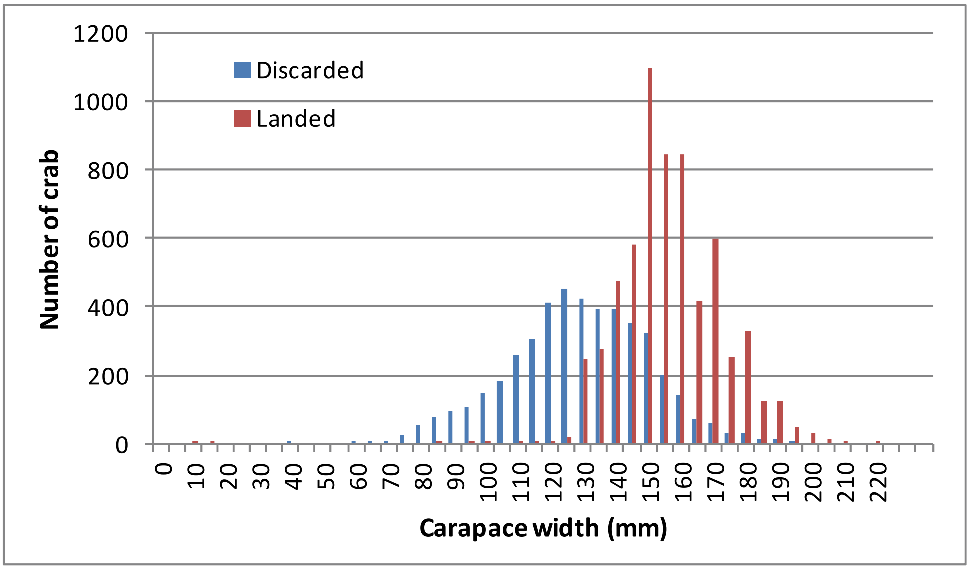


Figure 24. Size distribution of brown crab landed and discarded from inshore vessels during 2009-2012.

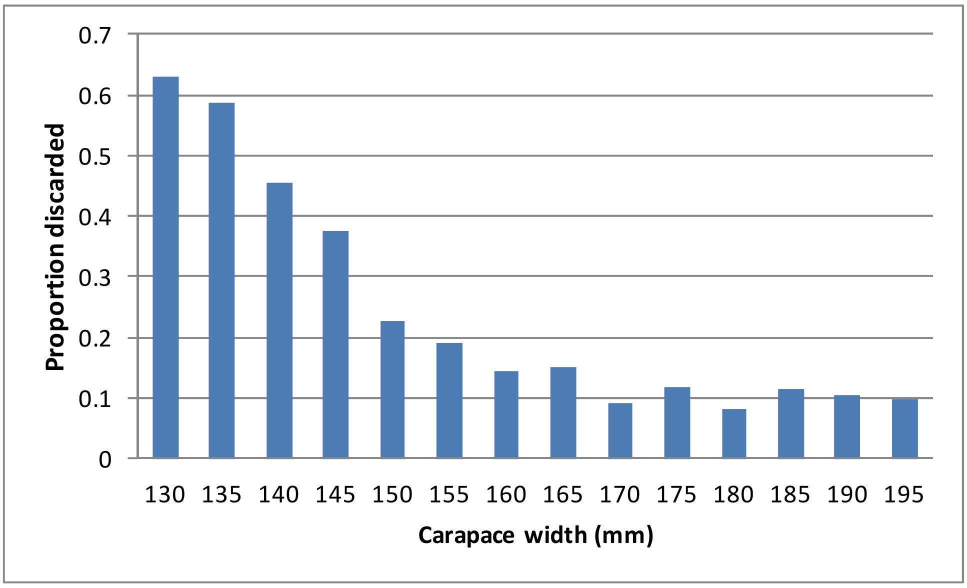


Figure 25. Proportion of crab discarded in relation to size in the crab fishery 2009-2012.

7 Scallop (*Pecten maximus*)

7.1 Management advice

The over 15 m scallop fleet has re-developed following a de-commissioning scheme in 2006.

Although the maximum fleet size is capacity limited and vessels over 10 m in length require permits to fish for scallop, landings and effort have increased successively in each year during the period 2006-2012. The fleet fishes mainly in the Irish Sea and Celtic Sea.

Catch per unit effort appears to have increased in the Celtic Sea, southern Irish Sea and Northern Irish Sea in recent years.

Effort or landings from these stocks should be managed at stock level so that depletion of biomass is avoided. Given the uncertainties and possible bias in catch rate data and in mortality estimates using length and age composition data a high spatial resolution catch and effort monitoring programme should be developed.

7.2 Issues relevant to the assessment of the scallop fishery

No analytical assessments are currently undertaken. Limited size and age data are available and a series of annual surveys were undertaken in the period 2000-2005 in the Celtic Sea. Spatial variability in growth rates in particular indicates the need for a spatially explicit approach to assessment and therefore the need for spatially explicit and systematic sampling programmes.

A number of other approaches to assessment have been explored including depletion assessment of commercial catch and effort data with variable success.

7.3 Data sources

Available data predominantly consists of landings, catch and effort derived from logbook data and information on the number of dredges used by vessels and size composition data. The latter is obtained opportunistically at processing plants and at sea. Data at processing plants can be linked to vessel and ICES rectangle.

By-catch information is collected during MI observer trips undertaken quarterly on Irish vessels.

7.4 Evolution of the fishery 1970-2012

The Irish offshore scallop fishery developed in the 1970s south of Waterford and later expanded south into ICES VIIg. By 2000 the fleet was fishing in all the main beds in the Celtic Sea, Irish Sea and western approaches. By 2005 the fleet was fishing in the western and eastern Channel and had expanded the known boundaries of the Tuskar and the Celtic Sea beds. Following poor market conditions and costs of maintaining an ageing fleet and reported drop in catch rates some vessels were decommissioned in 2006 and effort dropped dramatically. Between 2006 and 2012 the fishery has expanded again in the Celtic and Irish Seas.

Annual landings reached an all time high of approximately 2,700 tonnes in 2012. Landings increased exponentially during the period 2006-2012 (Figure 26).

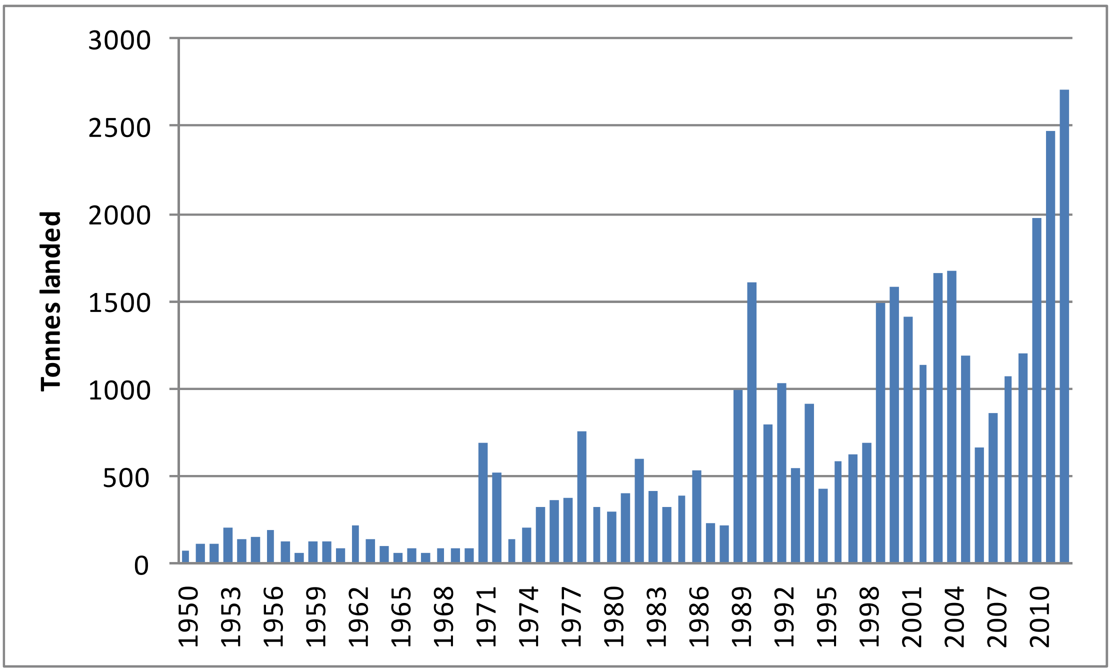


Figure 26. **Estimates of landings of scallop into Ireland 1950-2012 (source: ICES, EU logbook data with some correction factors).**

7.5 Stock structure and assessment units

7.5.1 Adult scallop beds

Scallop are distributed over large but discrete areas (beds) in the north east Celtic Sea, southern Irish Sea, Liverpool Bay, Cardigan Bay, the Western approaches and in various locations in the English Channel (Figure 27).

Smaller stocks occur in inshore waters on the south west and west coasts including Roaringwater Bay, Kenmare River, Valentia, at the Blasket Islands, in Galway Bay, Kilkieran Bay and Clew Bay.

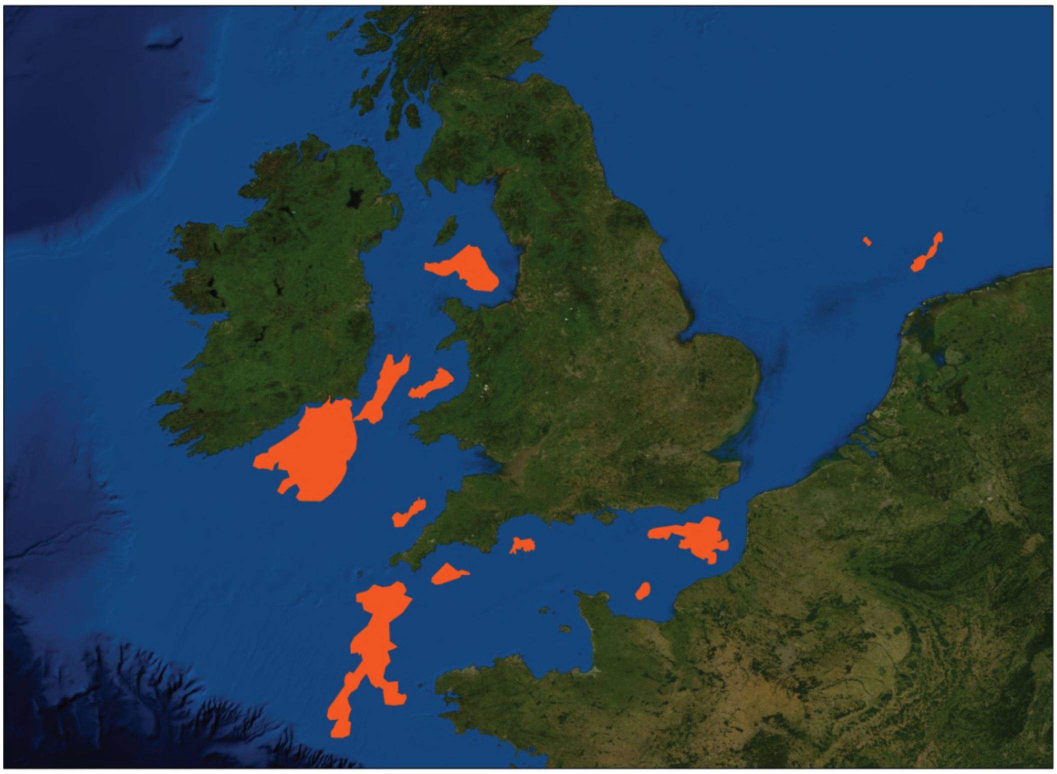


Figure 27. **Distribution of scallop beds in the Irish and Celtic Seas and English Channel inferred from VMS data from the Irish fleet 2004-2011.**

7.5.2 Larval dispersal and connectivity between adult stocks

The geographically discrete adult beds are potentially connected through larval dispersal from spawning scallops (Figure 28). Larvae may live in the water column for up to 42 days depending on temperature and food supply and can drift considerable distances during that time depending on prevailing currents and wind forcing.

Larvae disperse in a south westerly direction from the Celtic Sea stock and also from the Tuskar stock in the south Irish Sea. Dispersal from the Bristol Channel, Cardigan Bay and Liverpool Bay stocks is limited and in a northerly direction. These three stocks are isolated and are probably self recruiting. The Tuskar stock may supply recruits to the Celtic Sea which is partially self-recruiting. There appears to be limited transfer of larvae in an east west direction across the Irish Sea. This summary, presented in Figure 28, pertains to 2011 and used meteorological data and physical advection outputs for that year to drive the dispersal simulations.

Scallop beds which are interconnected, through larval dispersal to other beds may have more regular recruitment and be more resilient to fishing mortality than stocks which are isolated. For instance the north east Celtic Sea stock receives larvae from the Tuskar stock in the south Irish sea and from the Bristol Channel stock at the eastern margins. However, the scale and direction of connectivity may vary annually depending on meterological forcing during the larval phase.

Maximum extent of larval dispersal after 42 days

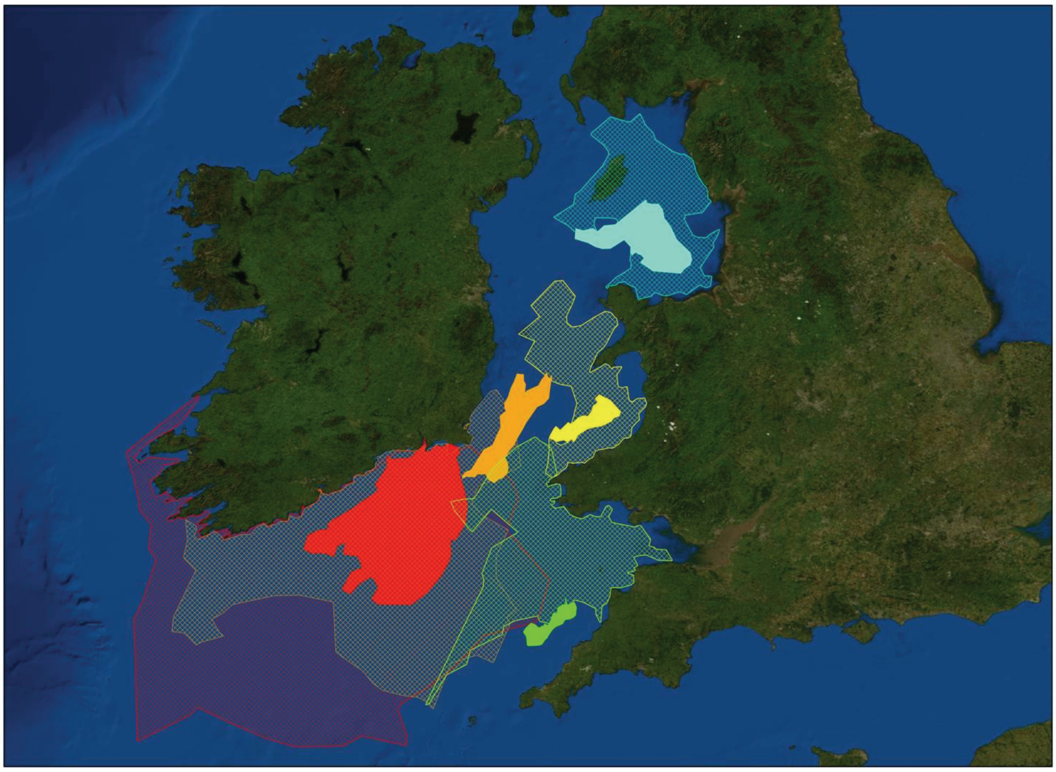


Figure 28. **Scallop larval dispersal in the Irish and Celtic seas. The coloured areas show the distribution of scallop beds. The semi-transparent layers show the distribution of larvae dispersed from each bed over 42 days. The arrows show the main direction and scale of dispersal. Dispersal simulations were carried out using the LTRANS model.**

7.6 Productivity Susceptibility Analysis

Productivity-Susceptibility Analysis (PSA) is a semi-quantitative and rapid risk assessment tool that uses information on the life history characteristics of a stock (i.e. productivity) and its susceptibility to the fishery in question. Stocks with a low productivity score and high susceptibility score are considered to be at a high risk of becoming depleted and may have long recovery times. The Productivity is intrinsic to the biological characteristics of the species (with variation between stocks perhaps) while the Susceptibility reflects the degree to which it is exposed to fishing effort and fishing mortality.

A modified version of PSA is used here, for the Celtic Sea stock only, to indicate changes in annual susceptibility of scallop due to changes in fishing patterns

$$S = A*((F*E)+(F*(M_c+M_d))$$

where A is the proportion of the area over which the stock is distributed that is exposed to fishing in the year. This is estimated from the distribution of VMS points in the year relative to the distribution of VMS points for the fishery in all years. F is fishing effort within A calculated as the total length of the dredge track derived from the VMS data and the width of the dredge track estimated from the known number of dredges used by each vessel. F is discounted for dredge efficiency (E) (here taken to be 0.14) but additional mortality due to contact with the dredge (M_c, arbitrarily estimated at 0.1) and discard mortality (M_d, also 0.1) is accounted for. In this way changes in gear design that might affect M or E can be incorporated into the index. S here is the effective effort of the fleet on a given stock.

Productivity scores for scallop were calculated at 1.44 (in a scale range of 1-3 where 1 is highly productive and 3 is low productivity). Scallop have high fecundity, mature and breed at an early age and have a low trophic level. These characteristics indicate that scallop may be resilient (have high recoverability) to fishing mortality.

In the Celtic Sea stock susceptibility to fishing was highest during the period 2001-2004 and at its lowest point in 2006. Although effort increased from 2006-2011 the proportion of the stock area (determined from all VMS data points for the period 2001-2011) exposed to fishing during these years remained low and susceptibility scores accordingly remained relatively low. There were no changes to gear design or configuration that would have changed efficiency or contact or discard mortality.

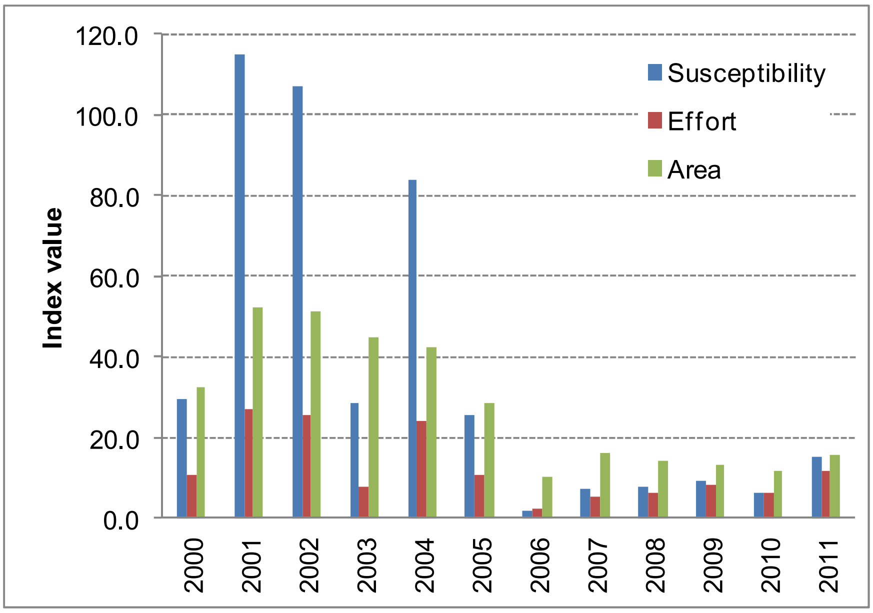


Figure 29. Susceptibility, effort and fishing area indices for the scallop fleet in the Celtic Sea 2000-2011.

7.7 Catch per unit effort indicators

Catch per unit effort data were derived from EU logbook data which shows daily landings by ICES rectangle and separate information on the number of dredges used by each vessel (this is highly correlated with vessel length). There are a number of data quality issues associated with this index including missing data, outlying and implausible values and poor correlation between the sum of the logbook data and the official reported landings. Data on fishing hours per day is poorly recorded in the logbooks and is not used here. Therefore the index assumes there has been no trend in daily hours fished during fishing operations during the period. There is seasonality in the catch rates which are not standardised for.

LPUE was stable in the four main areas fished by the Irish fleet during the period1995-2004 at approximately 40kgs.dredge^{-1}.day^{-1}. LPUE increased from 2004-2010 in the south Irish Sea, in the Celtic Sea and in waters off the Isle of

Man. LPUE declined in the Western Channel from 2004-2008 but was higher in 2010-2011 (Figure 30).

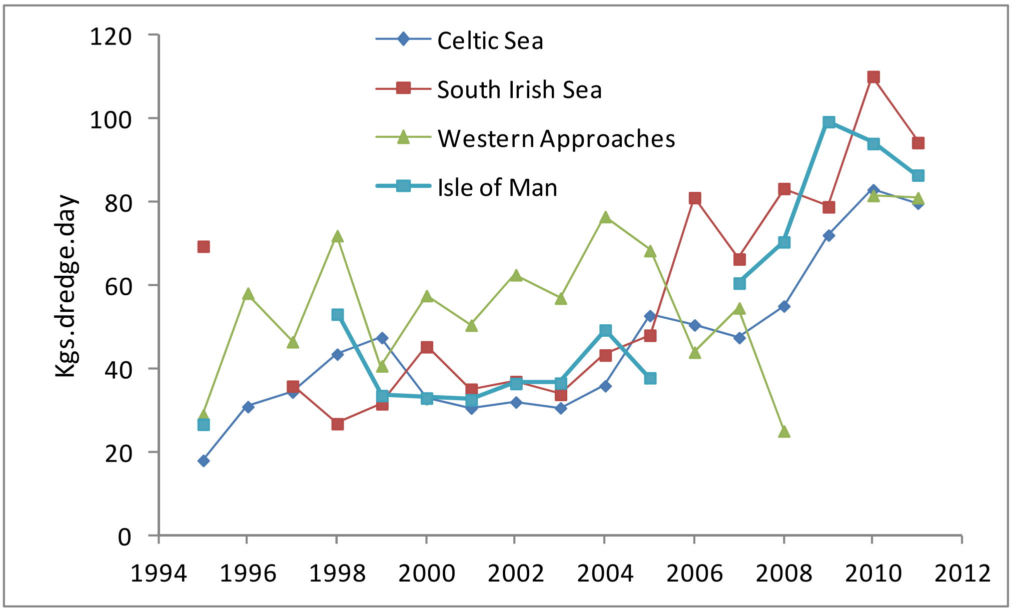


Figure 30. Catch per unit effort index for the main scallop grounds fished by the Irish fleet 1995-2011.

7.8 Eastern Celtic Sea

7.8.1 Landings and effort

Increased fishing activity by the Irish >15 m fleet since 2006 has resulted in increased landings and effort in the Celtic Sea (Figure 31). Landings increased from 368 tonnes in 2006 to 1,452 tonnes in 2011. There was a slight decline to 1,375 tonnes in 2012. In recent years the majority of fishing in the Celtic Sea has occurred in ICES statistical rectangles 32E2 and 33E3 but also 32E3 and 31E2.

VMS hrs increased from 4,465 hrs in 2006 to 15,372 hrs in 2012. Landings and VMS effort were linearly correlated. This correlation does not suggest an increase in LPUE.

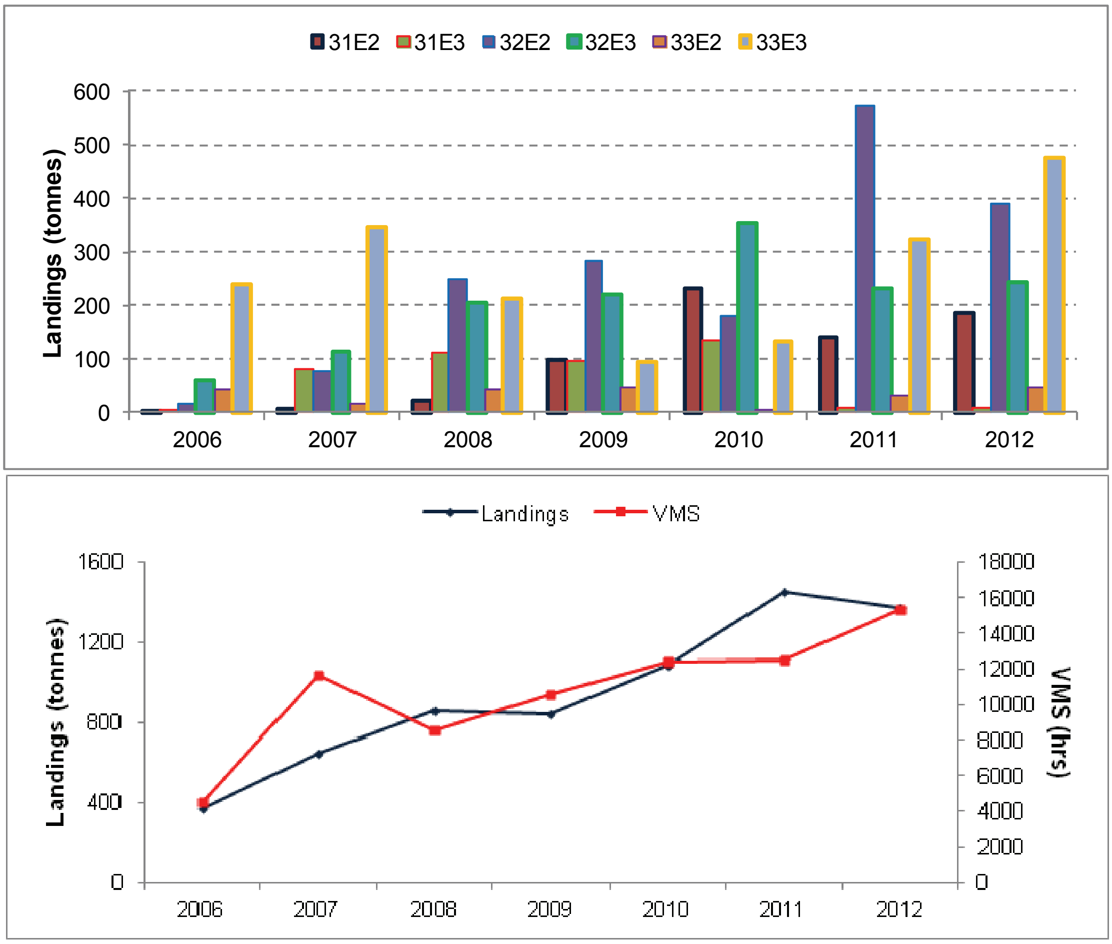


Figure 31. Landings by ICES statistical rectangle and total landings and effort by year in the Celtic Sea scallop fishery 2006-2012.

7.8.2 Size and age composition

The size distributions of scallop in the commercial landings from the Celtic Sea were largely similar in the period 2008-2011, with a mean shell height of 94 mm. In 2012 the mean shell height of Celtic Sea scallop increased by 3 mm to 97 mm.

From 2008-2012 the shell height ranged in size from 78-127 mm. The larger sized scallops caught in 2012 were fished from ICES statistical rectangles 32E2, 33E2 and 33E3.

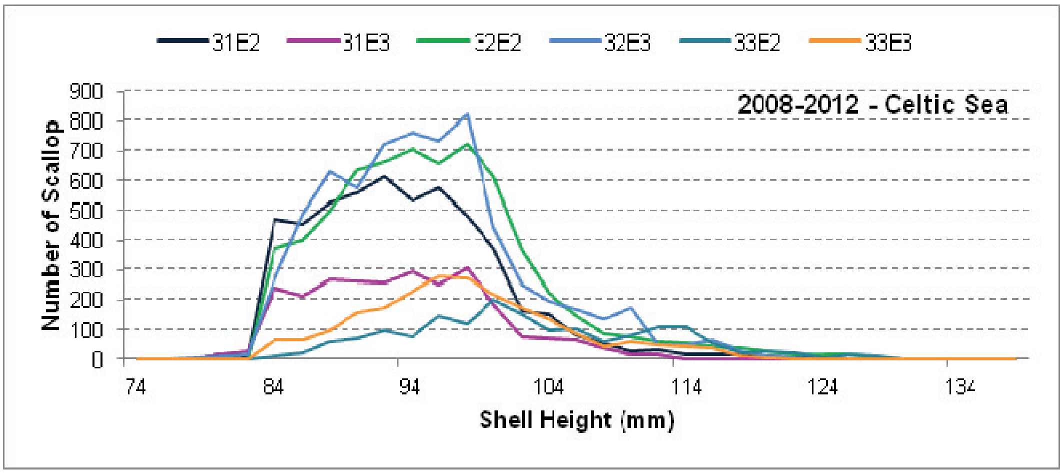


Figure 32. **Shell height distribution of scallop in landings by statistical rectangle for the Celtic Sea in the period 2008-2012 (no data for 2006 or 2007).**

7.8.3 Mortality

Size composition data for the Celtic Sea are available for the period 2009-2012. Using an age length key derived for the period 2001-2004 these data have been converted to age composition. A crude raising factor of the ratio of the sample weights to total weight of the landings provides the age composition of the landings. A pseudocohort (analysis of numbers at age in a single year data) or true cohort analysis provides estimates of Z of 1.6 between ages 5-8. There are currently many sources of bias and uncertainty in these data; age length keys need to be updated annually or quarterly to raise the size composition of the landings to age composition. This process also needs to be disaggregated to ICES rectangle within stock to account for spatial variability in growth rate. The process of raising requires an improved sampling design (Figure 33).

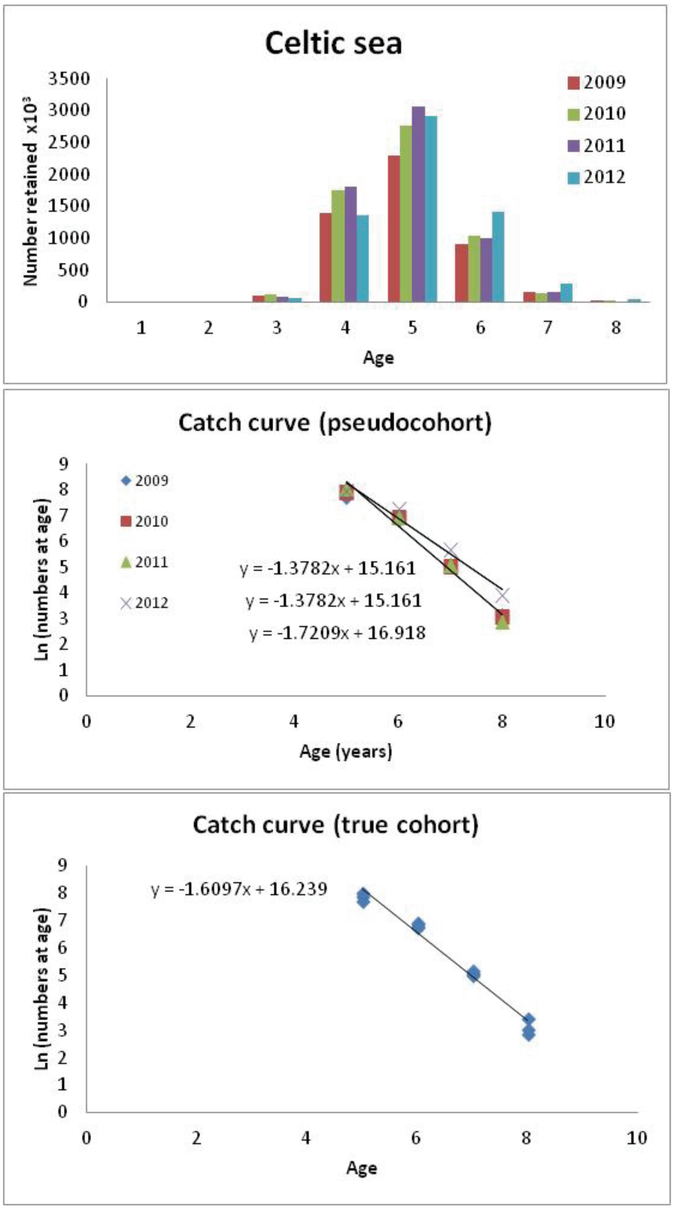


Figure 33. **Age composition of landings and estimates of mortality from pseudo cohort and cohort analysis of fully recruited (5-8) age classes.**

7.9 South Irish Sea

7.9.1 Landings and Effort

Scallop landings from the south Irish Sea increased overall from 2006-2011. Landings declined from 2011 to 2012. VMS effort and landings were highly correlated (Figure 34).

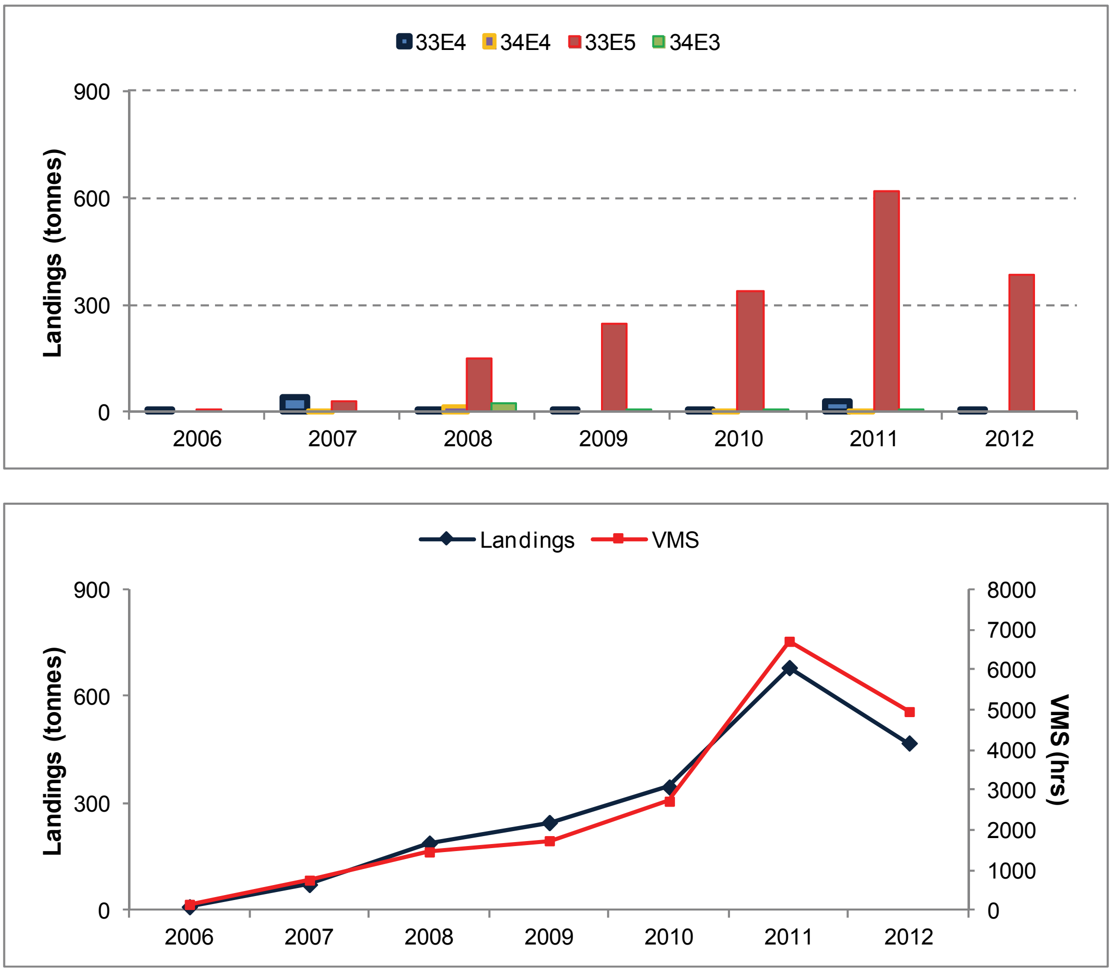


Figure 34. **Landings by ICES statistical rectangle and total landings and effort by year in the southern Irish Sea scallop fishery 2006-2012.**

7.9.2 Size and age composition

From 2009-2012, the majority (90%) of measured scallop from the South Irish Sea were fished from ICES statistical rectangle 33E5, where they ranged in size from 79-133 mm shell height. Mean shell height was 99±0.1 mm over the four years (Figure 35).

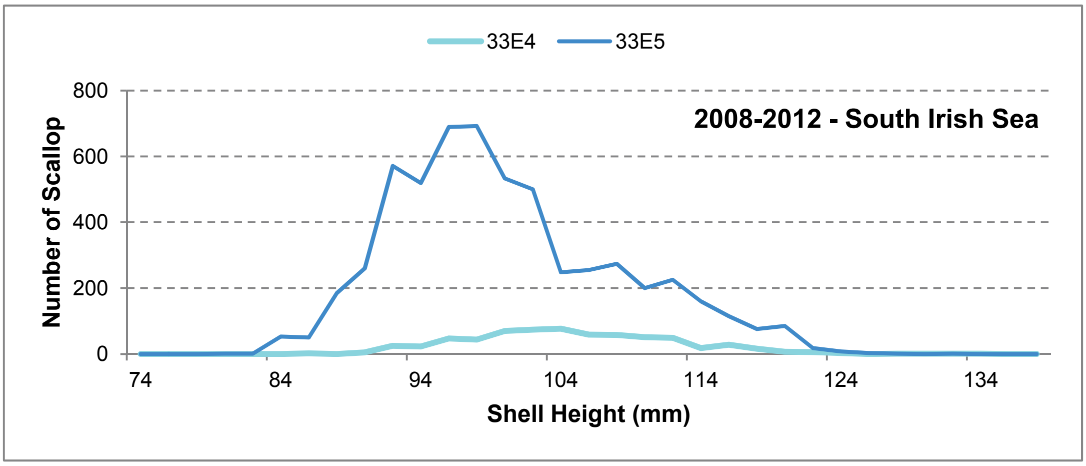
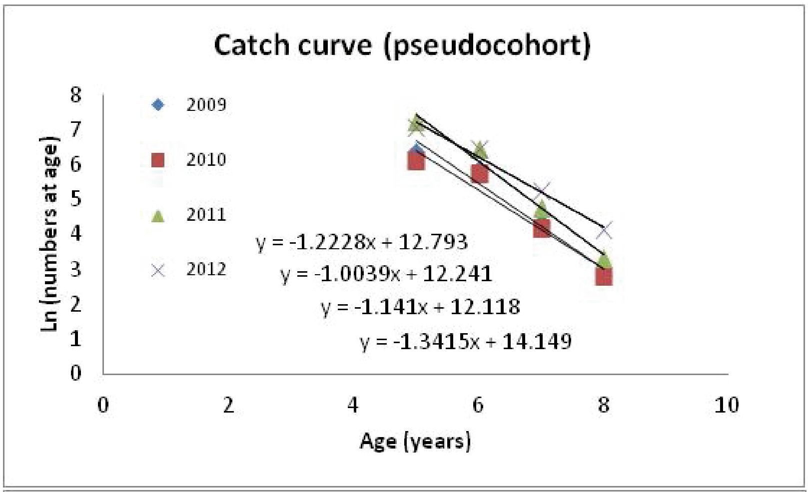


Figure 35. **Shell height distribution of scallop in landings by statistical rectangle for the south Irish Sea in the period 2008-2012 (There are no shell height measurements available for 2006 or 2007).**

7.9.3 Mortality estimates

Pseudocohort (analysis of numbers at age in a single year data) or true cohort analysis provides estimates of Z of 1.1 between ages 5-8. The same caveats apply to these estimates as described above for the Celtic Sea (Figure 36).



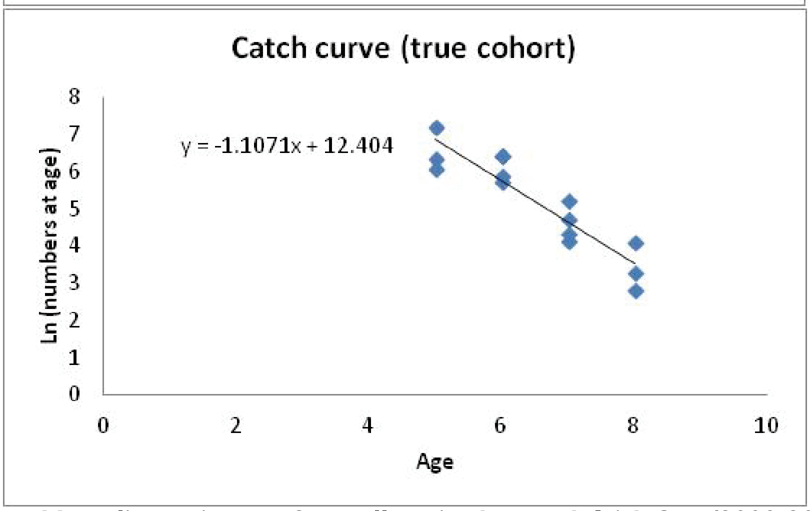


Figure 36. **Mortality estimates for scallops in the south Irish Sea (2009-2012).**

8 Surf clam (*Spisula solida*)

8.1 Management advice

The Waterford estuary stock is assessed by annual survey and retrospective analysis of LPUE data. LPUE is stable but average age is increasing and recruitment to the stock is episodic. TAC has been agreed on a voluntary basis since 2010. This should continue and take into account the increasing age profile of the stock and absence of regular recruitment. The same management process may be suitable for other surf clam stocks.

8.2 Issues relevant to the assessment of the surf clam fishery

The fishery is currently regulated using a minimum legal size of 25 mm shell length (longest dimension) effected through on board mechanical grading. Voluntary, TAC agreements have been in place in recent years.

The spatial extent of surf clam beds is very limited and the species requires particular substrates of coarse sand. There are at least six surf clam beds around the coast but not all are fished.

The species is relatively slow growing and long lived. Recruitment appears to be highly variable and the fishery may rely on strong year classes recruiting periodically into the stock. Year on year depletion of biomass, due to fishing mortality, may occur especially if there is no recruitment for a number of years.

Fishery independent survey estimates and age disaggregated catch rate data can provide indicators of trends in stock, biomass and recruitment. Provision of catch and effort data by industry is good and has been a legislative requirement in some cases. This, together with local TAC agreements, has improved the management of the fishery compared to historic 'boom and bust' scenarios.

8.3 Management Units

Surf clam beds exist as discrete locally distributed populations with specific substrate (coarse sand, gravel) requirements. A number of beds exist around the coast; Waterford Harbour, Youghal, at the Sovereign Rocks in Cork, south east Galway Bay, Kilkieran Bay, Clifden and Iniskea Island in Mayo. The Waterford Harbour, Clifden and Galway Bay stocks are exploited more frequently than the others. Each clam bed can be treated as a separate management unit.

8.4 Waterford estuary

8.4.1 Biomass 2010-2012

The biomass estimate for surf clams in the Waterford estuary in March 2012 was 219±50 tonnes. This value assumes a dredge efficiency of 100%, which is unlikely, and was higher than the 2011 biomass estimate of 175 tonnes (Figure 37 and Table 16). The variation in survey methodologies could account for the difference in biomass between years. However the total weight of surf clams above the minimum landing size of 25 mm (shell length) was less, 185±42 tonnes. The survey methodologies used to evaluate the surf clam stock in Waterford estuary have been poor to date resulting in crude biomass estimates and thus a precautionary TAC of 50 tonnes was proposed for the 2012 fishery. The market demand for the year was thought to be in the region of 80 tonnes. Further monitoring surveys were undertaken on the 19th and 29th May 2012. Dredge efficiency for these surveys was assumed to be 50% and a total biomass of 611±210 tonnes was estimated. An additional 40 tonnes of TAC was allocated as the March survey was thought to have underestimated the actual biomass.

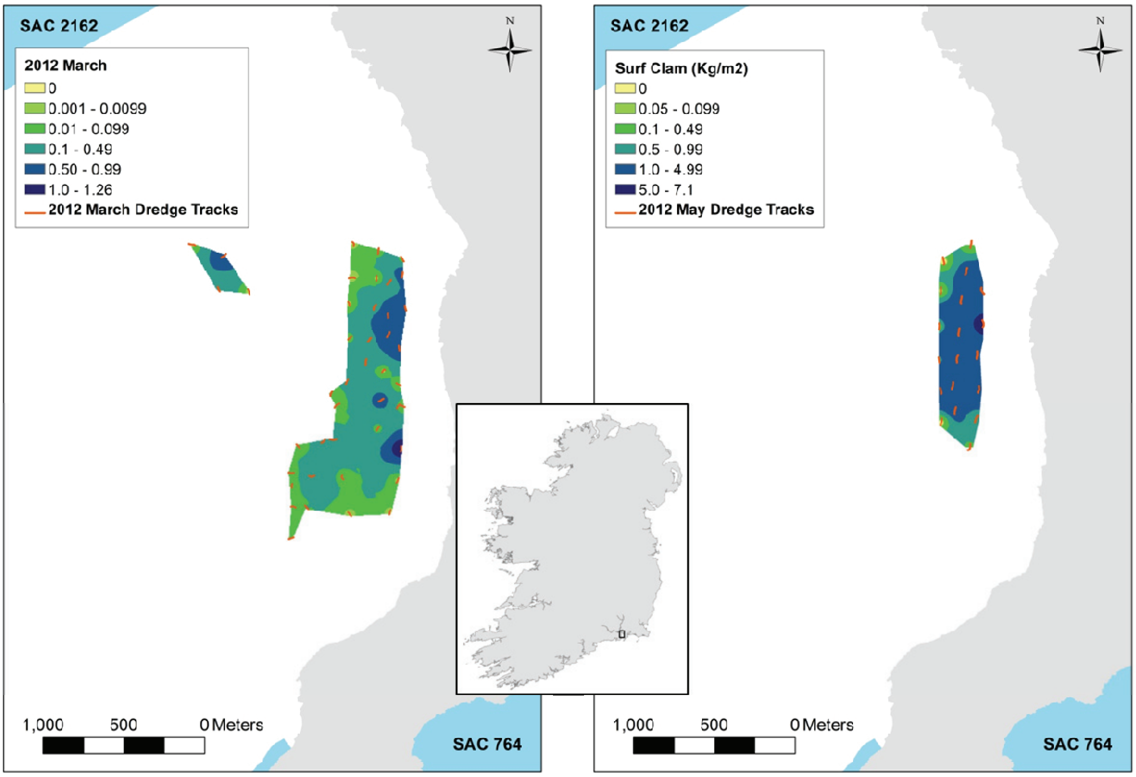


Figure 37. **Distribution of surf clam biomass in the Waterford estuary March and May 2012 (The location of the surf clam bed is indicated by a black rectangle on the inset map of Ireland).**

Table 16. **Biomass estimate of surf clams in the Waterford estuary in March 2012.**

Weight Contours	Area (m^2)	N	Weight (Kg)			Biomass (tonnes/m^2)	
			Mean	SD	95% CL	Total	95% CL
0	0	3	0.000	0.00	0.00	0.00	0.00
0.001-0.0099	11184	7	0.003	0.00	0.00	0.03	0.01
0.01-0.099	201397	14	0.042	0.03	0.01	8.44	2.82
0.1-0.49	464370	10	0.243	0.14	0.08	112.70	39.11
0.5-0.99	106417	7	0.851	0.10	0.08	90.61	8.15
1.0-1.26	5603	1	1.267	0.00	0.00	7.10	0.00
Total	**788971**	**42**				**218.88**	**50.09**

8.4.2 Size and age composition 2009-2012

Age composition data suggests that recruitment to the clam bed may be irregular with strong and weak year classes (Figure 38). The age composition of the landings was dominated by 3 year old clams in 2009 and 4+ clams in 2010. Four year olds also dominated in 2011, to a lesser extent, with the second highest proportion being 5 year olds. In 2012 33.8% of the 645 clams aged were 5+ and 83.9% of the clams were ≥25 mm in shell length. The modal shell length in 2012 was 35 mm.

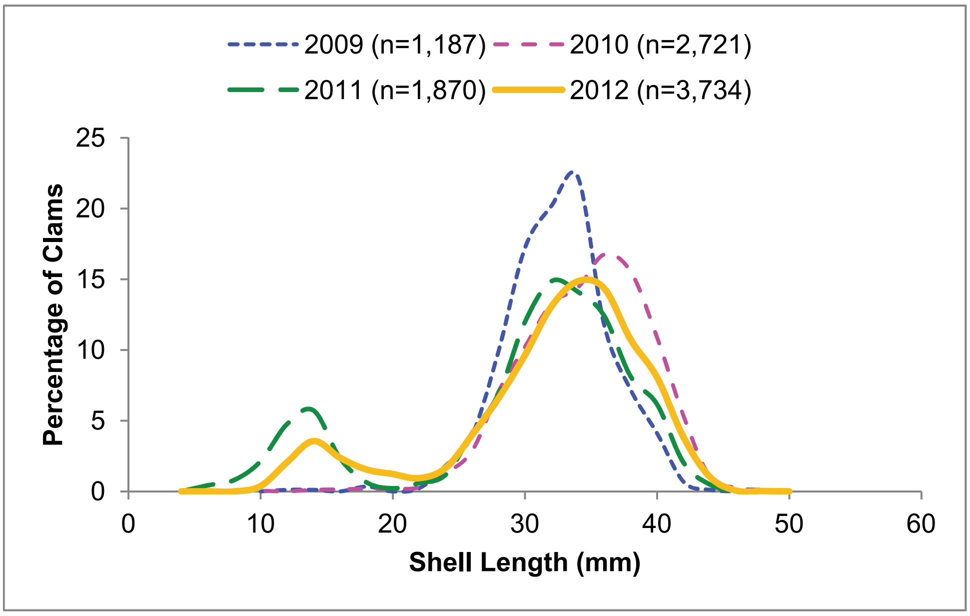


Figure 38. **Shell length of surf clams sampled in 2009, 2010, 2011 and 2012.**

Table 17. **Numbers and mean measurements recorded from surf clams sampled in 2012.**

Variable	Number	Mean	Standard Deviation	Standard Error
Height (mm)	3,734	23.73	6.30	0.10
Length (mm)	140	34.56	3.79	0.32
Age (yr)	645	3.89	1.79	0.07

8.4.3 Landings and catch rates 2009-2012

Total annual landings in the period 2009-2012 were 39, 162, 73 and 49 tonnes respectively. A total TAC of 90 tonnes, in two phases of 50 and 40 tonnes, was agreed in 2012. Harvest rules in this fishery included a minimum size of 25 mm shell length, a maximum landing of 2 tonnes per boat per day and an agreement to close the fishery when catch rates declined to 50% of their start of season value. No significant in season or across year depletion in catch rate was observed (Figure 39). Taking the years 2009-2012 in sequence is justified given the apparent absence of recruitment into the stock in 2009 and 2010 and the observed progression in the age composition of the landings during 2009-2012. Recruitment was observed in 2011 and 2012.

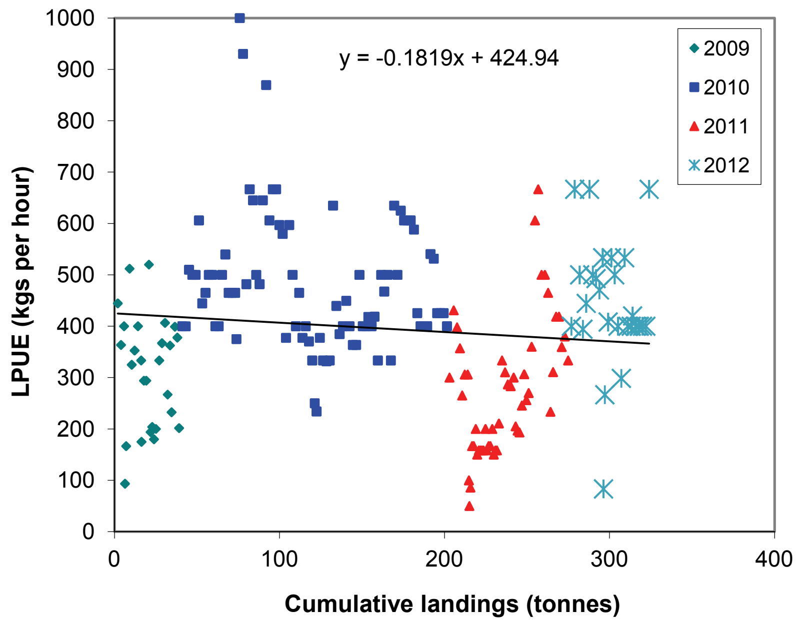


Figure 39. **Landing rates (kgs.hr^{-1}) in the Waterford Estuary surf clam fishery in relation to cumulative landings in 2009, 2010, 2011 and 2012.**

9 Cockle (*Cerastoderma edule*)

9.1 Management advice

The Dundalk cockle stock is assessed by annual survey and in season LPUE data. TAC is 33% of total biomass on condition that ecosystem indicators (seabeds, bird populations) are stable.

The management regime for cockles in Dundalk Bay in the period 2007-2012 used a suite of measures which effectively limited exploitation rates and protected juvenile cockles. The fishery measures as outlined in the various cockle management plans should be continued.

Maintenance of good environmental status in the intertidal habitats in which these fisheries occur should be a primary objective in order to reduce the risk of future recruitment failure and to ensure that conservation objectives for designated habitats and species are protected.

9.2 Issues relevant to the assessment of the cockle fishery

There are a number of cockle beds on the Irish coast. In recent years the main fishery has occurred in Dundalk Bay.

The Dundalk fishery is currently managed by a minimum landing size (17 mm shell width), seasonal closures, TAC (33% of biomass) and minimum biomass and catch rate opening and closing conditions, respectively.

Recruitment of cockles in Dundalk Bay occurs regularly but overwinter survival, in particular, is highly variable. As a consequence biomass, in some years, is insufficient to support a fishery. Recruitment failures occur frequently in the Waterford estuary and overwinter survival is also variable.

Annual surveys, provided they are completed close to the prospective opening date for the fishery, provide good estimates of biomass available to the fishery and the prospective catch rates.

Data provision by industry is mandatory, well complied with and provides in season data on catch and effort for implementation of TAC and catch rate harvest control rules.

Dundalk Bay and Waterford estuary are Natura 2000 sites. Cockle is both a characterising species of designated habitats within these sites and also an important food source for overwintering bird populations. Management of cockle fisheries must and is taking into account the conservation objectives for these habitats and species.

Continuing commercial fisheries for cockles in Natura 2000 sites will depend on favourable conservation status in designated environmental features that may be affected by this fishing activity.

9.3 Management Units

Cockle stocks occur in intertidal sand and mud habitats. These habitats occur as isolated and discrete areas around the coast and as a consequence cockle stocks occur as locally self-recruiting populations.

Although there are many cockle populations around the coast only two have supported commercial dredge fisheries in recent years; Dundalk Bay and Waterford estuary. Commercial stocks also occur in Tramore Bay, Co. Waterford and in Clew Bay Co. Mayo but these stocks have not been commercially fished in recent years.

9.4 Dundalk Bay

9.4.1 Biomass 2007- 2012

Biomass estimates from annual surveys in 2007-2012 are not strictly comparable because of differences in the time of year in which surveys were undertaken (Table 18). The annual estimates are highly sensitive to the timing of in year settlement and seasonal mortality of established cohorts relative to the time in which the surveys are undertaken. The March 2007 survey for instance would not have detected settlement that occurred in 2007.

The 2007 biomass of 2,277 tonnes was distributed mostly in cockles greater than 18 mm shell width. The fishery in 2007 removed approximately 900 tonnes (including an approximate estimate for hand gatherers) of cockles over 22 mm. Biomass was highest in 2008 due to a strong recruitment in the spring of 2008. The majority of the biomass in 2008 was less than 18 mm shell width and dominated by the 0+ cohort. There was no fishery in 2008. Biomass in 2009 was lower than in 2008 and similar to 2007. This was mainly due to lower densities of 0+ cockles. The biomass in 2010 was approximately 25% of the 2009 biomass and by far the lowest recorded since 2007. The stock in 2010 was dominated, numerically, by recently settled 0+ cockles and a low population density of adult cockles. The 1+ and 2+ cohorts were weakly represented. In May 2011 the biomass was 1,531 tonnes. The population was dominated numerically by 0+ and 1+ cohorts.

Although the stock was not fished in 2008 the biomass was lower in 2009 than in 2008 and lower again in 2010 despite the total landings from the 2009 fishery being only 108 tonnes. Natural mortality appears to have been very high during the winter of 2008-2009 and 2009-2010. This was verified by sampling of a high density patch of cockles from August 2008 to March of 2009 in the middle of the south Bull area. The biomass estimated in 2011 was approximately twice that recorded in 2010.

Table 18. Annual biomass, TAC and landings of cockles in Dundalk Bay 2007-2012.

Year	Survey Month	Biomass		TAC (Tonnes)	Landings (Tonnes)	
		Mean	95% CL		Vessels	Hand gatherers
2007	March	2,277	172	950	668	Unknown
2008	August	3,588	1,905	0	0	0
2009	June	2,158	721	719	108	0.28
2010	May	814	314	0	0	0
2011	May	1,531	94	510	325	0.25
2012	May	1,234	87	400	394	9.4

9.4.2 Biomass in 2012

A pre fishery survey was completed in May 2012. The fishery was open on July 1st and closed on August 26th when the TAC of 400 tonnes was taken.

The total biomass, ± 95% confidence limits, of cockles in the sampling domain (22.9 km^2) was 1,234±87 tonnes (Table 19, Figure 40). Approximately 1,049 tonnes of this biomass occurred in densities of over 5 m^{-2}. The biomass of cockles over 18 mm shell width was 998±72 tonnes with approximately 576 tonnes occurring in densities over 5 m^{-2}. The biomass of cockles greater than 22 mm shell width was 697±57 tonnes. Of which 175 tonnes occurred in densities over 5 m^{-2}.

Table 19. **Distribution of cockle biomass in Dundalk Bay in May 2012.**

Contours	Area		Density				Biomass (gm^{-2})		Biomass (tonnes)	
	Area (m^2)	% of area	N	Mean	S.d.	CL	Mean	CL	Mean	CL
0	35526	0.16	26	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.12 - 0.99	702183	3.07	33	0.46	0.21	0.07	3.65	0.84	2.57	0.59
1.0 - 4.99	7178297	31.38	98	3.00	1.05	0.21	25.43	2.27	182.57	16.28
5.0 - 9.99	9810902	42.89	69	7.22	1.31	0.31	54.13	3.33	531.05	32.71
10.0 - 24.99	5024052	21.96	76	14.37	3.94	0.89	97.83	6.84	491.48	34.37
25.0 - 39.99	106097	0.46	5	27.55	2.06	1.80	205.40	22.10	21.79	2.34
40.0 - 46.0	16958	0.07	2	45.75	0.71	0.98	267.42	32.73	4.53	0.56
Total	**22,874,014**		**309**						**1,234**	**87**

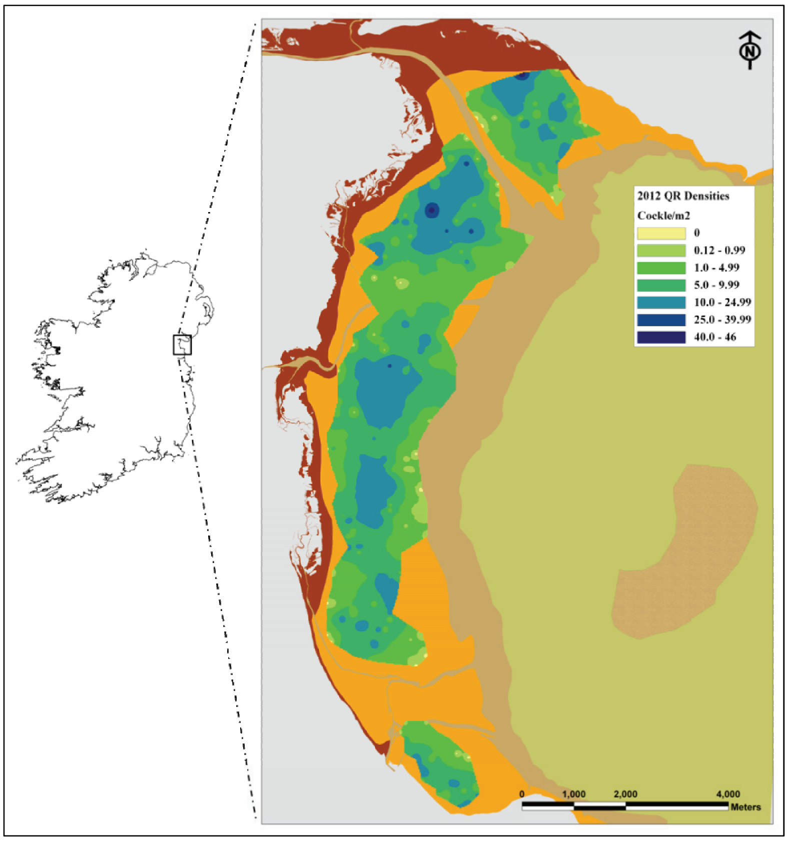


Figure 40. **Distribution of cockles in Dundalk Bay in May 2012. The surveyed area was 22.9km^2.**

9.4.3 Size and age in 2012

The size distribution of cockles in the samples was dominated by the 0+ and 1+ cohorts at modal shell widths of approximately 8 mm and 21 mm (Table 20, Figure 41).

The dominant 0+ cohort from 2011 grew and became the 1+ cohort for 2012.

In May 2011 0+ cockles made up 62% of the those sampled and the 1+ group made up 18%. A year later only 34.9% of the cockles surveyed were 0+ cockles, while the 1+ cohort made up a further 54%. A proportion of the second component in the 2012 size distribution also contained cockles of 2+ and older.

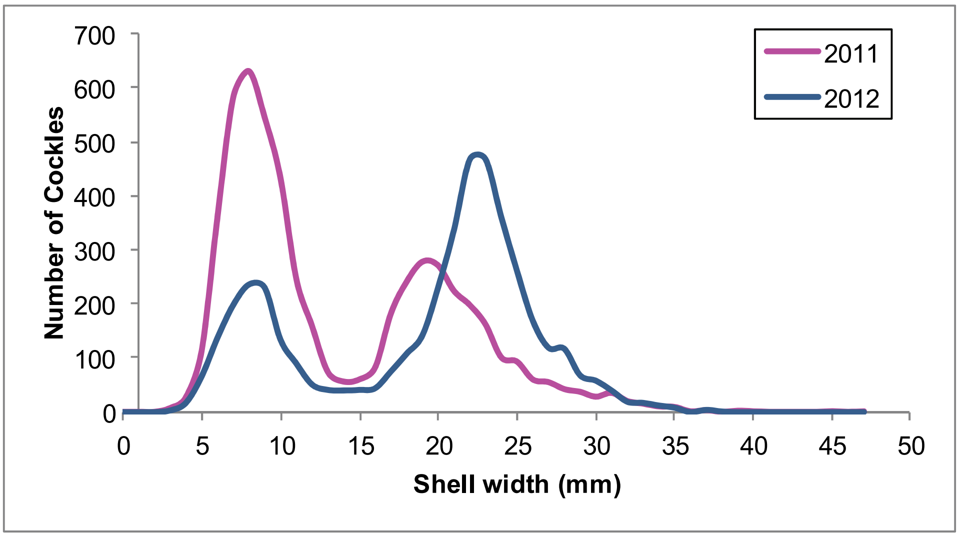


Figure 41. Shell width distribution of cockles in Dundalk Bay in May 2012 and May 2011. The operational minimum landing size is 22 mm.

Table 20. Size at age data for Dundalk cockles in May 2012.

Age	0+	1+	2+	3+	4+	5+
N	401	614	89	36	9	1
%	34.87	53.39	7.74	3.13	0.78	0.09
Mean±SE (mm)	8.83±0.09	22.13±0.06	26.95±0.19	31.16±0.26	33.22±0.57	36.5

9.4.4 Landings and catch rates in 2012

Estimates of total landings varied from 397 tonnes in the fishing activity records to 410 tonnes in sales data (source SFPA). Catch rates declined from approximately 300 $kg.hr^{-1}$ on week 3 of the fishery to 190 $kg.hr^{-1}$ on week 8 (Table 21, Figure 42). Extrapolation to zero catch rate provided an estimate of pre-fishery biomass of approximately 1,000 tonnes of cockle over 22 mm. This compared to 998 tonnes over the MLS of 18 mm from the survey and 697 tonnes over 22 mm.

Table 21. **Landings (tonnes) by week and gear type in the 2012 Dundalk Bay cockle fishery. Total landing was 397 tonnes. Date of landing is unknown for 30 tonnes. Landings data from Fishing Activity records.**

Week	Suction	Non-suction	Unspecified	Total
1	0.00	0.75	0.00	0.75
2	0.00	0.25	0.00	0.25
3	3.86	2.92	0.00	6.78
4	78.83	33.89	0.00	112.72
5	46.61	16.30	0.55	63.46
6	27.59	9.40	0.00	36.99
7	74.45	35.63	0.00	110.08
8	27.47	9.07	0.00	36.54
Total	**258.80**	**108.22**	**0.55**	**367.57**

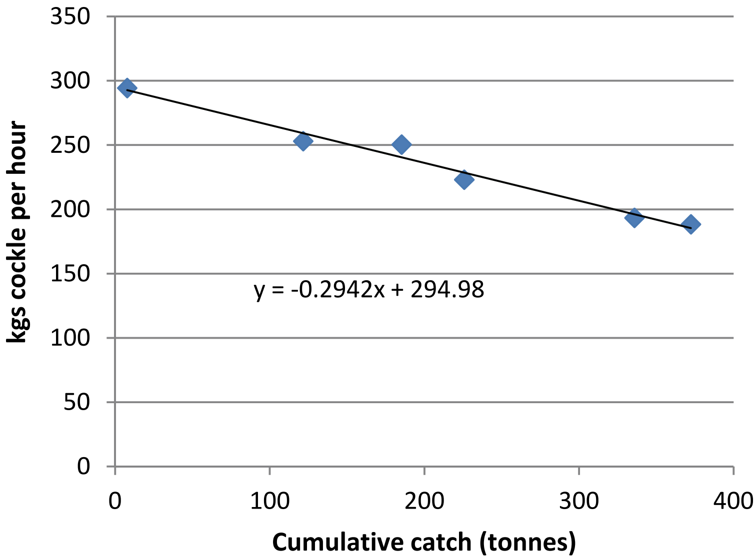


Figure 42. **Average landing rate per week (kgs.hr^{-1}) plotted against cumulative landings in the 2012 Dundalk Bay cockle fishery. Extrapolation to zero catch rates provides a pre-fishery estimate of biomass of cockles over 22 mm of approximately1,000 tonnes.**

9.5 Ecosystem indicators

9.5.1 Impacts on non target invertebrates

Core samples were collected at North Bull, Dundalk Bay during low tide on Aug 9th and 22nd from within visible dredge tracks (impact samples) and outside these tracks (control samples). Three impact and three control samples were taken at each of four stations across the fishing ground on August 9th and this was repeated on August 22nd.

The majority (74%) of cockles were collected from control samples (Table 22). All cockles over 22 mm were recorded from control samples collected on the 22nd August. None of the cockles sampled showed any sign of dredge damage.

A higher number of dead cockle shell was recorded in impact stations than in controls on August 22nd (Table 23). The dominant bi-valve species in the samples was *Angulus tenuis*. Mean abundances of *A. tenuis* were higher in samples collected from control stations compared with impact samples (Table 24).

Table 22. Abundances of *Cerastoderma edule* recorded from core samples collected from within (impact) and outside (control) dredge tracks in the north of Dundalk Bay on the 9th and 22nd August.

Sampling Event	Stations	Control	Impact
9th August	1	0	1
	2	0	0
	3	1	0
	4	2	0
22nd August	1	3	0
	2	1	1
	3	3	0
	4	7	4

Table 23. Dead shell of *Cerastoderma edule* recorded from core samples collected from within (impact) and outside (control) dredge tracks in the north of Dundalk Bay on the 22nd August.

Sampling Event	Stations	Control	Impact
22nd August	1	133	261
	2	1	2
	3	5	2
	4	6	9

Table 24. Mean abundances (± SD) of *Angulus tenuis* from Control and Impact samples collected from Dundalk Bay on the 9th and 22nd August.

Sampling Event	Stations	Control	Impact
9th August	1	4.67 ± 3.06	2.67 ± 1.53
	2	12.33 ± 2.52	9.33 ± 3.79
	3	4.33 ± 1.15	4.00 ± 1.00
	4	10.67 ± 4.73	7.33 ± 3.79
22nd August	1	9.83 ± 3.54	3.33 ± 1.03
	2	8.33 ± 3.50	7.50 ± 2.43
	3	11.83 ± 3.37	8.17 ± 2.99
	4	12.83 ± 3.06	9.17 ± 2.79

The shell of *Angulus tenuis* is thin and the bivalve occurs in the top few centimetres of sediment (Tebble, 1976) and is, therefore, vulnerable to capture by cockle fishing gear in surface sediments. The sensitivity of *A. tenuis* to abrasion and physical disturbance that may be caused by fishing activity has not been reported. However, the sensitivities of similar species such as *Fabulina fabula*, *Macoma balthica* and *Cerastoderma edule* are classified as low (http://www.marlin.ac.uk/). Although they have intermediate intolerance to physical abrasion the recoverability of these species is high due to short generation times and the fact that they mature in their first or second year of life. Seasonal variability in these species is strong and dominated by recruitment and growth in summer and mortality during winter. Kraan *et al.* (2007) showed increased abundance of *A. tenuis* one year after a dredge fishery for cockles in the Dutch Wadden Sea.

9.5.2 Monitoring distribution and abundance of non-target species

Monitoring and mapping of *A. tenuis* in 2008, 2011 and 2012 in Dundalk Bay (Figure 43) shows that the distribution and abundance of *A. tenuis* is stable with overall densities ranging from 4-200+ individuals per m^2. No population level effects of cockle fishing on this species have been observed to date.

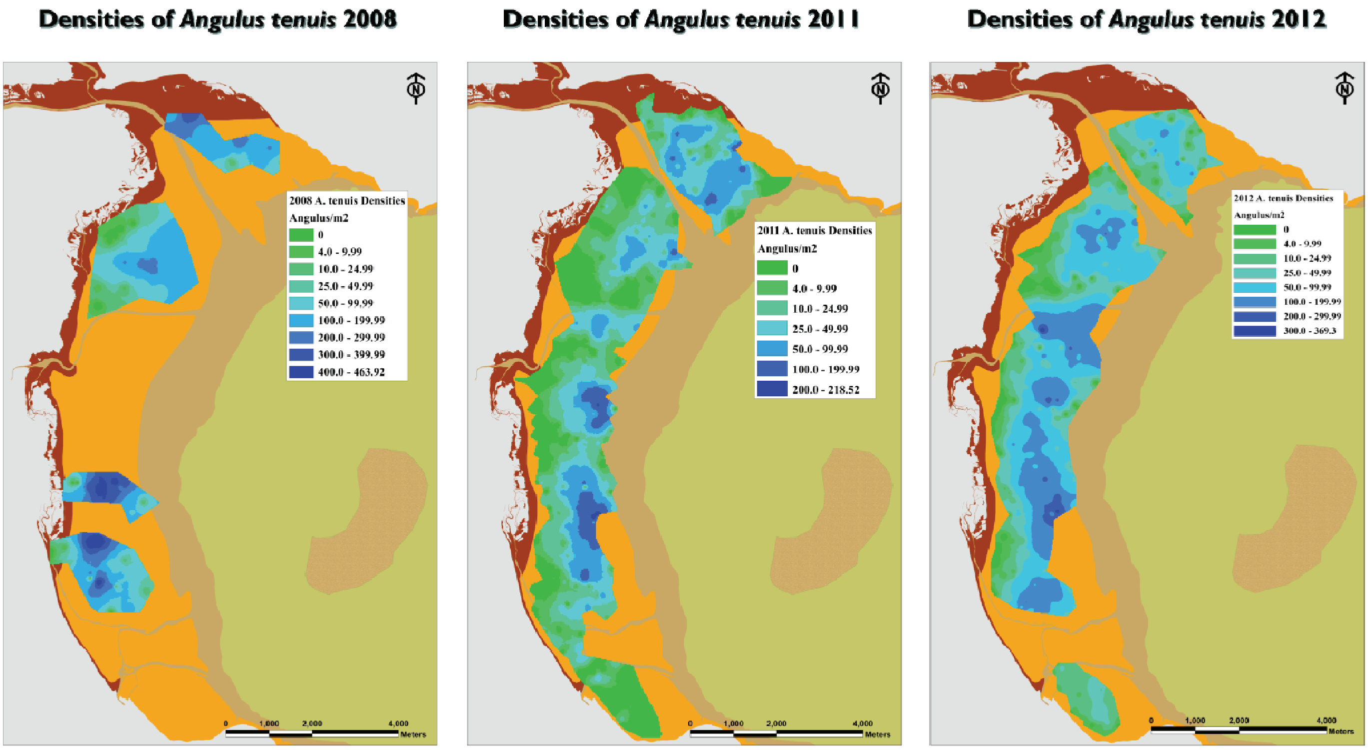


Figure 43. Density distributions of the bivalve *Angulus tenuis* in Dundalk Bay 2008, 2011 and 2012.

9.5.3 Oystercatcher population trends

In the period 2011-2013 two independent surveys of oystercatcher populations have been completed; a high tide monthly count by I-WeBS and a low tide monthly count by Atkins Ireland under contract to the MI. The data shows that the I-WeBS survey significantly underestimates the number of oystercatcher at the site.

The I-WeBS data showed peak counts of 7,655 in 2011/12 and less than 6,000 in 2012/13 resulting in an I-WeBS index for oystercatchers of 0.72. The annual index is relative to a long term average and indicates a decline in the population.

Full low tide counts are not available for the 2011/12 season. However, the Oystercatcher population size can be estimated from the upper shore/outer bay low tide counts and numbers estimated from the scan counts of the main sandflats. These estimates indicate a total population size of around 7,000-8,000 during the 2011/12 winter which would give a population index for 2011/12 of 1.04-1.13.

The low tide counts for the 2012/13 season show a very consistent seasonal pattern (Figure 44, Figure 45). These counts are considered to provide a very reliable population estimate and indicate a total population size for 2012/13 of around 10,000 which would give a population index for 2012/13 of 1.24.

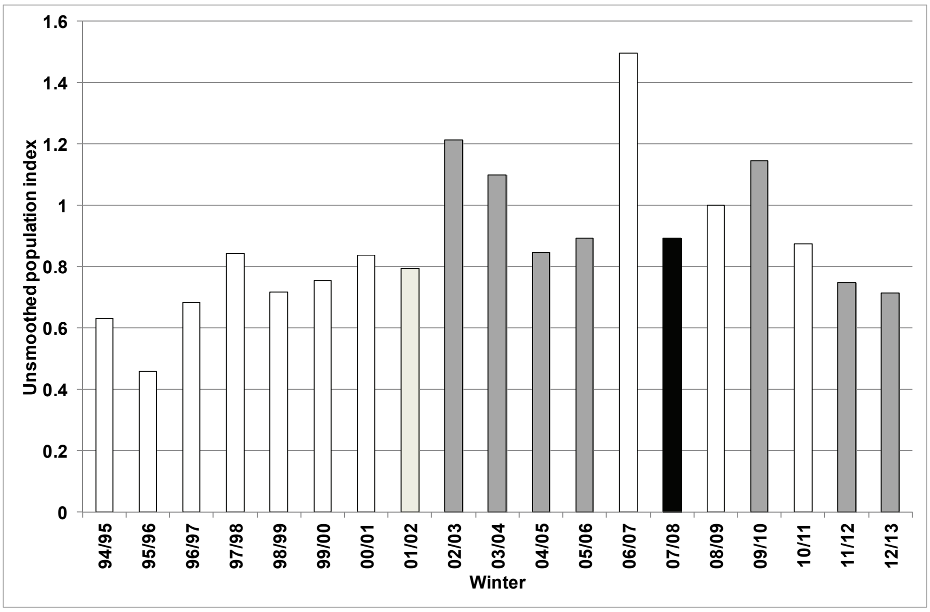


Figure 44. **Annual variation in the unsmoothed Oystercatcher index at Dundalk Bay, 1994/95-2012/13. The shading indicates the intensity of the cockle fishery.**

Figure 45. **Monthly low tide oystercatcher counts July 2012-March 2013.**

9.5.4 Oystercatcher diet and feeding behaviour

In both seasons, cockles were a significant component of the Oystercatcher diet throughout the winter. In 2011/12, the frequency of captures was highest in September and late December and lowest in February (Table 25). In 2012/13, the frequency of captures was high between July and October. It was lower in February, but still higher than in the late winter of 2011/12. The cockle captures in 2012/13 were of two distinct components; small cockles below the size range normally predated by Oystercatchers (< 10 mm shell width) and normal-sized cockles within the size range normally predated by Oystercatchers (≥ 10 mm shell width). The frequency of capture of cockles >10 mm declined between August and September to levels observed during/after the 2011 cockle fishery, but the overall frequency of cockle captures increased due to a large increase in the frequency of captures of small cockles. In 2011/12, there did not appear to be any significant predation of small cockles.

We have also estimated, the proportion of birds feeding on cockles. In addition to birds where cockle captures were observed during focal observations, birds where prey captures are not observed during the focal observations can often be classified as feeding or not feeding on cockles, based on their behaviour. In 2012, the proportion of birds feeding on cockles remained high (80-90%) between July and October, falling slightly in late winter to (70-80%). In 2011/12, the proportion of birds feeding on cockles was high (70-90%) in September, but probably fell to around 50% in October and remained around this level or lower throughout the rest of the winter

Many prey captures could not be identified as the prey item was caught while probing and ingested without being removed from the sediment: these prey captures were not cockles (as Oystercatchers feeding on cockles show very distinctive handling actions) and were likely to be mainly worms and some small clams. Sea squirts were a significant prey item in early November 2011 after large numbers were washed up on the sandflats following storms. In late 2012 little or no predation of sea squirts was directly observed, but this probably reflects the absence of focal observations during the mid-winter period; decaying remains of sea squirts, some showing apparent signs of Oystercatcher predation, were quite frequent on the sandflats in late winter 2012. Small prey items (probably small surface-active invertebrates) were frequently caught but are unlikely to be significant energetically.

Table 25. Frequency of successful cockle captures, shown as the percentage of observations during which the prey item was caught.

	2011/12	2012/13		
Visit	Cockles (all)	Cockles (all)	Cockles (normal)	Cockles (small)
July		68%	68%	1%
Aug		70%	66%	19%
Sep	72%	90%	44%	77%
Oct	43%	73%	43%	34%
early Nov	29%			
late Nov	49%			
early Dec	37%			
late Dec	61%			
Jan	36%			
Feb	12%	53%	44%	21%
Mar	31%			

9.6 Waterford Estuary and Tramore Bay

9.6.1 Biomass 2007-2012

Survey data for the period 2007-2012 provided fishery independent estimates of biomass (Table 26). Biomass was similar in Woodstown in 2007 and 2008 but lower in Passage East in 2008 than in 2007. No commercial cockles were found in either area during the 2009-2011 surveys. In 2012 208 tonnes of cockles were present in Woodstown. No fishery occurred.

A large biomass of 2,375 tonnes was present in Tramore in 2007. No surveys were completed in Tramore in 2008-2010. The biomass in 2012 was 795 tonnes.

In 2007 TACs, representing 33% of the biomass, were set for Passage East and Woodstown. The TAC for Tramore was set to zero as no management plan was agreed. In 2008 TACs were zero in all areas as no appropriate assessment of the impact of the fishery on the conservation objectives of the Special Areas of Conservation in which the fisheries take place had been undertaken. The commercial biomass in Woodstown was close to zero in 2009 and 2010. It increased in 2011, however, the majority of the cockles were below the minimum landing size. The biomass in Passage East has been close to zero since 2009.

Although a commercial biomass was found in Tramore in 2011 and 2012 no fishery plan has been developed and thus the TAC remained at zero.

Table 26. Annual biomass estimates and TACs for cockle beds in Waterford Estuary and Tramore.

Year	Area	Biomass	95% CL	TAC	Landings
2007	Woodstown	367	24	121.11	154
	Passage East	276	24	91.08	
	Tramore	2,375	230	0	0
2008	Woodstown	388	221	0	0
	Passage East	96	60	0	0
	Tramore	-	-	0	0
2009	Woodstown	0	0	0	0
	Passage East	0	0	0	0
	Tramore	-	-	0	0
2010	Woodstown	0	0	0	0
	Passage East	0	0	0	0
	Tramore	-	-	0	0
2011	Woodstown	236	43	0	0
	Passage East	0	0	0	0
	Tramore	1,495	184	0	0
2012	Woodstown	208	40	0	0
	Passage East	0	0	0	0
	Tramore	795	140	0	0

9.6.2 Biomass Woodstown and Passage East 2012

A total biomass of 208±40 tonnes was present in Woodstown in July 2012 (Figure 45 and Table 27). The biomass estimated for Passage East, on the 28th and 29th August was close to zero (Figure 45). No cockles were recorded from the majority of sampling stations (80%) surveyed with only 13 cockles being recorded in total.

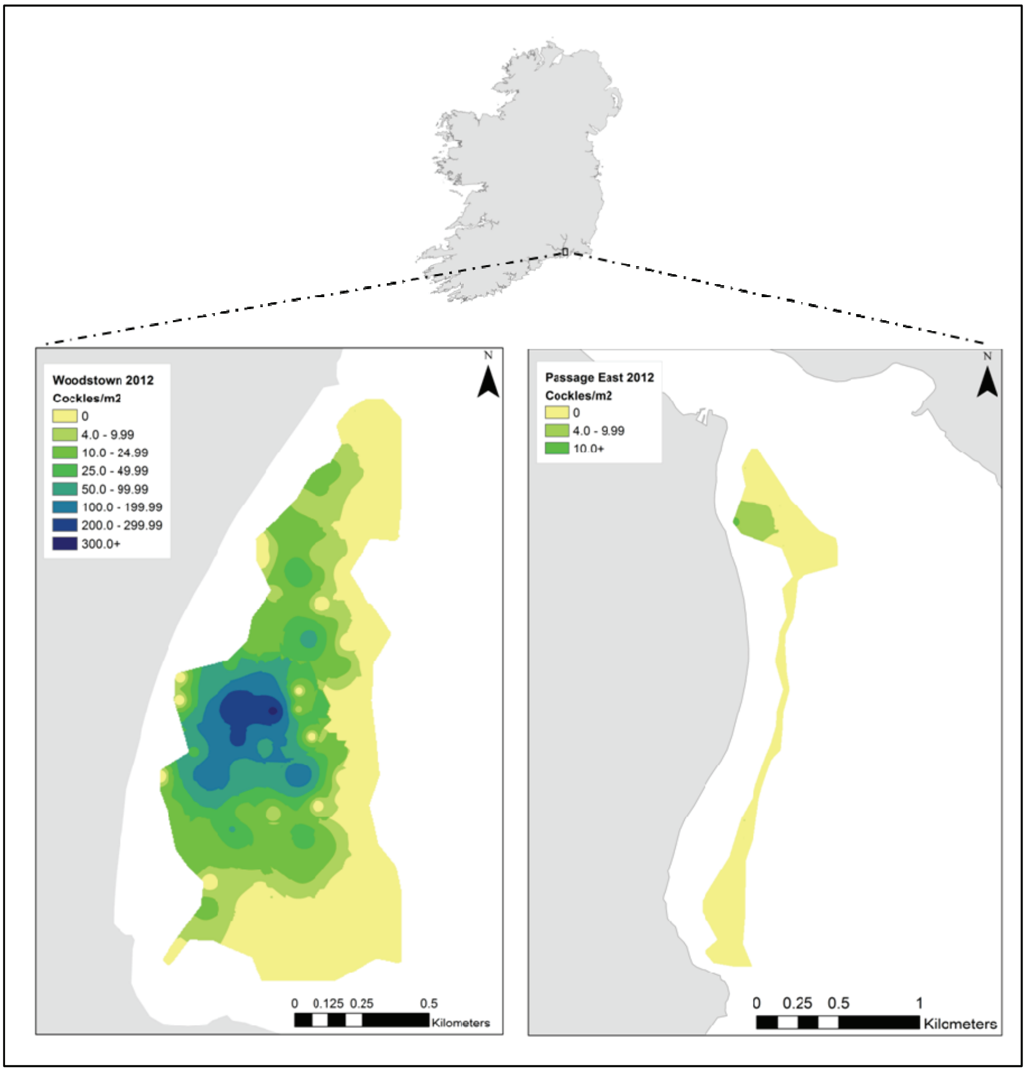


Figure 46. **Distribution of biomass of cockles at Woodstown and Passage east in Waterford Estuary in 2012.**

Table 27. Distribution of cockle biomass at Woodstown in July 2012 (CL=Confidence Limits).

Contours	Area		Density			Biomass (gm^{-2})		Biomass (tonnes)	
	Area (m^2)	% of area	N	Mean	95% CL	Mean	95% CL	Mean	95% CL
0	474,877	39.28	47	0.00	0.00	0.00	0.00	0.00	0.00
4.0 - 9.99	163,079	13.49	11	5.09	1.10	38.25	10.50	6.24	1.71
10.0 - 24.99	250,354	20.71	13	14.15	1.69	94.15	16.16	23.57	4.05
25.0 - 49.99	113,984	9.43	4	42.00	6.79	278.15	56.14	31.70	6.40
50.0 - 99.99	101,061	8.36	5	64.80	9.08	382.32	60.89	38.64	6.15
100.0 - 199.99	76,545	6.33	2	156.00	23.52	963.00	161.74	73.71	12.38
200.0 - 299.99	28,307	2.34	2	258.00	74.48	1154.60	340.29	32.68	9.63
300 +	822	0.07	1	320.00	0.00	1396.80	85.02	1.15	0.07
Total	**1,209,028**		**85**					**208**	**40**

9.6.3 Size and age composition Woodstown and Passage East 2012

Approximately 87% of cockles recorded in July 2012 at Woodstown were 2+ year olds having settled in 2010 (Figure 47). Only 9 of the cockles recorded were 0+ years indicating a poor settlement year in 2012. The age composition is displayed in Table 28.

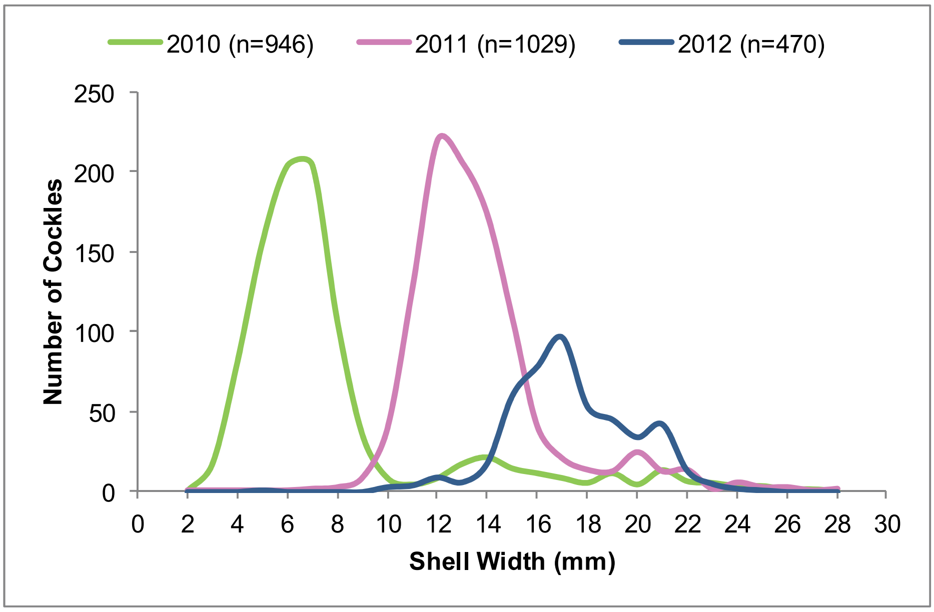


Figure 47. Size distribution of cockles in Woodstown 2010-2012.

Table 28. Size at age of cockles in Woodstown in 2012.

Age	N	%	Shell Width (mm)	
			Mean	SD
0	9	2.01	9.68	2.16
1	37	8.28	14.14	2.00
2	388	86.80	17.09	2.04
3	13	2.91	19.74	3.02

9.6.4 Biomass Tramore 2012

A total biomass of 795±140 tonnes of cockles were recorded at Tramore back strand in July 2012, approximately 50% less than the biomass estimate for 2011. Over 95% (760±161 tonnes) of the total biomass was equal to or over the minimum legal size of 17 mm shell width. Densities exceeded 500 cockles.m^{-2} in some areas (Table 29, Figure 48).

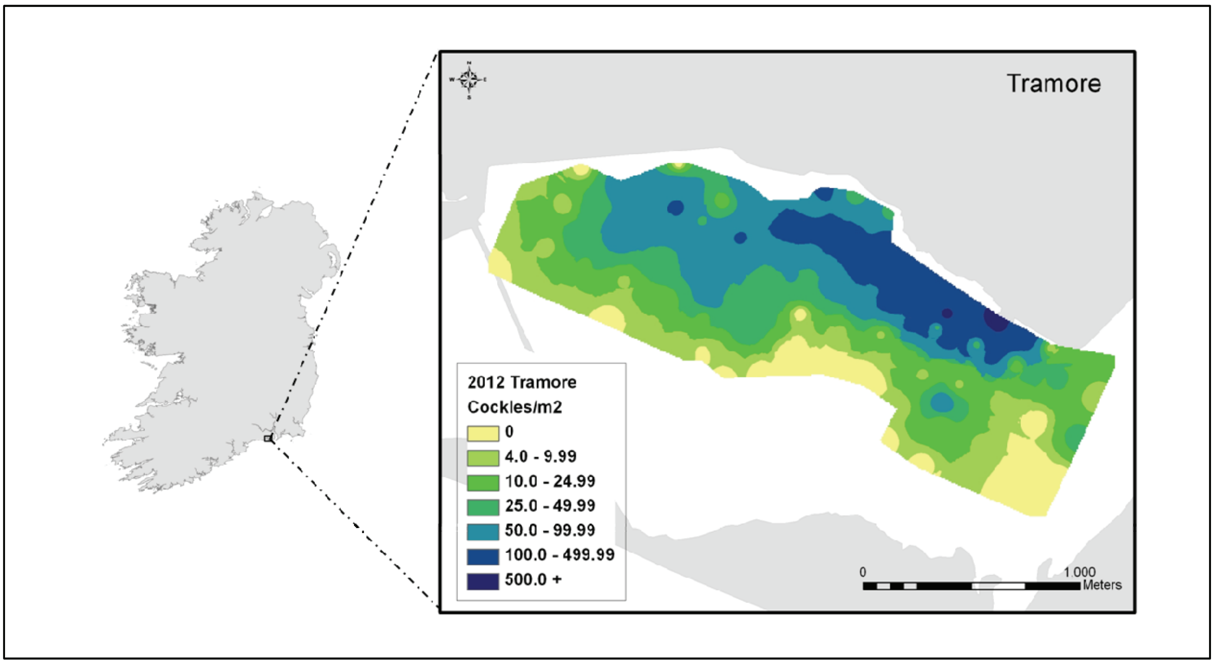


Figure 48. Distribution of cockle biomass in Tramore back strand in July 2012.

Table 29. Distribution of cockle biomass in Tramore back strand in July 2012.

Contours	Area		Density			Biomass (gm^{-2})		Biomass (tonnes)	
	Area m^2	% of Area	N	Mean	95% CL	Mean	95% CL	Mean	95% CL
0	235,174	10.74	18	0.00	0.00	0.00	0.00	0.00	0.00
4.0 - 9.99	369,782	16.89	22	6.36	0.84	79.62	20.92	29.44	7.73
10.0 - 24.99	474,812	21.69	9	16.44	3.57	266.39	76.01	126.48	36.09
25.0 - 49.99	338,517	15.46	16	38.25	3.20	322.97	54.64	109.33	18.50
50.0 - 99.99	485,927	22.19	13	74.77	7.18	711.13	95.78	345.56	46.54
100.0 - 499.99	275,939	12.60	11	131.64	14.28	575.40	83.58	158.78	23.06
500+	9,368	0.43	2	676.00	211.68	2706.42	873.77	25.35	8.19
Total	**2,189,518**		**91**					**795**	**140**

9.6.5 Size and age composition Tramore 2012

The shell width of the cockles sampled ranged from 2.61 to 36.88 mm. Approximately 57.5% of the cockles measured had a shell width of 17 mm or greater, while only 26.8% were ≥22 mm (Figure 49). These figures are lower than those recorded in 2011, when over 75% of the cockles measured were ≥17 mm and over 50% were ≥22 mm.

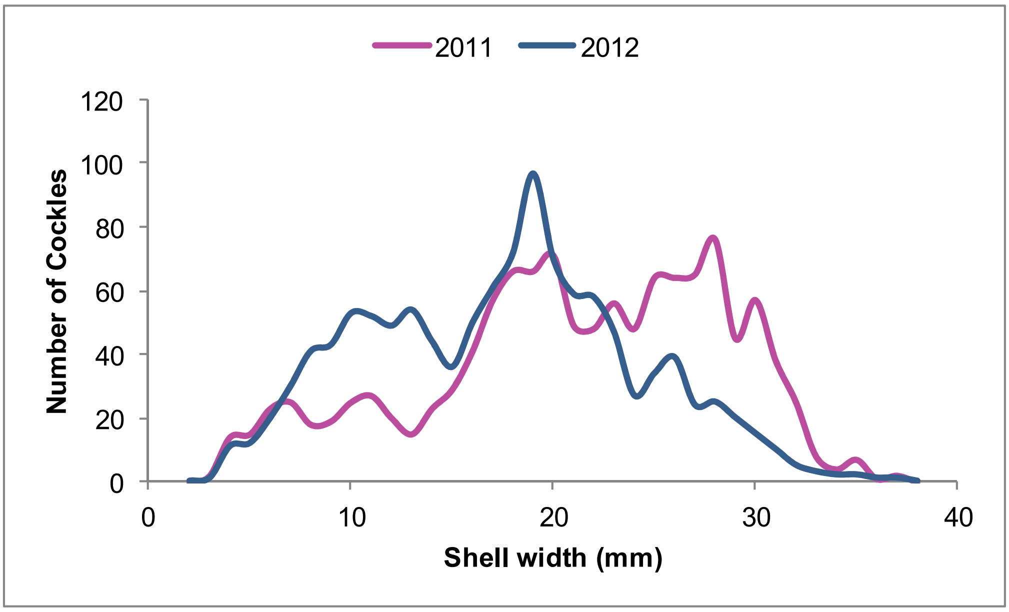


Figure 49. **Size composition of cockles at Tramore backstrand in June 2011 and July 2012.**

The majority of the cockles sampled (67.33%) from the backstrand at Tramore were greater than 2+ years. The 3+ cohort dominated at 23.65%. The 0+ and 1+ age groups, in 2012, were both greater than 10% of the total cockles sampled (12.98% and 19.69%, respectively). The oldest cockles recorded during the 2012 survey were spawned in 2002 (Figure 50).

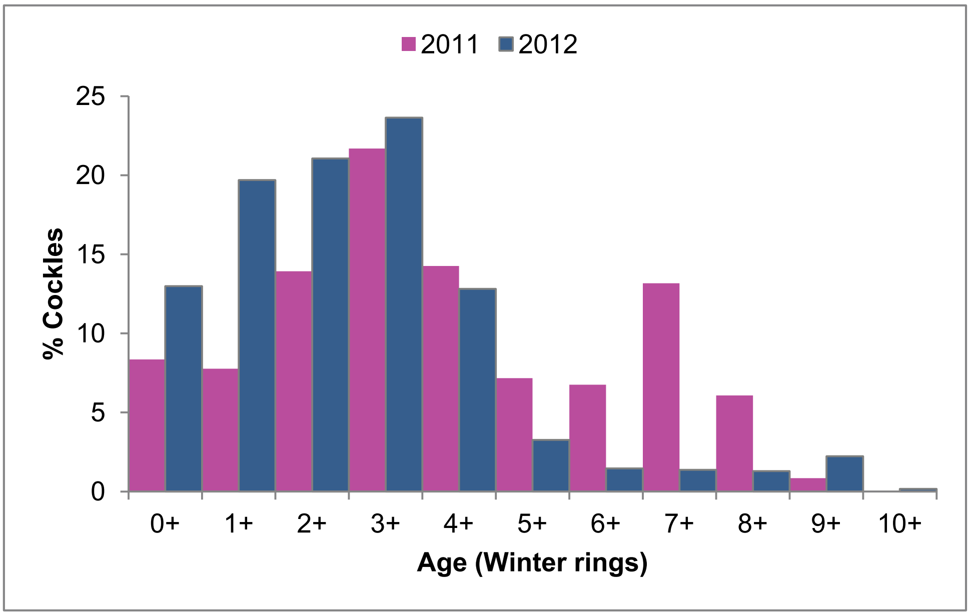


Figure 50. **Age composition of cockles at Tramore backstrand in June 2011 and July 2012.**

10 Oyster (*Ostrea edulis*)

10.1 Management advice

Stock biomass is generally low in all areas, except Fenit, and management measures to restore recruitment and re-build spawning stocks are necessary. Various threats to native oyster stocks exist including naturalisation of Pacific oyster (*Crassostrea gigas*), *Bonamia* infection, poor habitat conditions for settlement, low spawning stocks.

A control programme for Pacific oyster in Lough Swilly may be required although the continuation of the commercial dredge fishery for Pacific oyster in the Lough may go some way to controlling its expansion.

Generally, although seasonal quotas and minimum size regulations are in place for some fisheries, management plans or recovery plans should be developed in order to restore productivity to stocks.

Oyster beds are also constituents of habitats designated under the Habitats Directive in many areas. Specific conservation objectives have been defined for these habitats in some sites. Oyster management plans also need to consider measures that comply with the conservation objectives for designated habitats.

10.2 Issues relevant to the assessment of the oyster fishery

A number of native oyster beds occur as separate stocks in Bays around the coast. Biomass is currently low, compared to historic levels, in most areas. The Fenit bed holds the majority of the national biomass of native oyster.

Recruitment is variable in most areas and seems to have failed in recent years in a number of locations. Larval production and settlement is conditional on density of spawning stock, high summer temperatures and the availability of suitable substrate.

The fishery is managed primarily by a minimum landing size of 76-78 mm. The minimum size is generally reached at age 4-5. Oysters generally mature well below the MLS.

Oyster stocks face a number of threats including *Bonamia* infection, which decimated stocks in the 1970s, and is prevalent in a number of beds today. Native oyster is also competing for habitat with naturalised Pacific oyster in some areas. Poor substrate conditions for settling oysters may be limiting recruitment and low stock density may also be reducing reproductive output.

Management authority has been devolved to local co-operatives through fishery orders issued in the late 1950s and early 1960s or through 10 year Aquaculture licences. Although conditions, such as maintaining oyster beds in good condition or having management plans in place, attach to these arrangements in most cases management objectives and management measures are not sufficiently developed. In Lough Swilly all management authority rests with the overseeing government department.

Although management may be devolved through the fishery orders or aquaculture licences vessels fishing for oysters must be registered on the sea fishing vessel register (DAFM) and operators must also hold a dredge licence which is issued by Inland Fisheries Ireland (IFI).

The co-operatives operate seasonal fisheries and may also limit TAC. The TACs may be arbitrary and scientific advice or survey biomass estimates or other indicators have not generally been used in setting TACs.

All the main oyster beds in Ireland occur within Natura 2000 sites. Oyster is a characterising species of sedimentary habitats of large shallow inlets and bays. It can also be a key habitat forming species in conditions where recruitment rates are high and where physical disturbance is low.

Management of oyster fisheries will need to consider the conservation objectives for this species and its associated habitat where it occurs in Natura 2000 sites.

Annual surveys provide biomass indices or absolute biomass estimates and size structure of oyster stocks annually. Poor information on growth rate, which varies across stocks, limits the assessment of mortality rates and yield predictions.

10.3 Biomass estimates

In 2012 oyster biomass was estimated from dredge surveys, in Fenit (inner Tralee Bay), in beds at Maharees and outer Tralee Bay, Galway Bay and Lough Swilly (Table 30).

Table 30. Biomass estimates for native oyster stocks in Lough Swilly, Galway Bay, Fenit and outer Tralee Bay surveyed in 2012.

Location	Biomass±SD (tonnes)	Survey Month
Lough Swilly	177.52±23.04	October
Galway Bay	28.69±11.97	February
Galway Bay	55.25±17.98	November
Fenit	1,329.45±680.19	February
Fenit	1,684.1±244.49	September
Maharees	199.73±102	March
New Bed (Tralee Bay)	69.06±33.2	March

10.4 Management Units

Oyster stocks occur as discrete isolated units in a number of Bays around the coast. Although native oysters were historically widespread in many areas, including offshore sand banks in the Irish Sea and along the south east coast their distribution is now reduced. The main stocks occur in Tralee Bay, Galway Bay, Kilkieran Bay in Connemara, Clew Bay, Blacksod Bay and Lough Swilly.

10.5 Survey methods

Oyster beds were surveyed by dredge. Dredge designs vary locally and those locally preferred dredges were used in the current surveys. Dredge efficiencies were estimated in 2010 by comparison of the numbers of oysters caught in the dredge and the numbers subsequently counted on the same dredge track by divers immediately after the dredge tow had been completed.

Predetermined survey grids were used where the distribution of the oyster beds were well known. In other cases the local knowledge of the Skipper of the survey vessel was used to locate the beds which, in some areas, are patchy and occur at discrete depths on particular substrates. GPS units with visual display of the local area were used to distribute sampling effort throughout the oyster beds, the boundaries of which were indicated by the skipper of the vessel.

Densities, converted for dredge efficiency, were subsequently interpolated using an Inverse Distance Weighting (IDW) algorithm. Contours were drawn at intervals reflecting the range in observed densities. The geographic area inside each contour was calculated and used to raise the average densities and biomass of oysters m^{-2} within each contour to the total population or at least that proportion of the population selected by the dredge.

10.6 Lough Swilly

10.6.1 Distribution and abundance of native oyster

Densities of native oyster (*E. edulis*) in October 2012, corrected for 35% dredge efficiency, ranged from 0-16.6 oysters m^{-2} (Figure 51). However, density at the majority of stations was below 7 oysters m^{-2} with a density of 16.65 oysters m^{-2} being recorded from only one sample.

The total number and biomass of native oysters in the survey area were estimated to be 5.86 million oysters and 177.52±23.04 tonnes, respectively.

The density range of native oysters in November 2011 was less at 0-3.8 oysters m^{-2}. The total number and biomass estimate of 5.13 million oysters and 124.39±0.24 tonnes, respectively, were also lower than those recorded in 2012, indicating growth in the native oyster stock.

Table 31. Density and biomass of native oyster in Lough Swilly in October 2012.

Density	Area (m^2)	N	Mean Density (m^2)	95% CL Density	Number of oysters	Biomass (gms m^2)	95% CL Biomass	Total Biomass (Tonnes)	CL Biomass (Tonnes)
0	2,294,192	78	0.00	0.00	0	0.00	0.00	0.00	0.00
0.025 - 0.099	2,764,164	40	0.05	0.01	141,179	2.31	0.29	6.39	0.81
0.1 - 0.49	3,833,324	46	0.25	0.03	970,248	10.36	1.34	39.69	5.13
0.5 - 0.99	1,405,978	10	0.79	0.11	1,111,144	23.55	3.28	33.11	4.62
1.0 - 2.49	507,302	16	1.37	0.18	696,463	37.77	4.85	19.16	2.46
2.5 - 4.99	389,819	3	2.76	0.47	1,076,682	84.56	14.38	32.96	5.61
5.0 - 9.99	259,867	3	5.77	0.66	1,499,344	148.89	16.97	38.69	4.41
10+	21,891	1	16.65	0.00	364,486	342.75	0.86	7.50	0.02
Total	**11,476,537**	**197**			**5,859,547**			**177.52**	**23.04**

10.6.2 Size composition of native oyster

Native oysters ranged in size from 7-124 mm and averaged 54.9±18.2 mm (Figure 52). Only 11.7% of the oysters measured were equal to or greater than the minimum landing size of 76 mm. A shell modal size of 62 mm was recorded for *O. edulis* in October 2012 compared with 40 mm from the previous years' survey, indicating that overall shell size had increased.

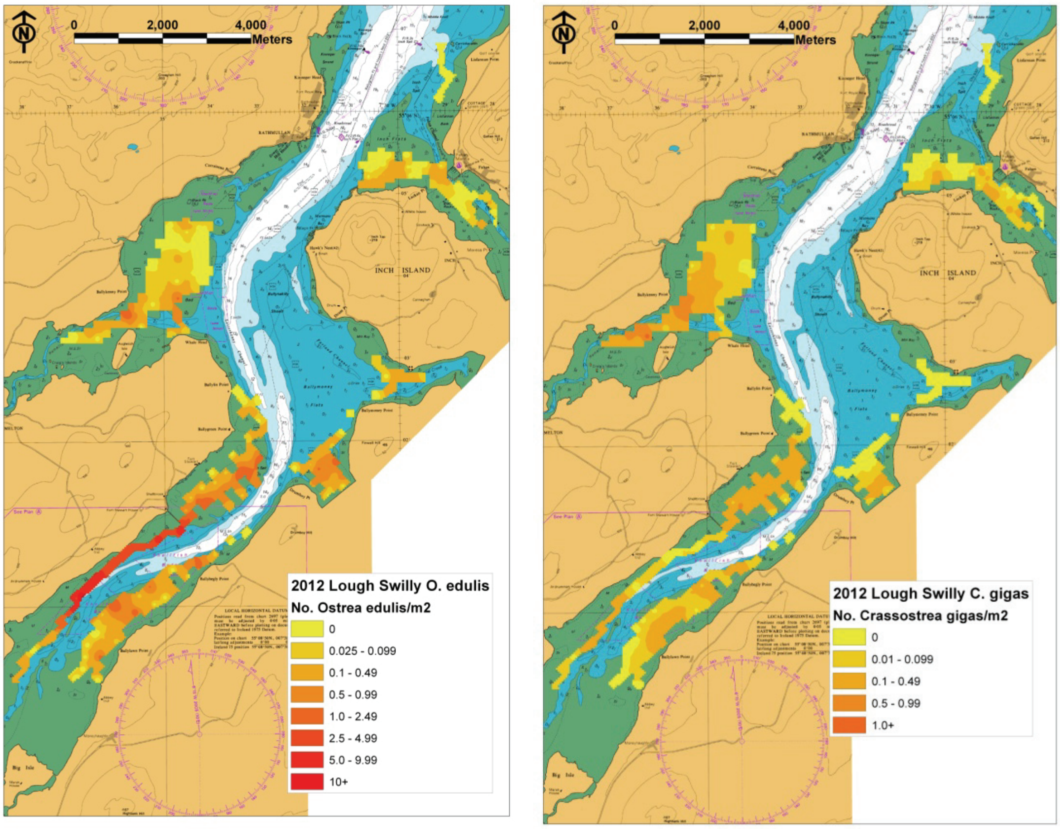


Figure 51. **Interpolated distribution and density of native and pacific oyster in Lough Swilly in October 2012.**

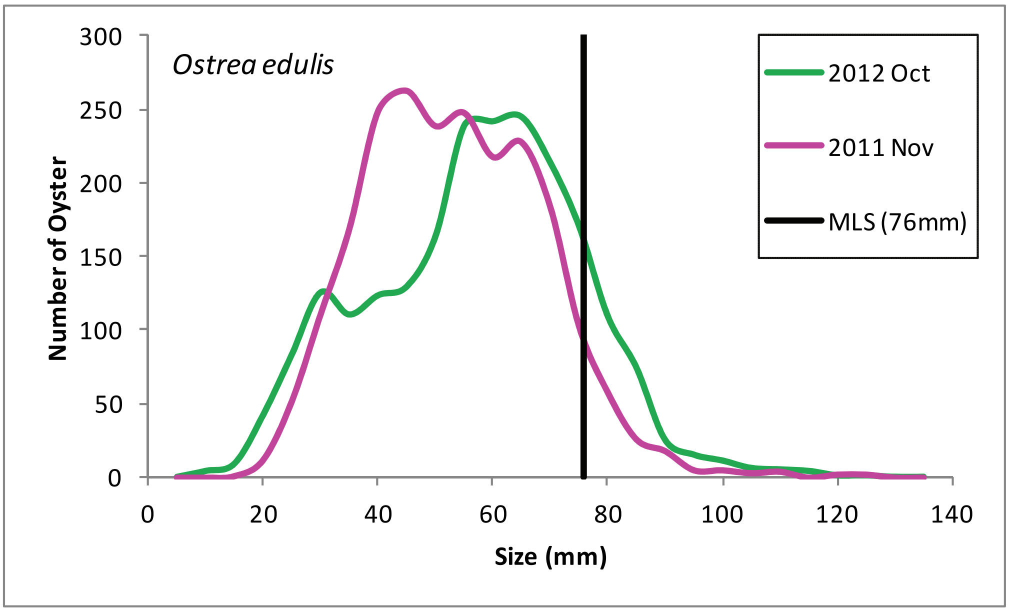


Figure 52. **Size distribution of native oyster in Lough Swilly, in 2011 and 2012.**

10.6.3 Distribution and abundance of Pacific oyster

Densities of Pacific oyster (*Crassostrea gigas*) ranged from 0-1.14 oysters m^{-2} (Figure 51). The total number of *C. Gigas* was estimated at 1.4 million oysters. Both densities and numbers of Pacific oysters declined from 2011 to 2012, indicating that the unrestricted fishing effort on *C. Gigas* in Lough Swilly is affecting pressure on the stock and seems to be restricting the capacity of the population to expand any further.

10.6.4 Size composition of Pacific oyster

The size range of Pacific oysters in October 2012 was 18-205 mm. A larger shell modal length of 114 mm was recorded in 2012 compared to 72 mm in 2011 (Figure 53).

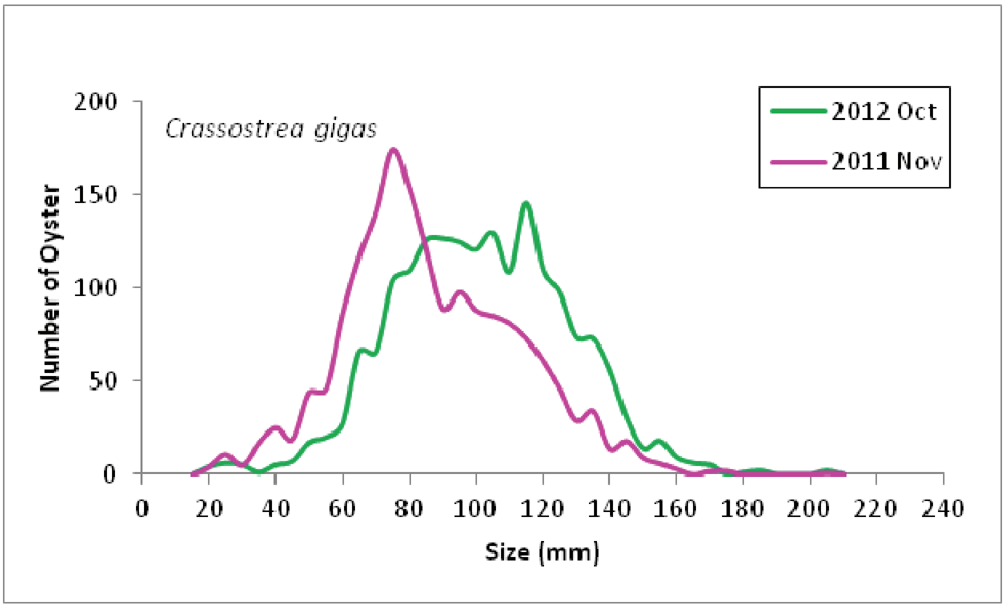


Figure 53. Size distribution of pacific oysters in Lough Swilly, 2011 and 2012.

10.7 Galway Bay

10.7.1 Distribution and abundance of the native oyster

The distribution of native oysters in Galway Bay is restricted compared to its historic distribution. Two surveys were completed in 2012; a post-fishery survey in February 2012 and a pre-fishery survey in November 2012 before the fishery opened in December (Figure 54 and Table 32).

A total area of 1.17 km^2 was surveyed and assuming a dredge efficiency of 35.5%, estimated for oyster dredges in other areas in 2010, densities ranged from 0-0.92 oysters m^{-2}. The total biomass of oysters in the surveyed area was 28.69±11.97 tonnes consisting of 0.65 million oysters. Approximately 12.5% (3.59 tonnes) of this biomass was over the minimum landing size of 76 mm.

In November an area of approximately 1.11km^2 was surveyed and oyster densities ranged between 0-3.5 oysters per m^{-2}. Total biomass and numbers of oyster were estimated to be 55.25±17.98 tonnes and 0.92 million oysters, respectively. Approximately 37.5% (20.7 tonnes) of the November biomass was equal to or greater than the minimum landing size (76 mm).

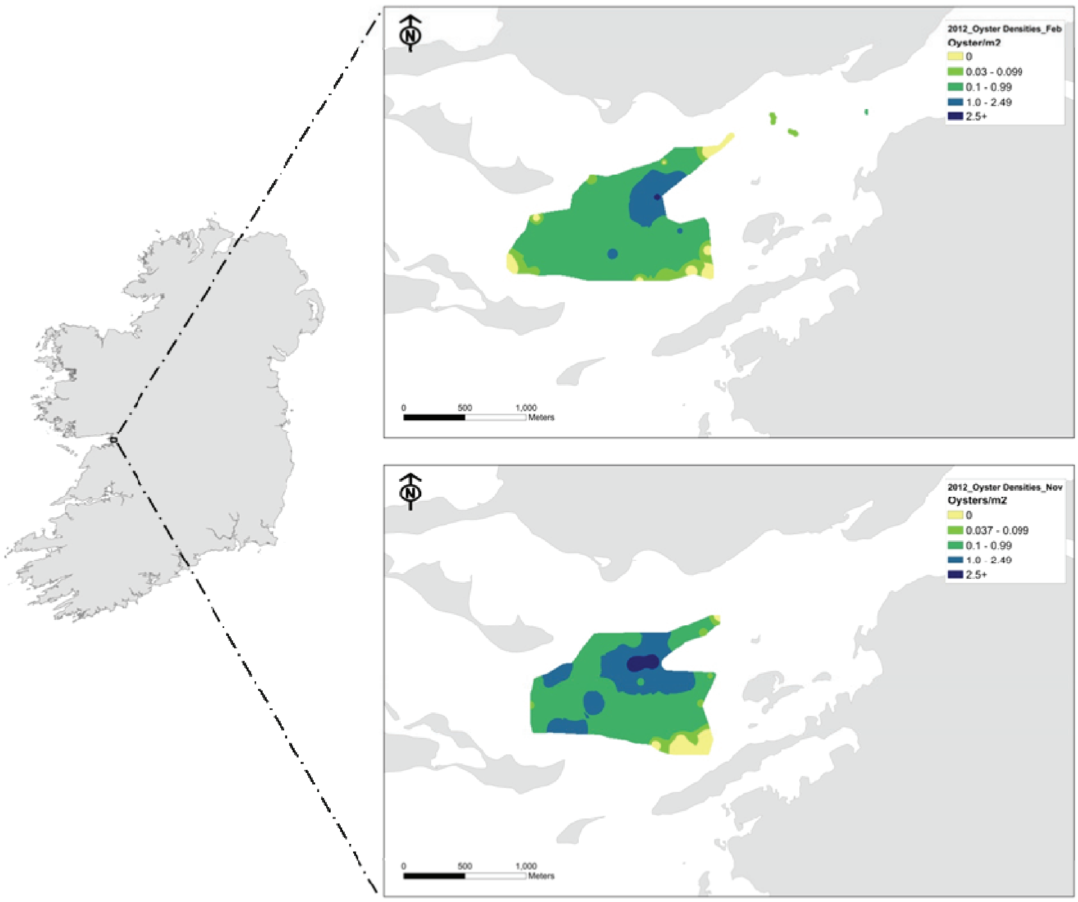


Figure 54. Distribution and density of native oysters in south east Galway Bay in February and November 2012.

Table 32. Distribution of native oyster biomass in south east Galway Bay in February and November 2012 assuming a dredge efficiency of 35.5%.

February 2012									
Density (DE=35.5%)	**Area (m^2)**	**N**	**Mean density m^2**	**95% CL density**	**Number of oysters**	**Biomass (gms m^2)**	**95% CL Biomass m^2**	**Total biomass (tonnes)**	**CL Biomass (tonnes)**
0	53981	11	0.00	0.00	0	0.00	0.00	0.00	0.00
0.03-0.099	89644	5	0.05	0.02	4841	3.16	2.79	0.28	0.25
0.1-0.99	891864	21	0.51	0.12	457399	22.89	8.68	20.41	7.74
1.0-2.49	132022	5	1.35	0.33	178758	58.88	28.19	7.77	3.72
2.5+	1981	1	2.60	0.00	5149	112.28	127.28	0.22	0.25
	1169492				**646147**			**28.69**	**11.97**

November 2012									
Density (DE=35.5%)	**Area (m^2)**	**N**	**Mean density m^2**	**95% CL density**	**Number of oysters**	**Biomass (gms m^2)**	**95% CL Biomass m^2**	**Total biomass (tonnes)**	**CL Biomass (tonnes)**
0	58270	6	0.00	0.00	0	0.00	0.00	0.00	0.00
0.037 - 0.099	41389	4	0.06	0.02	2276	2.53	1.46	0.10	0.06
0.1 - 0.99	671129	17	0.59	0.08	395176	36.36	9.99	24.41	6.71
1.0 - 2.49	309837	9	1.39	0.20	431809	82.31	25.92	25.50	8.03
2.5+	27966	2	3.22	0.00	89966	187.23	113.91	5.24	3.19
	1108591	**38**			**919228**			**55.25**	**17.98**

10.7.2 Size and age composition of native oyster

In February 2012 oysters ranged in size from 21-110 mm and averaged±sd 60.9±12.0 mm in shell length (Figure 55). The modal size was 62 mm. In November the average shell size was 65.1±17.4 mm, ranging from 15-114 mm. The modal shell length of 72 mm was 20 mm larger than in February.

Approximately 37% (equivalent to 340,000 oysters) of oysters were over the legal size in November compared to 12% in February (equivalent to 81,000 oysters). Two smaller size cohorts were also detected during the November survey, one ranging between 52-56 mm and one at approximately 32 mm.

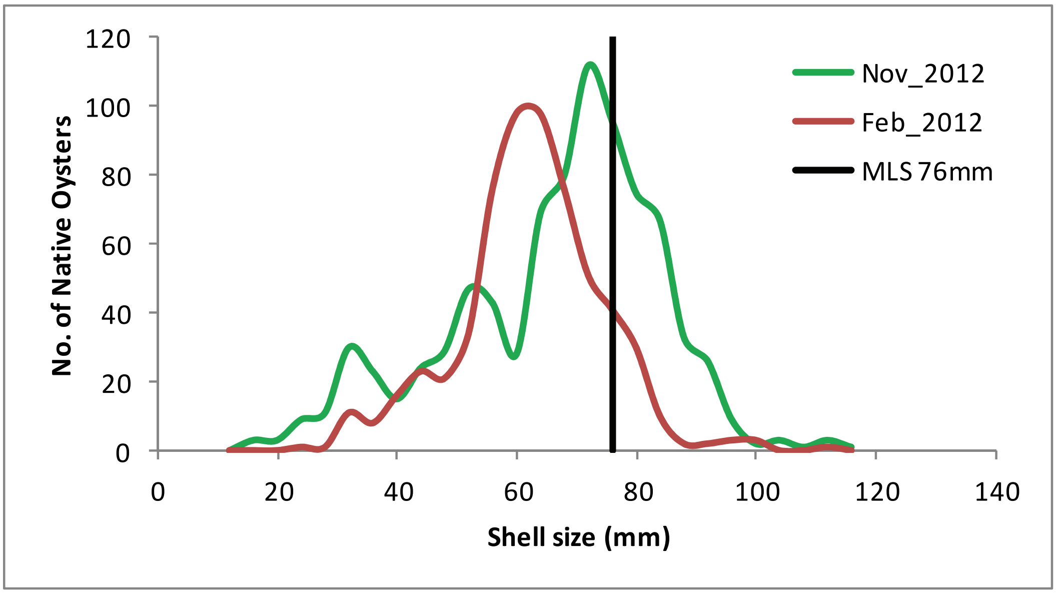


Figure 55. **Size distribution of native oysters in south east Galway Bay in 2012.**

10.8 Tralee Bay

10.8.1 Fenit Survey 2012

The main oyster bed in Tralee Bay is east of Fenit in the inner Bay. Two patches also exist in the outer Bay.

A post-fishery survey was undertaken on the Fenit bed in February 2012 and on the 1st March 2012 the two beds in the outer Bay were also surveyed. The total number and biomass of oysters in the survey area (3.8 km^2) was estimated to be 36.21 million and 1,329±680.19 tonnes, respectively (Figure 56).

Densities in the Fenit bed, corrected for a dredge efficiency of 17.5%[1], ranged from 0-67.2 oysters m^{-2} (Table 33). Approximately 2% (27.21 tonnes) of this biomass was equal to or over the minimum landing size of 78 mm.

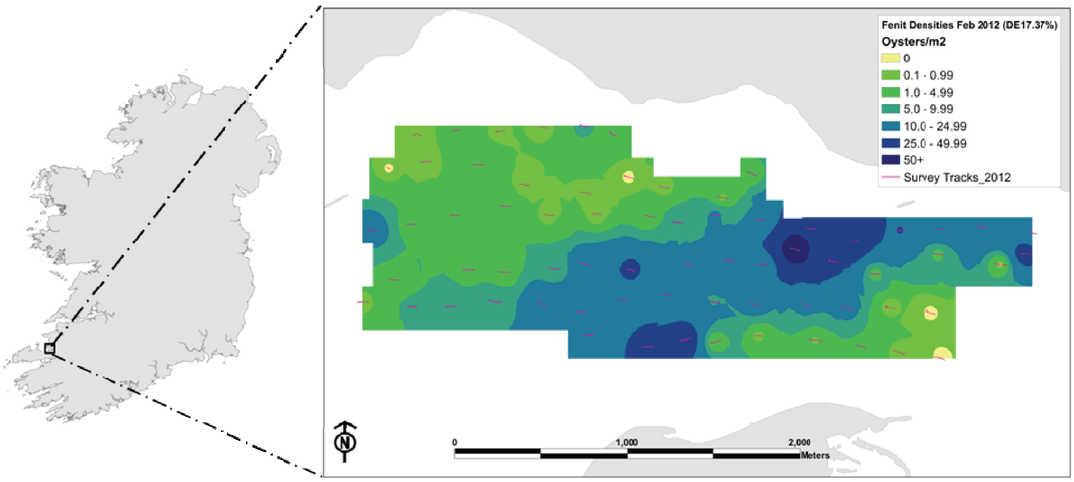


Figure 56. **Survey tracks and contoured densities in the Fenit native oyster bed in February 2012.**

Table 33. Density and biomass of oysters in Fenit in February 2012.

Density (DE=17.37%)	Area (m^2)	N	Mean density (m^2)	95% CL density	Number of oysters	Biomass (gms m^2)	95% CL Biomass (m^2)	Total Biomass (tonnes)	CL Biomass (tonnes)
0	17282	6	0.00	0.00	0	0.00	0.00	0.00	0.00
0.1-0.99	426161	15	0.53	0.13	225865	21.73	15.38	9.26	6.55
1.0-4.99	1260471	15	2.39	0.48	3015886	90.61	48.51	114.22	61.15
5.0-9.99	655995	7	7.80	1.26	5116763	273.15	223.37	179.19	146.53
10.0-24.99	1127938	18	14.61	1.67	16479800	544.42	222.65	614.07	251.13
25-49.99	285966	8	34.79	5.69	9947337	1237.48	751.22	353.88	214.82
50+	21209	1	67.20	0.00	1425275	2774.18	0.00	58.84	0.00
	3.80	**70**			**36210927**			**1329.45**	**680.19**

Densities of the outer bay beds were lower ranging from 0-4.5 oysters m^{-2} in the Maharees Bed and 0-1.25 oysters m^{-2} in the New Bed, which is more centrally situated within Tralee Bay (Figure 56).

The total biomass and number of oysters in the survey area of the Maharees bed (2.3 km^2) was estimated to be 199.73±102.33 tonnes and 2.3 million, respectively (Table 34).

A further 69.06±33.20 tonnes consisting of 0.7 million oysters were estimated from a 1 km^2 area of the New bed (Table 34).

The annual pre-fishery survey for 2012 was undertaken on the Fenit oyster bed in September covering an area of 4km^2. Oyster densities, correct for a dredge efficiency of 17.37%, ranged from 0-66 oysters m^{-2}. The total number and biomass of oysters in the survey area was estimated to be 33.71 million and 1,684±244 tonnes, respectively. Approximately 6.12% (103 tonnes) of this biomass was equal to or over the minimum landing size of 78 mm.

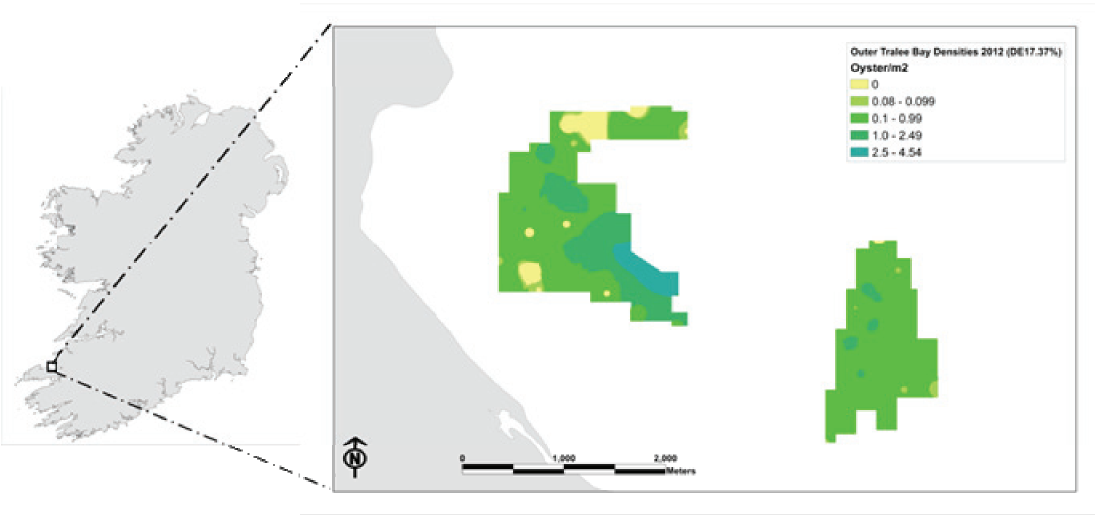


Figure 57. **Contoured densities in the oyster beds of outer Tralee Bay in March 2012.**

Table 34. **Density and biomass of oysters in outer Tralee Bay in March 2012.**

Maharees Bed									
Density (DE=17.37%)	**Area (m^2)**	**N**	**Mean density (m^2)**	**95% CL density**	**Number of oysters**	**Biomass (gms m^2)**	**95% CL Biomass (m^2)**	**Total Biomass (tonnes)**	**CL Biomass (tonnes)**
0	174572	8	0.00	0.00	0	0.00	0.00	0.00	0.00
0.08 - 0.099	71864	4	0.08	0.00	5749	18.88	11.17	1.36	0.80
0.1 - 0.99	1339978	16	0.59	0.16	793937	65.98	27.39	88.41	36.70
1.0 - 2.49	600128	7	1.50	0.32	899334	121.24	63.37	72.76	38.03
2.5 - 4.54	155262	3	3.60	1.13	558424	239.98	172.57	37.26	26.79
	2341804	**38**			**2257445**			**199.78**	**102.33**
New Bed									
Density (DE=17.37%)	**Area (m^2)**	**N**	**Mean density (m^2)**	**95% CL density**	**Number of oysters**	**Biomass (gms m^2)**	**95% CL Biomass (m^2)**	**Total Biomass (tonnes)**	**CL Biomass (tonnes)**
0	2943	1	0.00	0.00	0	0.00	0.00	0.00	0.00
0.07 - 0.099	20762	5	0.08	0.00	1562	8.92	3.32	0.19	0.07
0.1 - 0.99	1297821	22	0.49	0.10	633411	48.06	20.70	62.38	26.86
1.0 - 1.24	58607	5	1.14	0.08	66962	110.87	106.95	6.50	6.27
	1380133	**33**			**701935**			**69.06**	**33.20**

Table 35. Density and biomass of oysters in Fenit in September 2012.

Density (DE=17.37%)	Area (m^2)	N	Mean density (m^2)	95% CL density	Number of oysters	Biomass (gms m^2)	95% CL Biomass (m^2)	Total biomass (tonnes)	CL Biomass (tonnes)
0	10632	8	0.00	0.00	0	0.00	0.00	0.00	0.00
0.08 - 0.099	3361	3	0.09	0.01	291	6.83	0.54	0.02	0.00
0.1 - 0.99	439826	11	0.56	0.19	245903	36.58	12.40	16.09	5.45
1.0 - 4.99	1361290	14	2.60	0.60	3540326	127.02	29.52	172.91	40.18
5.0 - 9.99	939491	14	7.00	0.68	6574424	333.48	32.53	313.30	30.56
10.0 - 24.99	1087160	17	15.76	2.10	17129165	765.03	101.95	831.71	110.83
25.0 - 49.99	160356	5	33.88	6.30	5433182	1925.96	357.97	308.84	57.40
50.0+	11926	1	65.98	0.00	786904	3456.60	4.38	41.22	0.05
	4014042	**73**			**33710195**			**1684.10**	**244.49**

10.8.2 Size composition of oysters in Tralee Bay

In February 2012 the surveyed oysters in Fenit ranged in size from 2-104 mm and averaged±sd 50.76±18.34 mm in shell length. Two size cohorts were detected during the post-fishery survey (Figure 59). Fewer small oysters (<47 mm) were recorded in February 2012 than in September 2011 with a greater proportion of oysters ranging in size between 47-70 mm being observed. Later in the year, in September 2012 the surveyed oysters ranged in size from 4-106 mm and averaged±sd 58.44±13.89 mm in shell length. The two cohorts identified in September 2011 were not as distinguishable a year later. The majority (81%) of oysters measured in September 2012 were ≥47 mm and no significant settlement of oyster larvae was observed.

The surveyed oysters at the New Bed, toward the middle of Tralee Bay, ranged from 11-120 mm and averaged 69.1±23.2 mm in shell length. At Maharees the oysters ranged from 12-109 mm and averaged 68.3±17.5 mm in shell length (Figure 60). Two size cohorts were recorded from both beds, however the majority (approximately 91%) of oysters caught on the Maharees Bed were above 46 mm in shell length.

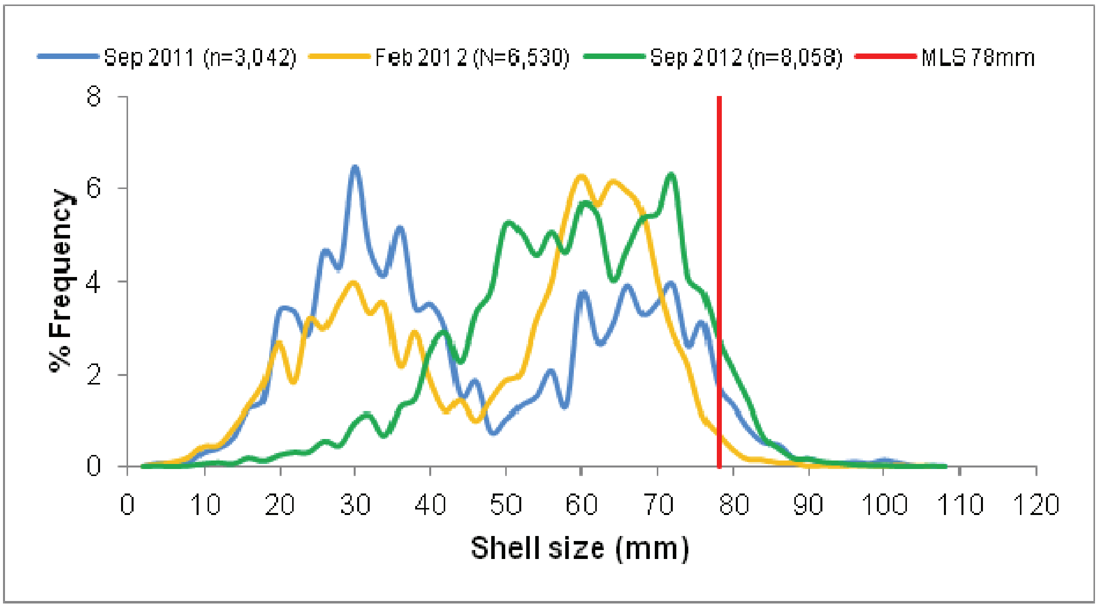


Figure 59. **Size distribution of oysters in the Fenit oyster bed in February and September 2012 compared to sizes recorded in September 2011. The minimum landing size of 78 mm is indicated by a red line.**

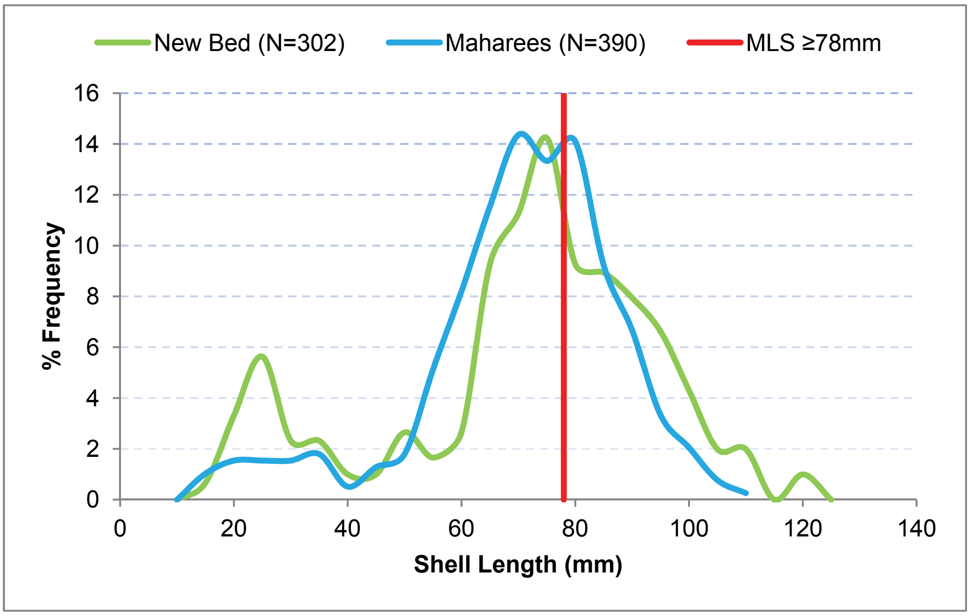


Figure 60. **Size distribution of oysters in outer Tralee Bay in February 2012.**

11 References

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12 Glossary

Accuracy A measure of how close an estimate is to the true value. Accurate estimates are unbiased.

Benthic An animal living on, or in, the sea floor.

Bonamia (ostrea) A parasite of native oyster which infects the blood cells and causes mortality of oysters.

Biomass Measure of the quantity, eg metric tonne, of a stock at a given time.

Bi-valve A group of filter feeding molluscs with two shells eg scallops, cockles.

Catch curve A curve describing the change (usually exponential decline) in numbers of fish in the catch at each successive age/length.

Cohort (of fish) Fish which were born in the same year.

Cohort analysis Tracking a cohort of fish over time

Demersal (fisheries) Fish that live close to the seabed and are typically targeted with various bottom trawls or nets.

Ecosystems are composed of living animals, plants and non living structures that exist together and 'interact' with each other. Ecosystems can be very small (the area around a boulder), they can be medium sized (the area around a coral reef) or they can be very large (the Irish Sea or even the eastern Atlantic).

Exploitation rate The proportion of a population at the beginning of a given time period that is caught during that time period (usually expressed on a yearly basis). For example, if 720,000 fish were caught during the year from a population of 1 million fish alive at the beginning of the year, the annual exploitation rate would be 0.72.

Fishing Effort The total fishing gear in use for a specified period of time.

Fishing Mortality Deaths in a fish stock caused by fishing usually reported as an annual rate (F).

Fishery Group of vessel voyages targeting the same (assemblage of) species and/or stocks, using similar gear, during the same period of the year and within the same area (e.g. the Irish flatfish-directed beam trawl fishery in the Irish Sea).

Fishing Licences A temporary entitlement issued to the owner of a registered fishing vessel to take part in commercial fishing.

Fleet Capacity A measure of the physical size and engine power of the fishing fleet expressed as gross tonnage (GTs) and kilowatts (KWs).

Fleet Segment The fishing fleet register, for the purpose of licencing, is organised in to a number of groups (segments).

Length converted catch curve A curve describing the change (usually exponential decline) in numbers of fishing in successive size groups after adjusting for the different periods of time required for fish to grow from one length group to the next using information on their growth rate.

Linearised length converted catch curve A linearised form (by transformation of data on numbers at length to natural logs of numbers at length) of the length converted catch curve.

Management Plan is an agreed plan to manage a stock. With defined objectives, implementation measures, review processes and usually stakeholder agreement and involvement.

Management Units A geographic area encompassing a 'population' of fish de-lineated for the purpose of management. May be a proxy for or a realistic reflection of the distribution of the stock.

Minimum Landing Size (MLS) The minimum body size at which a fish may legally be landed.

Natura A geographic area with particular ecological features or species designated under the Habitats or Birds Directives. Such features or species must not be significantly impacted by fisheries.

Natural Mortality Deaths in a fish stock caused by predation, illness, pollution, old age, etc., but not fishing.

Pelagic (fisheries) Fish that live in the water column and are typically targeted with various mid-water trawls, nets or lines.

Polyvalent A type of fishing licence. Entitlements associated with these licences are generally broad and non-specific. Vessels with such licences are in the polyvalent segment of the fishing fleet.

Precision A measure of how variable repeated measures of an underlying parameter are.

Quota A portion of a total allowable catch (TAC) allocated to an operating unit, such as a Vessel class or size, or a country.

Recruitment The amount of fish added to the exploitable stock each year due to growth and/or migration into the fishing area. For example, the number of fish that grow to become vulnerable to the fishing gear in one year would be the recruitment to the fishable population that year. This term is also used in referring to the number of fish from a year class reaching a certain age. For example, all fish reaching their second year would be age 2 recruits.

Recruitment overfishing The rate of fishing, above which, the recruitment to the exploitable stock becomes significantly reduced. This is characterised by a greatly reduced spawning stock, a decreasing proportion of older fish in the catch, and generally very low recruitment year after year.

Reference points Various reference points can be defined for fished stocks. These can be used as a management target or a management trigger (i.e. point where more stringent management action is required). Examples include fishing mortality rate reference points, biomass reference points, indicator eg catch rate reference points or those based on biological observations.

Sales Notes Information on the volume and price of fish recorded for all first point of sale transactions.

Shellfish Molluscan, crustacean or cephalopod species that are subject to fishing.

Size composition The distribution, in size, of a sample of fish usually presented as a histogram.

Steady state conditions When the population processes in a stock, namely recruitment, growth and mortality rates are 'constant' over a given period of time.

TAC Total Allowable Catch

Vivier A fishing vessel, usually fishing for crab, with a seawater tank(s) below decks, in which the catch is stored live.

VMS Vessel Monitoring System

VPA Virtual Population Analysis, a method of reconstructing the past biomass of a cohort or cohorts of fish in a population

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