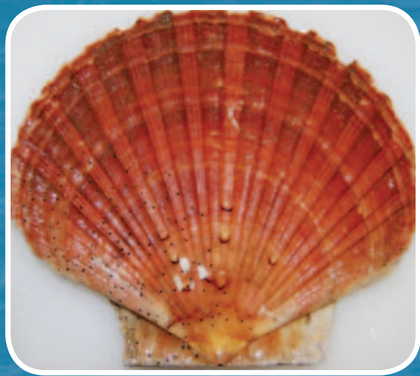
Shellfish Stocks and Fisheries Review

December 2010





BIM
Bord Iascaigh Mhara
Irish Sea Fisheries Board

Marine Institute
Foras na Mara

Shellfish Stocks and Fisheries

Review 2010

An assessment of selected bivalve stocks

The Marine Institute and Bord Iascaigh Mhara

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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 (<13m) and landings for all species are presented. The assessment of 2009 reviewed legislation, economic performance and management arrangements for shellfisheries in Ireland. These issues are not updated here as this information is still valid for 2010. The intention of the annual reviews 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 and which reflects the recent work of the Marine Institute (MI) and An Bord Iascaigh Mhara (BIM) in the assessment and management of shellfisheries.

The advice presented here on 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) and although they come under the competency of the Common Fisheries Policy they are generally not regulated by TAC and in the main, are distributed inside the national 12nm territorial limit. They are managed under a national co-operative framework involving Department of Agriculture Fisheries and Food (DAFF), The Sea Fisheries Protection Authority (SFPA), An Bord Iascaigh Mhara (BIM), the Marine Institute (MI) and Industry (Anon 2005). Management is organised around a number of Species Advisory Groups which provide advice to DAFF. However, these groups were not active in 2009 or 2010 and no management plans for shellfish were developed in 2010. The need to engage with other stakeholders is also increasing, especially in relation to the interaction between fisheries and the environment and consideration of ecosystem effects of fisheries in general.

The main customers for this review are DAFF and industry groups that may be involved in the development of management plans for shellfisheries.

2 Fishing Fleet

2.1 The Shellfish Fleet

The Irish fishing fleet is, for the purpose of licencing, divided into a number of segments. Vessels in the polyvalent segment, which contains the majority of vessels, have general access to the majority of shellfish stocks although access to a number of these stocks is further restricted. Vessels in the specific segment can only fish for bivalves while vessels in the potting segment can only use pots and, therefore, can only target crustaceans and whelk.

Vessels in the polyvalent segment targeting shellfish are generally less than 13m in length. Vessels licenced for potting only, targeting crustaceans and whelk, are all less than 12m in length as this was a condition of incorporating these vessels into the registered fleet in the period 2004-2006. All vessels in the Aquaculture and Specific segments target bivalves.

The shellfish fleet as defined above numbered 1901 in December 2010 (Table 1). In addition 5 polyvalent vessels over 18m in length fish for crab offshore and 2 polyvalent vessels and 2 vessels in the Beamer segment over 13m in length target scallop off the south east coast. The number of vessels targeting shellfish increased by 58% between 2006 and 2010 and increased by 3% from 2009 and 2010. The 5 year increase was predominantly due to regularisation of the potting fleet which were operating outside of the registered fleet prior to 2006 and to registration of existing vessels operating dredges in fishery order and aquaculture licenced areas. The polyvalent general fleet, under 13m in length, also increased by 18% between 2006 and 2009 and by 6% between 2009 and 2010.

Vessels in the Aquaculture and Specific segments vary from small oyster dredgers working inshore to offshore seed mussel and scallop dredgers. The average length and capacity of vessels in these segments declined between 2006 and 2010.

Polyvalent potting vessels have higher engine capacities in proportion to their gross tonnage than polyvalent general vessels (Table 1).

Table 1. Length and capacity profile of the Irish Shellfish fleet 2006-2010 (excluding 5 vivier crabbers and a number of polyvalent scallop vessels over 13m)

Segment	2006	2007	2008	2009	2010
Number of vessels					
Aquaculture	16	21	39	73	86
Polyvalent General	953	950	994	1131	1198
Polyvalent Potting	80	492	490	481	467
Specific	157	117	128	154	150
Grand Total	1206	1580	1651	1839	1901
Average length of vessels (m)					
Aquaculture	31.62	30.00	21.51	14.75	13.33
Polyvalent General	7.95	7.89	7.82	7.67	7.57
Polyvalent Potting	7.32	6.74	6.76	6.71	6.67
Specific	14.70	13.40	13.22	12.09	12.06
Average Gross Tonnage of vessels					
Aquaculture	212.05	197.86	117.30	64.18	54.12
Polyvalent General	4.68	4.61	4.38	4.14	3.96
Polyvalent Potting	2.96	2.28	2.30	2.22	2.16
Specific	38.62	27.34	25.93	20.54	20.29
Average kilowattage of vessels					
Aquaculture	468.55	433.79	284.45	166.11	142.51
Polyvalent General	35.49	36.46	34.05	31.77	30.43
Polyvalent Potting	44.50	29.60	30.29	29.70	28.93
Specific	162.81	124.53	113.26	96.36	94.26
Kilowatts per GT					
Aquaculture	2.21	2.19	2.42	2.59	2.63
Polyvalent General	7.58	7.91	7.77	7.68	7.69
Polyvalent Potting	15.03	12.99	13.20	13.39	13.41
Specific	4.22	4.56	4.37	4.69	4.65

3 Landings 2004-2009

3.1 Overview

Annual landings of crustaceans and bivalves, excluding *Nephrops* and wild blue mussel (*Mytilus*) seed, which is re-laid for on-growing, during the period 2004-2009 varied from 29,533 tonnes in 2004 to approximately 14,000 tonnes in 2008-2009. The main decline in volume occurred in brown crab and whelk. Landings of scallop declined from a high in 2004 to a low in 2006 but recovered during 2007-2009 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 308 tonnes in 2007 but recovered to 430-490 tonnes in 2008-2009 (Table 2).

Decline in volume of crab was mainly due to falling market price, diverted fishing activity of the offshore vivier fleet to the southern North Sea, where crab are landed directly into the continent, and to initiatives by the industry to curb landings to stimulate market price. Lobster landings may have declined due to reduced fishing activity in response to poor market prices. Native oyster and cockle landings fluctuate annually. Cockle fisheries are significantly affected by variability in recruitment which has been poor in recent years. Native oyster landings depend on local management decisions that are taken by the co-operatives in relation to the perceived state of the stocks locally and to stock decline due to *Bonamia* infection, low spawning stock biomass and poor recruitment.

The value of crustacean and bivalve fisheries varied from approximately €85million in 2004 to approximately €44m in 2008-2009.

Table 2. Annual landings (tonnes) and value (€ millions) of crustacean and bivalve shellfish (excl. prawns and mussels) into Ireland 2004-2009. Scallop landings in 2009 have been allocated the 2008 figure. Unit value is from 2008 sales note data or from estimated values.

		Landings (tonnes)							Value (€ millions)					
ScientificName	**Common name**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	***Unit value***	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Aequipecten opercularis	Queen scallop	110	75	172	26	4		*€1.77*	€0.19	€0.13	€0.30	€0.05	€0.01	€0.00
Buccinum undatum	Whelk	7589	4151	3144	3635	1947	2239	*€1.61*	€12.22	€6.68	€5.06	€5.85	€3.14	€3.61
Cancer pagurus	Edible crab	14217	9527	10827	9251	7640	6614	*€2.11*	€30.00	€20.10	€22.85	€19.52	€16.12	€13.96
Carcinus maenas	Shore crab	268	27	46	91	72	244	*€0.57*	€0.15	€0.02	€0.03	€0.05	€0.04	€0.14
Cerastoderma edule	Cockle	207	107	7	643	9	173	*€2.50*	€0.52	€0.27	€0.02	€1.61	€0.02	€0.43
Chaceon affinis	Red crab	214	294	152	83	44	105	*€1.09*	€0.23	€0.32	€0.17	€0.09	€0.05	€0.11
Ensis	Razor clams	400	404	547	356	451	293	*€2.66*	€1.06	€1.07	€1.45	€0.95	€1.20	€0.78
Homarus gammarus	Lobster	856	635	625	308	498	431	*€14.53*	€12.43	€9.23	€9.09	€4.48	€7.24	€6.27
Littorina littorea	Periwinkle	1674	1139	1210	609	1141	1103	*€2.04*	€3.42	€2.33	€2.47	€1.25	€2.33	€2.25
Maja brachydactyla	Spider crab	180	141	153	70	153	443	*€1.26*	€0.23	€0.18	€0.19	€0.09	€0.19	€0.56
Necora puber	Velvet crab	291	245	281	142	267	205	*€2.50*	€0.73	€0.61	€0.70	€0.36	€0.67	€0.51
Palaemon serratus	Shrimp	405	151	319	325	180	228	*€15.17*	€6.14	€2.29	€4.84	€4.92	€2.73	€3.46
Pecten maximus	Scallop	2471	1277	742	953	1322	*1322*	*6.76*	€16.71	€8.63	€5.02	€6.44	€8.94	€8.94
Spisula	Surf clam	28		26	14	55	150	*€3.00*	€0.08	€0.00	€0.08	€0.04	€0.17	€0.45
Veneridae	Venus clam		217	4				*€1.84*	€0.00	€0.40	€0.01	€0.00	€0.00	€0.00
Palinurus elephas	Crayfish	80	30	34	16	18	28	*€35.70*	€2.87	€1.08	€1.21	€0.59	€0.66	€1.00
Ostreae edulis	Native oyster	543	94	233	291	88	327	*€4.20*	€2.28	€0.40	€0.98	€1.22	€0.37	€1.37
Total tonnage		**29533**	**18513**	**18522**	**16815**	**13891**	**13905**		**€89.26**	**€53.73**	**€54.45**	**€47.50**	**€43.87**	**€43.83**

4 Cockle (*Cerastoderma edule*)

4.1 Management recommendations

The management regime for cockles in the period 2007-2010 used a suite of measures which effectively limited exploitation rates and protected juvenile cockles. Natural mortality during the period 2008-2010 was high indicating strong environmental effects on recruitment and survival.

The fishery measures as outlined in the various Dundalk Bay cockle management plans should be continued.

In addition mortality of discarded cockles and non-target bivalves should be estimated and mitigation measures put in place if required. 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 the conservation objectives for these Natura sites are protected.

4.2 Summary

Recruitment to cockle fisheries in 2009 and 2010 has been poor resulting in low stock biomass which was inadequate to support commercial fisheries in 2010. In Dundalk Bay biomass in 2010 was approximately 33% of the average biomass in 2007-2009 while in Waterford there were no commercial sized cockles. Biomass, in a previously un-surveyed stock in Clew Bay, was approximately 350 tonnes. A biomass of approximately 2250 tonnes was present in Tramore Bay in 2007 but was not surveyed in 2008-2010 and has not supported a fishery.

4.3 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.

4.4 Dundalk Bay

4.4.1 Biomass 2007- 2010

Biomass estimates from annual surveys in 2007-2010 are not strictly comparable because of differences in the time of year in which surveys were undertaken. 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 18mm shell width. The fishery in 2007 removed approximately 900 tonnes (including an approximate estimate for hand gatherers) of cockles over 22mm. 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 18mm 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 indicating that settlement in 2009 was weaker than in 2008. 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.

Although the stock was not fished in 2008 the biomass was lower in 2009 than in 2008 and lower again in 2010 although the total landings from the 2009 fishery were 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. Heavy rainfall in summer of 2008 and periodic easterly gales in winter 2008-2009 are probably the main factors leading to such mortality. The 2009 fishery extracted 108 tonnes of the 2158 tonnes of biomass. Conditions for survival in the wet summer of 2009 and extremely cold winter of 2009-2010 probably led to high mortality.

Table 3. Annual cockle biomass and TAC in Dundalk Bay 2007-2010

Year	Survey Month	Biomass		TAC (tonnes)	Landings	
		Mean	95% CL		Vessels	Hand gatherers
2007	March	2277	172	950	668	Unknown
2008	August	3588	1905	0	0	0
2009	June	2158	721	719	108	0.28
2010	May	814	314	0	0	0

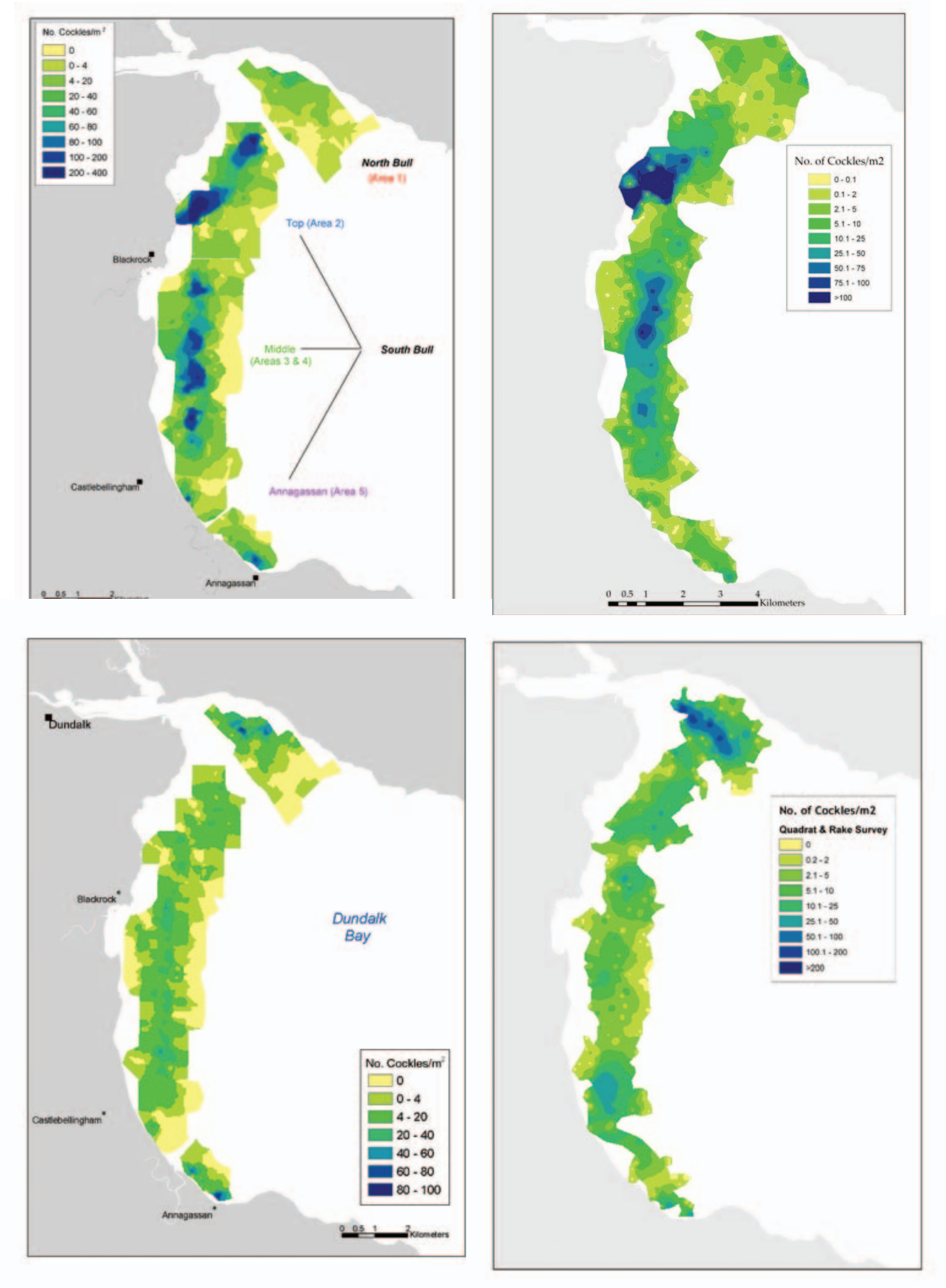


Figure 1. Distribution of biomass of cockles in Dundalk Bay in March 2007 (top left), August 2008 (top right), June 2009 (bottom left) and May 2010 (bottom right).

4.4.2 Summary of trends in size and age structure

Annual surveys have been undertaken at different times of year since 2007. The modal size of each year class and in particular the 0+ settlement is therefore not directly comparable. However a number of observations are possible

- In 2007 the size structure indicated the presence of a number of age classes dominated by the 1+ and 2+ year classes. This survey in March was too early to detect the 2007 settlement. The fishery removed over 900 tonnes of cockles (>22mm shell width or >27mm shell height) in autumn of 2007 but catch rates at the close of the fishery were approximately 50% of their initial value at the opening of the fishery, simplistically suggesting a 50% exploitation rate

- The 2008 survey was undertaken in August. The population was dominated by the 0+ cohort which had settled in the spring of 2008. Recruitment was stronger than in 2007. There was no fishery in 2008
- In 2009 the June survey detected a strong 0+ year class and 1+, 2+ and 3+ cockles in lower abundance. The fishery removed just over 100 tonnes of cockles (>22mm width) in the autumn of 2009.
- In 2010 the May survey detected the 0+ settlement but very low abundance of other year classes other than a residual population of 3-6 year old cockles. The 1+ and 2+ cohorts were poorly represented. There was no fishery.

4.4.3 Total Allowable Catch 2007-2010

In the cockle management plan a 'rule of thumb' approach to setting annual TACs limits the exploitation rate to 33% of the total biomass of cockles in the bay. Annual take up of the TAC ranged from close to 100% in 2007 to only 15% in 2009 (Table 3). Low take up in 2009 was due to other restrictions in the management plan such as threshold rates of catch below which the fishery was to be closed, a limited fishing season, limited fishing days during the season, daily maximum catch, a minimum, market driven, landing size of 22mm shell width which is higher than the 17mm legal requirement and spatial restriction on where fishing can occur. In addition an unknown but probably significant natural mortality occurred in the period between the biomass survey and when the fishery opened. A zero TAC was set in 2008 as a precaution, and as required by the Habitats and Birds Directives, because an appropriate assessment of the environmental impact of the fishery had not been undertaken. A zero TAC was set in 2010 because of low biomass and low densities which were deemed to be below commercial viability.

4.4.4 Effects on benthic habitats

Surveys were carried out on the benthic macrofaunal communities of Dundalk Bay before, subsequent to and four months following the 2009 cockle dredge fishery in order to monitor the impacts of dredging activities on these communities and to determine their recovery rate once dredging activities ceased. A total area of $14km^2$ was designated for fishing activities based on biomass estimates determined from an assessment of the cockle stocks carried out in May 2009 (Figure 2). Fishing vessels transmitted GPS data in real time so that their fishing positions could be verified. A total of sixty six locations were sampled; 33 as control sites outside the designated fishing areas and 33 as impact sites within the designated fishing areas. One quadrat ($0.25m^2$), three core samples and a sediment sample were collected at each sampling station.

Sampling was undertaken prior to the fishery in September 2009, in November 2009 following closure of the fishery on November 1st and again in early March 2010.

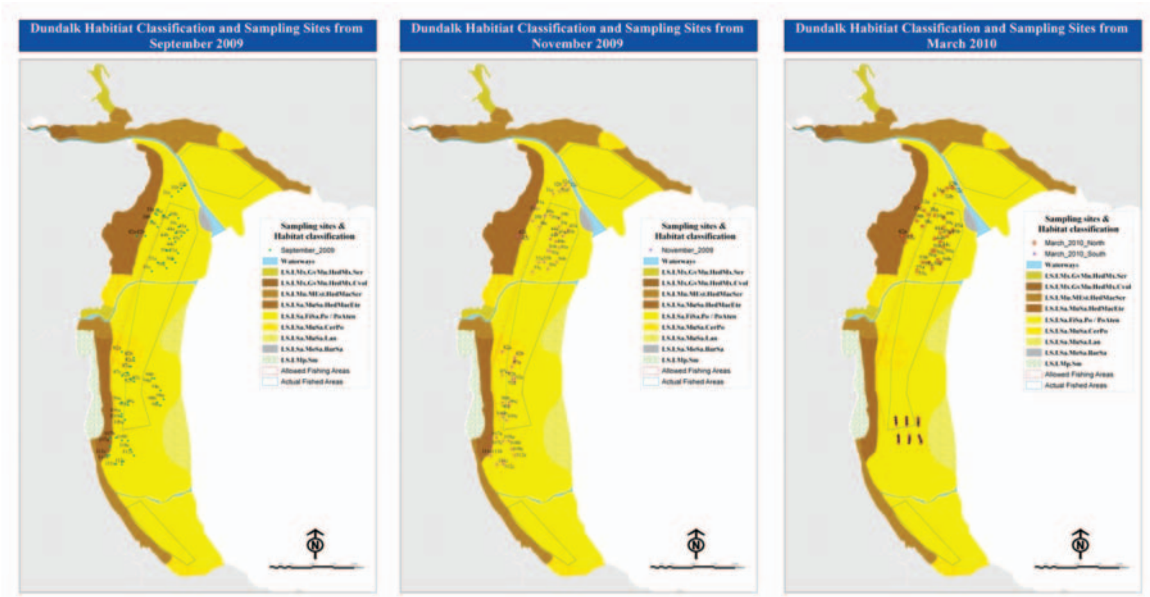


Figure 2. Map indicating the control and impact sites in Dundalk Bay sampled in September 2009, November 2009 and March 2010.

Sediment samples collected pre and post fishery showed no significant difference in the percentage of gravel, sand and mud. Sand made up the largest proportion of all sediment samples, ranging from 82% to 99% in September 2009 and 86% to 99% in November 2009.

During the survey 151 quadrat and 538 core samples were collected and analysed. Data from the southern sampling area for March 2010 (90 samples) was analysed separately. No overall significant difference between the control and impact sites across the three sampling periods and between the northern and southern sampling areas was indicated by two-way crossed ANOSIM analysis (Table 4). Some divergence of communities does occur, however none of these values are above 0.5 indicating that the faunal communities on average are highly overlapping.

Looking at the control and impact sites of the northern and southern sampling areas separately over each time period does indicate significant differences with R values greater than 0.5 (Table 5).

The ANOSIM analysis carried out on the southern data collected in March 2010 did not detect any significant difference between any of the sites. R values for between control and impact sites across the shore levels or between shore levels across the control and impact sites were 0.118 (p=0.03%) and 0.303 (p=0.01%), respectively. The higher value for location along the shore suggests this factor may have more of an influence on any community differences between samples than the fishing activities.

Dundalk Bay contains 11 intertidal biotopes (Aquatic Services Unit, UCC 2008). Of the 11 intertidal biotopes identified 'Polychaetes and *Angulus tenuis* in littoral fine sand' (LS.LSa.FiSa.Po/PoAten) is the most dominant within Dundalk Bay and the majority of the designated cockle fishing areas overlap this biotope. The faunal community recorded during the current survey work most closely resembles the Eunis biotopes '*Cerastoderma edule* and polychaetes in littoral muddy sand' (LS.LSa.MuSa.CerPo) and 'Polychaetes and *Angulus tenuis* in littoral fine sand'.

Table 4. Matrix of Global R statistics from two-way crossed ANOSIM analysis for both quadrat and core samples collected in September 2009, November 2009 and March 2010, at control and impact sites in northern and southern sampling areas (CI = Control or Impact). Global R-values close to 0 indicate no difference and close to 1 indicate significant difference

		Time period_Location	Time period_CI	Location_CI
Quadrat	Control or Impact	0.261 (p=0.01%)		
	North or South		0.217 (p=0.01%)	
	Time period			0.188 (p=0.01%)
Core	Control or Impact	0.316 (p=0.01%)		
	North or South		0.276 (p=0.01%)	
	Time period			0.143 (p=0.01%)

Table 5. Matrix of Global R statistics from one-way ANOSIM analysis for core samples collected in September 2009, November 2009 and March 2010 (N=North, S=South; C=Control, I=Impact).

	September NC	November NC	March NC	September SC	November SC
September NI	0.653 (p=0.01%)				
November NI		0.593 (p=0.01%)			
March NI			0.646 (p=0.01%)		
September SI				-0.165 (p=99.5%)	
November SI					0.01 (p=36.4%)

The former biotope consists of extensive clean fine sand or muddy sand shores with abundant cockles (*Cerastoderman edule*) and an accompanying community including species such as *Eteone longa*, *Scoloplos armiger*, *Pygospio elegans*, *Capitella capitata*, *Crangon crangon*, *Bathyporeia* sp., *Hydrobia edule* and *Macoma balthica*. The latter biotope occurs on the mid and lower shore on moderately wave-exposed and sheltered coasts, with predominantly fine sand which remains damp throughout the tidal cycle. The sediment is often rippled, and an anoxic layer may occasionally occur below a depth of 10cm, though it is often patchy. The infaunal community is dominated by the abundant bivalve *Angulus tenuis* together with a range of polychaete species. Burrowing amphipods (*Bathyporeia* spp.) may occur in some samples from this biotope. The infauna of this biotope may be reduced during winter, as increased storminess and wave action increases sediment mobility and may lead to some species migrating or being washed out of the sediment.

Previous studies have shown that the composition and functioning of biotopes can be changed and impaired by dredging. It is generally expected that there will be a reduction in species diversity and abundance in the areas where the dredge has operated. Soft sediment biotopes, however, do recover from such disturbance. The two-way design ANOSIM analysis carried out on the data recorded no significant differences overall. Further one-way analysis on the sampling areas over each of the three time periods did distinguish significant diverging communities between the northern control and impact sites. Differences detected are unlikely to be due to fishing pressure as these differences were already present in September 2009 prior to the fishery. The average abundance of certain species recorded in November 2009 was lower after fishing, nonetheless communities of the impact sites did not differ significantly between September and November 2009 or four months later in March 2010.

Dundalk Bay is a large exposed east facing bay which is often subjected to high winds and strong wave action from easterly storms making this habitat a highly dynamic environment. Faunal communities within this bay need to be highly adaptable to natural sediment movement resulting from stormy conditions. The differences in community structure within the impact sites in September and November 2009 may differ from those recorded in March 2010 due to affects of winter weather conditions and colder temperatures.

4.5 Waterford Estuary and Tramore Bay

4.5.1 Biomass 2007-2010

Surveys in 2007-2010 provided fishery independent estimates of biomass. 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 Woodstown or Passage East during the 2009 or 2010 surveys. A large biomass of 2375 was present in Tramore in 2007. No surveys were completed in Tramore in 2008-2010.

Table 6. Annual biomass estimates and TACs for cockle beds in the Waterford Estuary and Tramore

Year	Area	Biomass	95% C.I.	TAC	Landings
2007	Woodstown	367	24	121.11	154
	Passage East	276	24	91.08	
	Tramore	2375	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

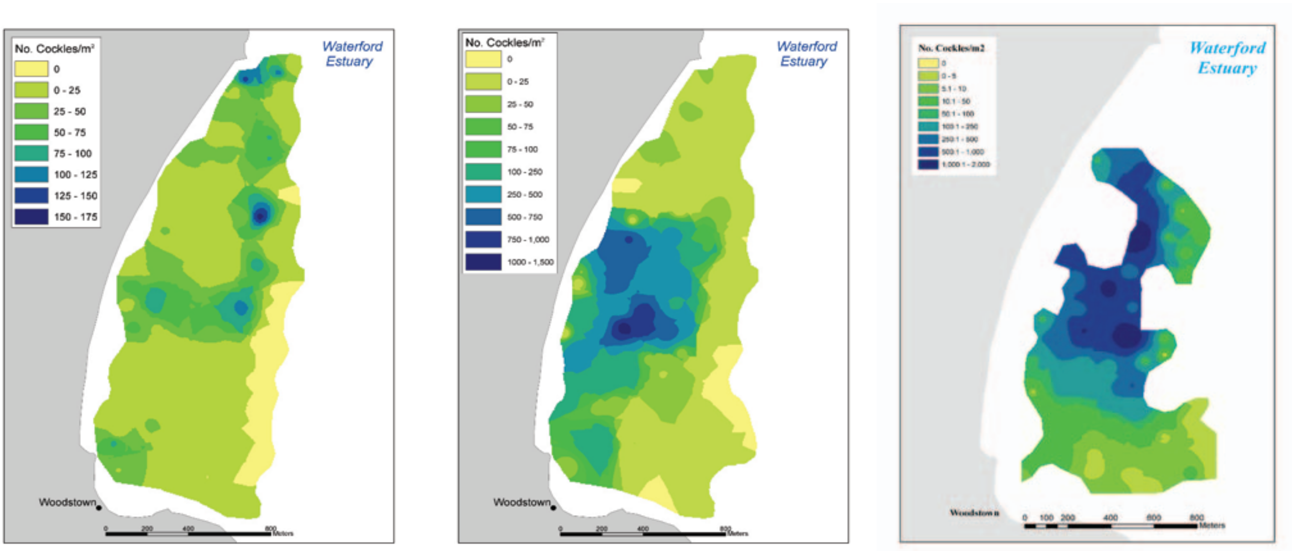


Figure 3. Distribution of biomass of cockles at Woodstown, Waterford Estuary in 2007 (left), 2008 (middle) and 2010 (right).

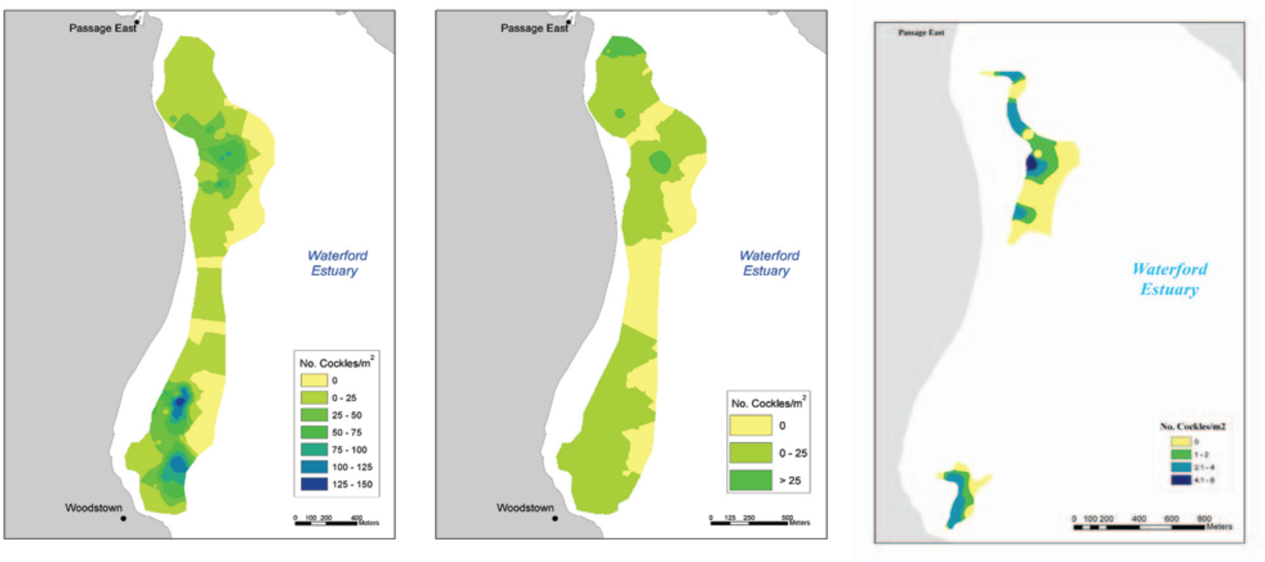


Figure 4. Distribution of biomass of cockles at Passage East, Waterford Estuary in 2007 (left), 2008 (middle) and 2010 (right).

4.5.2 Total Allowable Catch 2007-2010

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 set to 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.

As the commercial biomass in 2009 and 2010 was estimated to be zero the TAC was set to zero and no proposal to open the fisheries was developed. Figure 3 shows high densities of cockles being recorded in Woodstown during the 2010 survey, however 96% consisted of the 0+ cohort and thus were not of exploitable size (only 6% were >17mm and less than 1.5% were >22mm in depth).

4.6 *Clew Bay*

4.6.1 Biomass 2010

Clew Bay was not surveyed for cockles prior to 2010. Two areas, one on the south east shore at Murrisk and one on the north shore east of Mullranny were surveyed on the basis of local and anecdotal information on cockle stocks in the area.

No commercial quantities of cockles were found on the south shore. A patch containing approximately 351 tonnes was found on the north shore (Table 7,Figure 5) .

Table 7. Mean weight of cockles and total biomass at different densities (m^{-2}) on the north shore of Clew Bay in 2010.

Density Contours	Area (m^2)	N	Average density (m^2)	95% CL density	Biomass gm^2	95%CL Biomass gm^2	Total biomass (tonnes)	95% CL Tonnes Biomass
0	260608	33	0.00	0.00	0.00	0.0	0.0	0.0
1 - 9.9	63541	12	5.00	1.05	39.95	14.77	25.4	9.4
10 - 19.9	28805	1	16.00	0.00	250.56	0.00	72.2	0.0
20 - 29.9	74017	4	22.00	2.32	188.29	118.27	139.4	87.5
30 +	43181	5	33.60	1.97	265.45	106.25	114.6	45.9
	0.47	**57**					**351.5**	**142.8**

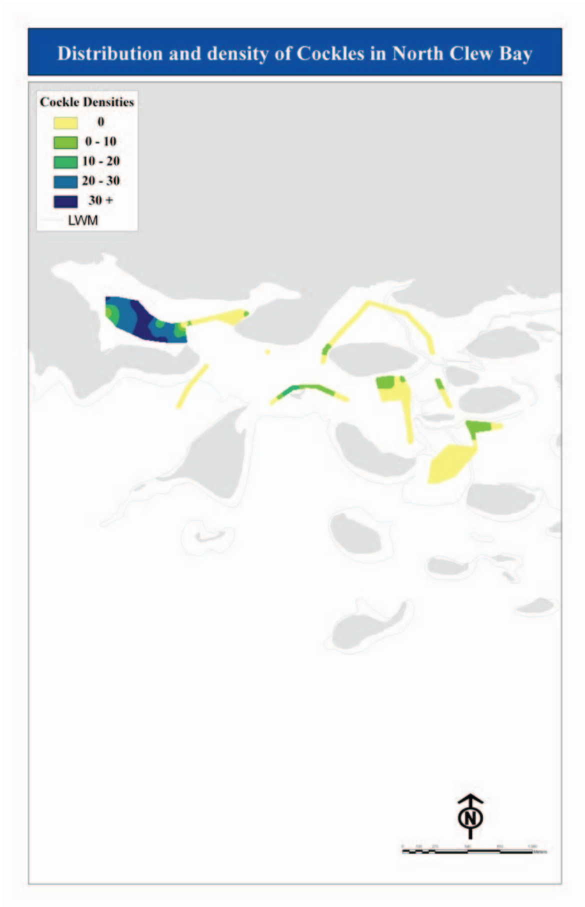


Figure 5. Distribution and density of cockles on the north shore of Clew Bay in 2010

4.6.2 TAC 2010

No fishery plan was established and the TAC was set to zero.

5 Scallop (*Pecten maximus*)

5.1 Management recommendations

The over 15m scallop fleet has re-developed in recent years following a decommissioning scheme in 2006. Although the maximum fleet size is capacity limited and vessels over 10m require permits to fish for scallop, landings and effort have increased successively in each year during the period 2006-2009 in the eastern Celtic Sea, which is the main fishing area for the Irish fleet. Landings and effort in 2009 were higher than in the period 2002-2006. Effort or landings from this stock should be managed so that depletion of the stock is avoided. Given the uncertainties and possible bias in mortality estimates using length and age composition data a high spatial resolution catch and effort monitoring programme should be developed.

Small scale inshore scallop fisheries are variously managed by industry co-operatives and Associations. Although seasonal quotas and minimum size regulations are in place reference points for these stocks should be developed and agreed with industry to ensure sustainable development of these fisheries.

5.2 Summary

The Irish over 15m scallop fleet in the period 2008-2009 fished mainly in the eastern Celtic Sea (locally the B&H ground), the southern Irish Sea and Liverpool Bay. Annual landings and effort in the eastern Celtic Sea increased in successive years between 2006-2009 and in 2009 were higher than in any year at least since 2002. Effort and landings in the Tuskar area have been low in recent years and the majority of the landings and effort in the southern Irish Sea has occurred in the Cardigan Bay area. Landings by Scottish vessels in the southern Irish Sea have increased significantly since 2006.

Mortality and harvest rate estimates are high especially in the eastern Celtic Sea. Although there is some doubt about the reliability of these estimates landings and effort also continue to increase in this area.

Data for small scale coastal scallop fisheries is poor. Biomass was estimated in Clew Bay, Kilkieran Bay and Valentia by independent dredge surveys in 2010. Exploitation rates in Clew Bay and Kilkieran Bay are low.

5.3 Management Units

A number of small scale coastal fisheries for scallop operate in bays around the coast. These can all be regarded as separate stocks and include fisheries in Clew Bay, Kilkieran Bay, Beirtreachbuoy Bay, Galway Bay, The Blaskets, Valencia Harbour, Kenmare Bay and Roaringwater Bay.

A larger offshore fleet operates out of Kilmore Quay and other ports in County Wexford and is responsible for over 90% of landings of scallop into Ireland. This fleet operates in the Irish Sea, Celtic Sea and previously in the English Channel fishing different stocks within this area on a seasonal basis. Two large scallop beds occur off the south east coast one in the eastern Celtic Sea (locally the B&H) and including all of ICES rectangles 31E2, 32E2, 31E3 and 32E3. Two beds occur in the southern Irish Sea in the Tuskar

(33E4) area and further east in Cardigan Bay (33E5). Further north a significant fishery occurs south east of the Isle of Man and extends into Liverpool Bay. Extensive scallop beds also occur off the north Cornwall coast (30 E4) and in the western (26E3, 27E3, 27E4, 28E4) and eastern (28F0) English Channel.

The southern Irish Sea and eastern Celtic Sea beds are interconnected, to a degree, by larval dispersal (Tully *et al* 2006).

5.4 *The offshore fishery*

5.4.1 Landings and effort

Landings of scallop by Irish registered vessels over 15m, and fishing in offshore areas, described above, were relatively stable from 1990-1998 and averaged 668 tonnes annually. In 1999 a number of additional licences were issued and the number of dredges in the fishery increased from 103 in 1997 to 498 in the period 1997-2000 and peaked at 528 in 2002. Landings increased to 1497 tonnes in 1999 and peaked in 2004 at 2257 tonnes. A kw.day regime was introduced in 2005 (Council regulation 1415/2004) and a number of vessels were also decommissioned in that year. The contraction in the fleet led to a reduction in landings to 527 tonnes in 2006. Post decommissioning the fleet was capacity limited and vessels now require a scallop permit to fish. From 2006-2009 landings increased from 527 tonnes to approximately 1200 tonnes.

The trend in effort (measured in VMS hours) was correlated with landings in the period 2004-2009 but less clearly in 2000-2003 (
Figure 6).

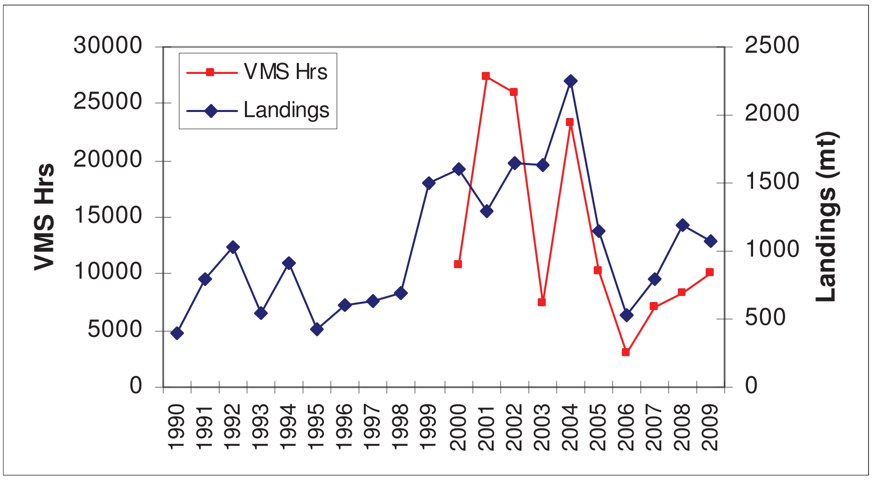


Figure 6. Landings and effort by the Irish >15m scallop fleet 1990-2009.

5.4.2 Geographic distribution of fishing

The VMS data shows how the spatial distribution of the fishery developed and contracted in the period 2000-2009 (Figure 7). As the trend in landings indicates the Irish fishery was already well established in a number of offshore scallop beds in 2000-2001. This expansion began in the 1980s with an increase in activity in the eastern Celtic Sea and Cardigan Bay area. By 1990 fishing also occurred in the Isle of Man-Liverpool Bay area and the eastern Celtic Sea fishery continued to expand. By 2000-2001 the fleet was active in the western Channel, Tuskar, south of the Isle of Man, north Cornwall and the Celtic Sea. The spatial extent of the Celtic Sea fishery had expanded further by 2001. By 2002-2003 the fleet was active in the eastern Channel and the Celtic Sea fishery expanded to the west. This pattern continued in 2004-2005 although activity in the Celtic Sea had reduced by that time. The effect of decommissioning is clear in 2006-2007 which shows a contraction of effort away from distant beds in the eastern and western Channel and a concentration of activity in the eastern Celtic Sea, Cardigan Bay and Liverpool Bay which continued in 2008-2009.

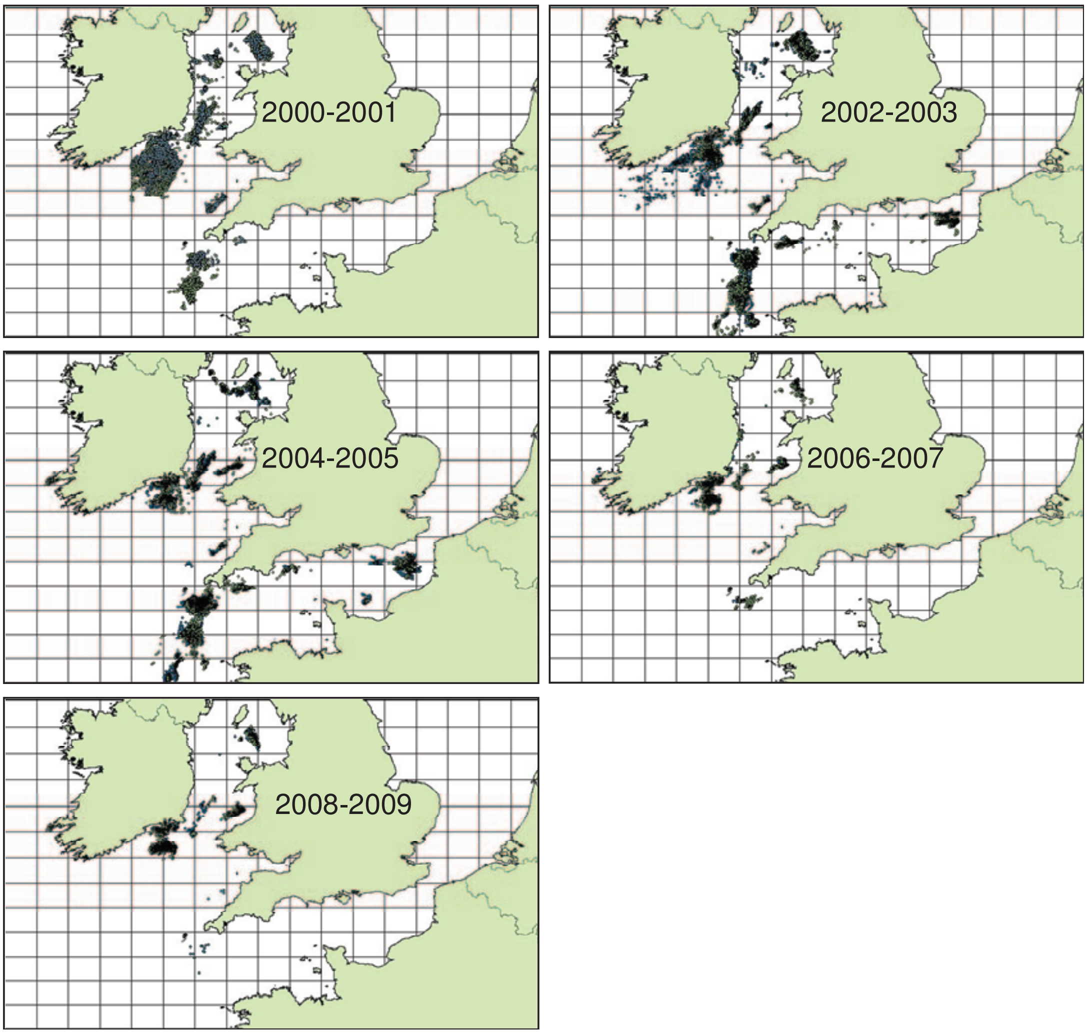


Figure 7. Vessel monitoring system data for the Irish scallop >15m fleet in the period 2000-2009

5.5 The eastern Celtic Sea fishery

5.5.1 Landings and effort

A significant proportion of the increase in landings and effort by the Irish >15m fleet that has occurred since 2006 is due to increased fishing activity in the eastern Celtic Sea (Figure 8). Landings increased from an average of 232 tonnes in the period 2003-2007 to 695 tonnes in 2008-2009.

VMS hrs also increased from an average of 2767 hrs in the period 2003-2006 to over 7000 hrs in 2009. The majority of the increase in landings has been from statistical rectangles 32E2 and 32E3. Scottish vessels landed less than 10 tonnes per annum from the area during the period 2003-2009 (source: Marine Science Scotland).

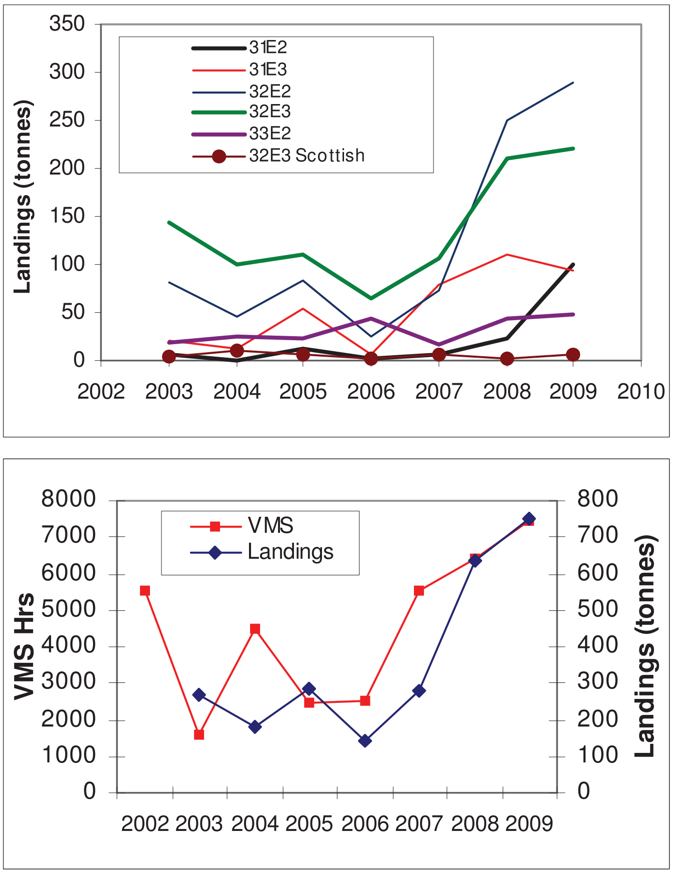


Figure 8. Landings by ICES statistical rectangle and total landings and effort by year in the eastern Celtic Sea scallop fishery 2003-2009.

5.5.2 Size composition and mortality

The size distributions of scallop in the commercial landings, and referenced to statistical rectangle, were largely similar in the periods 2003-2005 and 2009-2010 (Figure 9). The distributions suggest high mortality rates of fully selected scallop above 100mm shell height.

Using spatially explicit growth rate information estimated for the period 2003-2006 (Hervas 2008) total mortality rates (Z) were calculated from linearised length converted catch curves of the size composition data for the periods 2003-2005 and 2009-2010 assuming steady state conditions and using constant parameters. Pooling of samples approximates to the steady state assumption although in this case the time series is short.

Estimated average harvest rates, for fully selected (>100mm shell length) scallops, for the 5 ICES rectangles 31E2, 31E3, 32E2, 32E3 and 33E2 were marginally lower in 2009-2010 than in 2003-2005 at 0.58 compared to 0.66 respectively (Table 8).

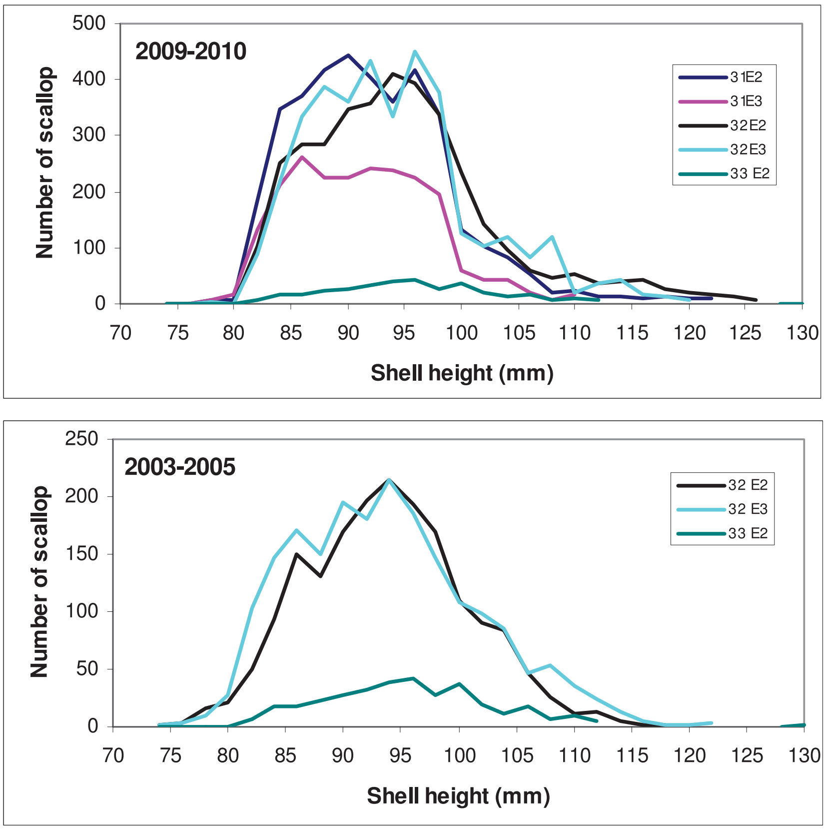


Figure 9. Shell height distribution of scallop in the landings by statistical rectangle in the period 2003-2005 and 2009-2010 and shell height distribution by statistical rectangle from survey data in 2003-2005.

Table 8. Mortality and harvest rate estimates for the eastern Celtic Sea, by statistical rectangle, for fully selected scallop for the periods 2003-2005 and 2009-2010 using spatially explicit growth parameters. Z = total annual mortality rate. Ci Z lower and upper are 95% confidence intervals for Z from the length converted catch curve regression for fully selected size classes. H = $1-e^{(-(Z-M))}$ where M = 0.2 throughout. N = the number of points included in the linear regression of Ln(N/dt) = a+b*t where t is the relative age derived from the growth parameters and mid-length of the size class (2mm class bins) for fully selected size classes.

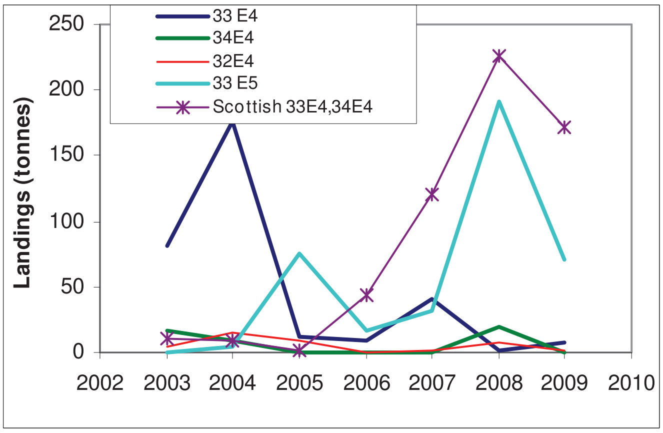
Stat rectangle	**31E2**	**31E3**	**32E2**	**32E3**	**33E2**	**33E3**
Growth parameters (Hervas 2008)						
k	0.34	0.29	0.31	0.27	0.31	0.32
L_{inf}	111.6	129.5	121.7	133.2	121.7	126.7
Mortality						
Z (2009-2010)	***0.88***	***2.37***	***0.67***	***1.25***	***0.9***	***1.05***
Ci Z lower	0.79	1.79	0.46	1.08	0.72	0.83
Ci Z upper	0.97	2.94	0.88	1.42	1.08	1.26
N	9	7	13	15	10	12
Annual harvest rate (H)	**0.49**	**0.89**	**0.37**	**0.65**	**0.50**	**0.57**
Ci H lower	0.45	0.80	0.23	0.59	0.41	0.47
Ci H upper	0.54	0.94	0.49	0.70	0.59	0.65
Z(2003-2005) landings			***1.25***	***1.51***	***1.14***	***0.62***
Ci Z lower			1.16	1.36	0.87	0.59
Ci Z upper			1.34	1.65	1.41	0.66
N			12	14	11	20
Annual harvest rate			**0.65**	**0.73**	**0.61**	**0.34**
Ci H lower			0.62	0.69	0.49	0.32
Ci H upper			0.68	0.77	0.70	0.37

5.6 The southern Irish Sea fishery

5.6.1 Landings and effort

Landings by Irish vessels declined from 2004-2006 in the Tuskar area (33 E4) and remained low in the period 2007-2009 (Figure 10). In contrast landings from Cardigan Bay (33E5) increased, especially in 2008, although this was not reflected in the VMS effort data.

Landings by Scottish vessels from 33E4 and 34E4 increased from 0 in 2005 to 230 tonnes in 2008.



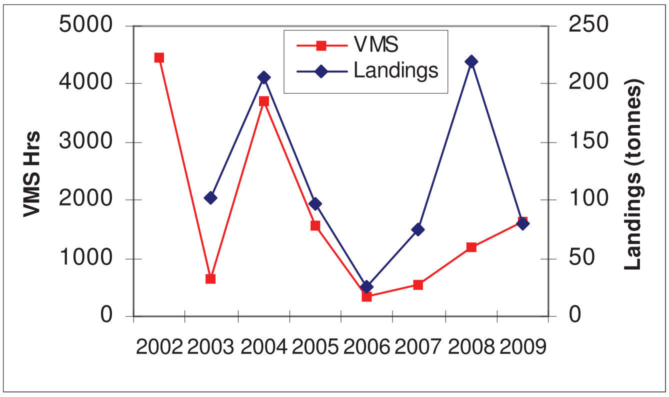


Figure 10 Landings by ICES statistical rectangle for Irish and Scottish vessels and landings and effort relationship by year for Irish vessels in the Tuskar scallop fishery 2003-2009

5.6.2 Size composition and mortality

The size distribution of scallop in the landings in the periods 2003-2005 and 2009-2010 suggests stronger recruitment in the former period (Figure 11). The size composition in 2009-2010 was truncated at 120mm shell height.

Estimated total mortality and harvest rates in the Tuskar and Cardigan Bay area were higher in the 2009-2010 period than in 2003-2005 although landings and effort declined significantly in the area during the period (Table 9). Harvest rates were lower than in the eastern Celtic Sea.

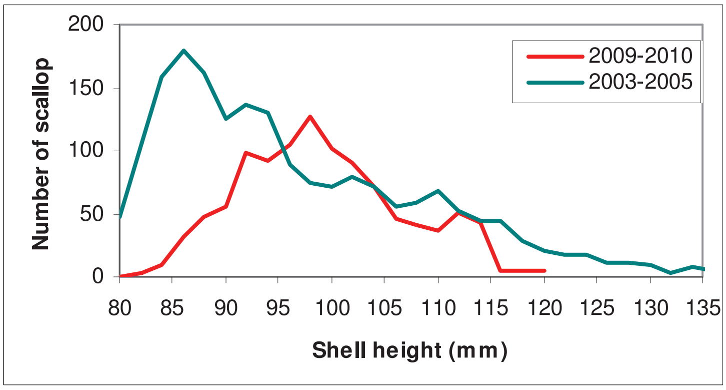


Figure 11. Size distribution of scallop in the landings from the Tuskar fishery in 2003-2005 and 2009-2010.

Table 9. Mortality and harvest rate estimates for scallop in Tuskar (33E4) and Cardigan Bay (33E5) in 2003-2005 and 2009-2010. See legend in Table 8 for details.

Statrec	**33E3**	**33E5**
Growth parameters (Hervas 2008)		
k	0.32	0.32
L_{inf}	126.7	126.7
Mortality		
Z (2009-2010)	***1.05***	***0.9***
Ci Z lower	0.83	0.79
Ci Z upper	1.26	1
N	12	15
Annual harvest rate (H)	**0.57**	**0.50**
Ci H lower	0.47	0.45
Ci H upper	0.65	0.55
Z(2003-2005) landings	***0.62***	
Ci Z lower	0.59	
Ci Z upper	0.66	
N	20	
Annual harvest rate	**0.34**	
Ci H lower	0.32	
Ci H upper	0.37	
Z(2003-2005) survey	***1.31***	
Ci Z lower	1.22	
Ci Z upper	1.4	
N	15	

5.7 The Liverpool Bay fishery

5.7.1 Landings and effort

Landings and effort by Irish vessels declined from 2003-2006 in the Liverpool Bay area and increased in the period 2007-2009 (Figure 12).

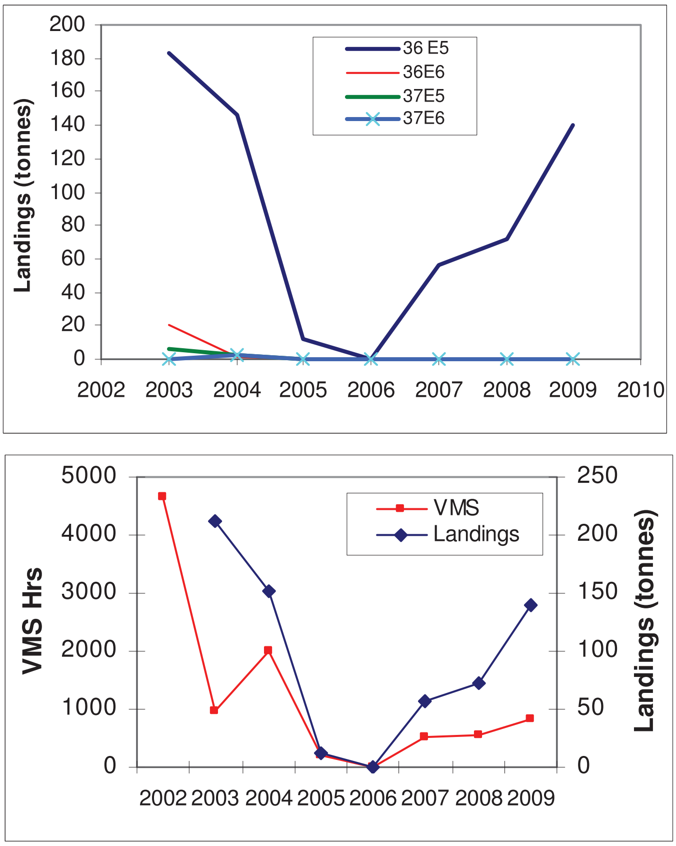


Figure 12. Landings by ICES statistical rectangle and total annual landings and effort by Irish vessels in the Liverpool Bay scallop fishery 2003-2009

5.7.2 Size composition and mortality rates

Comparison of size distribution data in 2003-2005 and 2009-2010 suggests stronger recruitment in the latter period (Figure 13). Mortality estimates and harvest rates were marginally lower in the 2009-2010 period compared to the 2003-2005 period. Harvest rates were lower than in the Eastern Celtic Sea (Table 10).

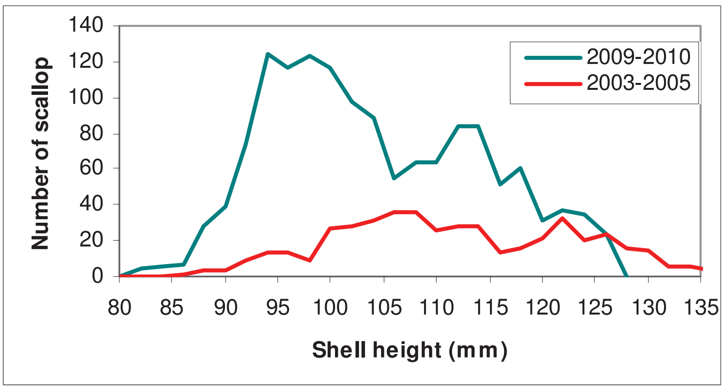


Figure 13. Size distribution of scallop in the landings from Liverpool Bay in 2003-2005 and 2009-2010.

Table 10. Mortality and harvest rate estimates for scallop in the Liverpool Bay area in 2009-2010 and 2003-2005.

Statrec	**36E5**
Growth parameters (Hervas 2008)	
k	0.388
L_{inf}	123
Mortality	
Z (2009-2010)	***0.57***
Ci Z lower	0.5
Ci Z upper	0.64
N	14
Annual harvest rate (H)	**0.31**
Ci H lower	0.26
Ci H upper	0.36
Z(2003-2005) landings	***0.65***
Ci Z lower	0.5
Ci Z upper	0.81
N	7
Annual harvest rate	**0.36**
Ci H lower	0.26
Ci H upper	0.46

5.8 Comment on mortality and harvest rate estimates in offshore stocks

Mortality and harvest rate estimates may be indicative only. Steady state stock conditions were assumed and a constant, in relation to size and age, parameters were used to estimate the rates from length converted catch curves. The rates are obviously sensitive to the size distributions and although sampling effort was substantial in each statistical rectangle there is some question over the assumption of constant catchability in relation to size for scallops fully recruited to the gear. Reduced catchability of larger scallops would lead to overestimation of mortality and harvest rates. In some areas changes in mortality and harvest rate estimates were not correlated to changes in landings and effort casting further doubt on the estimates.

Mortality and harvest rates estimated here using the linearised catch curve method were similar to estimates provided by Hervas (2008) using pseudo-cohort and true cohort analyses.

5.9 The Clew Bay scallop fishery

Scallop occur in commercial quantities in narrow depth bands surrounding the islands of inner Clew Bay (Figure 14). The boundaries of the distributions are difficult to define but they are restricted to seabed slopes and ledges between 5-32m depth.

5.9.1 Survey 2010

A total of 115 hauls were taken during April-June 2010 at an average depth of 22±6.0m with 3 spring loaded dredges moulted on a single beam. The dredge bar width was 0.8m with a tooth spacing of 7cm. Average tow length was 919±122m. Dredge efficiency was not estimated and the dredge efficiency of spring loaded toothed dredges, operated by the Irish offshore fleet, estimated by Hervas

(2008), was used to raise survey catch rates to scallop densities m-2.

Dredge tows (average length = 919±122m) were taken parallel to the seabed slope around Islands in the Bay where scallop were deemed to be present. The number of such areas surveyed was determined by knowledge of the commercial skipper who had fished scallop in the area for a number of years. In each area two tows, where possible, were taken at different depths parallel to the seabed slope. Subsequently the area of each scallop bed was estimated by extending a 20m buffer on either side of the two dredge tow lines and drawing a polygon to encompass that area. Fifty eight such polygons were drawn. Biomass estimates for each polygon was provided by

$$B = (\overline{X} * E) * A$$

where X is the average biomass per square meter uncorrected for dredge efficiency, E is the dredge efficiency and A is the area of the polygon over which scallop are deemed to be distributed. Average biomass per square meter was calculated as

$$\overline{X} = \overline{D} * Wt$$

Where D is the average density (numbers caught / swept area) and W_t is the average weight of scallop in the tow calculated from the shell size weight relationship.

Figure 14. Distribution of scallop beds in surveyed areas of Clew Bay in 2010.

5.9.2 Biomass

The total survey area was 4.03km^2. Average catch rate was 73±52 scallops per tow. Average catch rates of scallop >110mm shell length, which is the effective minimum market size, was 40±26 scallops per tow. On average 60±17% of scallops in the catch were >110mm. Average density of scallop corrected for a 20% dredge efficiency was 0.11±0.08m^{-2}.

Average biomass per survey polygon was 718±428kgs ranging from a minimum of 0 to a maximum of 1921kgs. Total biomass of scallops in the surveyed area was 42.3 tonnes. Given the unknown uncertainty in the dredge efficiency raising factor this figure is indicative only.

Annual landings of scallop from the surveyed area may vary from 0-10 tonnes suggesting a maximum annual exploitation rate of 25%.

5.9.3 Age, size composition and mortality rate

New growth parameters for Clew Bay scallops were estimated from the shell height to age relationship (Figure 15). The growth rate and shell height distribution data (Figure 16) were used to calculate total annual mortality (Z) from a linearised length converted catch curve for fully selected scallop.

Z was estimated to be 0.26±0.17. This low estimate of Z, equivalent to a loss rate of fully recruited scallops of 29% per year is not incompatible with the estimates of 25% exploitation rate obtained from the landings: biomass ratio (above) in years where a fishery occurs. In some years fishing mortality on this stock is known to be zero.

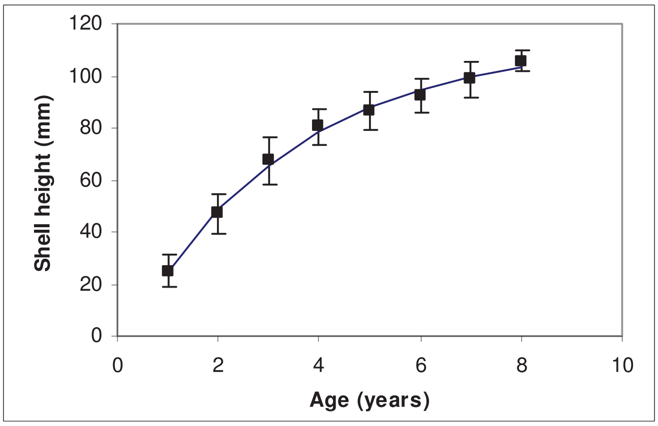


Figure 15. Shell height in relation to age of scallop in Clew Bay estimated from the growth history of the shell. Vertical bars are standard deviations. The fitted line in the vonBertalanffy growth model with parameter estimates k=0.31, H_∞=113 and t_o=0.2.

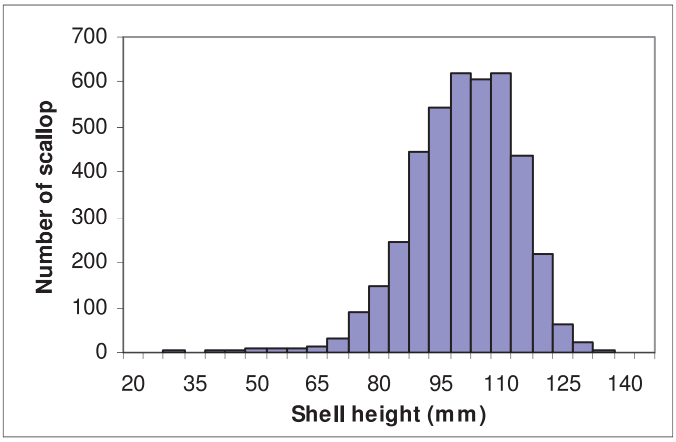


Figure 16. Shell height distribution of scallops from the Clew Bay survey.

5.10 The Kilkieran Bay scallop fishery

Scallops occur in the upper and middle reaches of Kilkieran Bay on mixed grounds of shell and maerl (Figure 17).

5.10.1 Survey 2010

A total of 79 hauls (Figure 17) were taken during November 2010 in water depths of 5-25m with a single fixed toothed dredge. The dredge bar width was 1.2m with a tooth spacing of 8-9cm and a 10cm flexible diamond mesh. Average tow track length was 114±11m. Dredge efficiency was estimated by comparison of numbers of scallop caught in the dredge and the numbers subsequently counted on the same dredge track by divers immediately after the dredge tow had been completed. Dredge efficiency, estimated along 10 separate tracks was 49±14% resulting in a dredge efficiency raising factor of 2.04±0.58.

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.

The total survey domain was 3.91km^2. Estimated population size and biomass was 0.5million scallop and 88±7 tonnes (Table 11). Approximately 73% of the population and 80% of the biomass was over the minimum landing size of 120mm shell length used to manage the fishery prior to 2010.

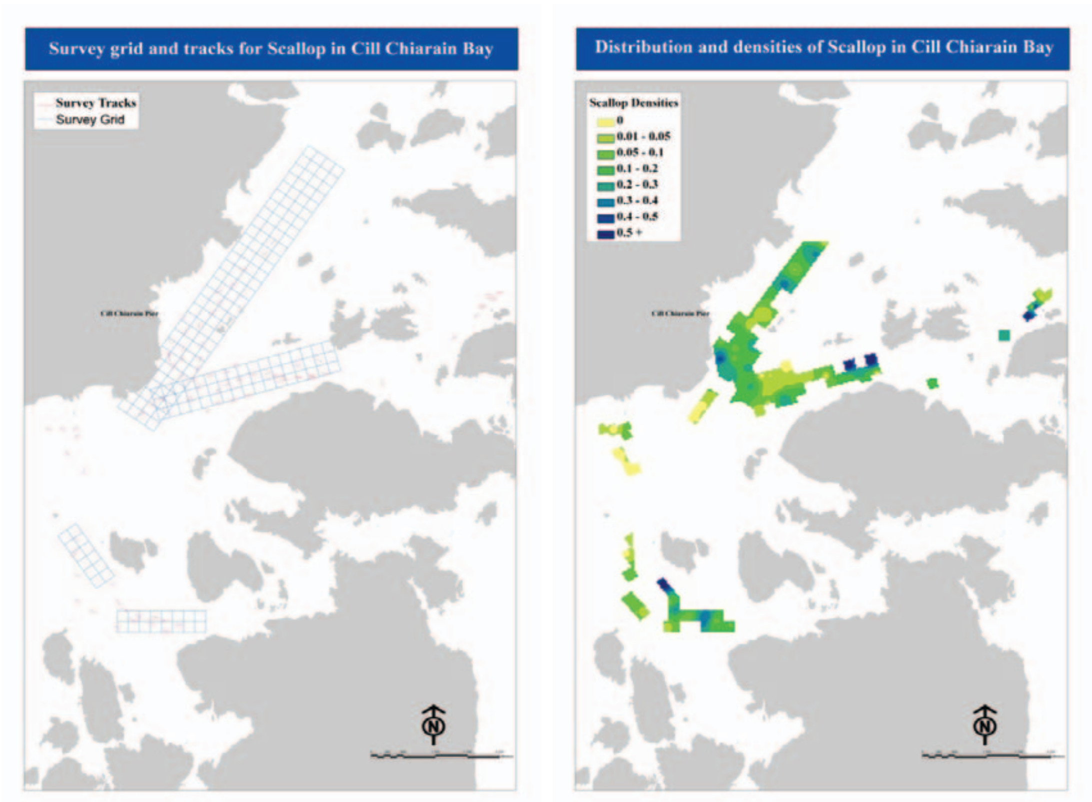


Figure 17. Survey grids, tow tracks and contoured densities of scallop in Kilkieran Bay expressed as numbers per square meter.

Table 11. Population and biomass estimates for scallop in Kilkieran Bay in November 2010. The survey area is post-stratified into areas with similar densities, the area within each stratum is given. N = the number of dredge tows in each stratum. 95% CL is the confidence limit for the various estimates.

Density Contour limits	Area (m^2)	N	Average density (m^2)	95% CL density	Number of scallops	Biomass gm^2	95%CL Biomass gm^2	Total biomass (tonnes)	95% CL Tonnes Biomass
0	254822	12	0.00	0.00	0	0.00	0.00	0.00	0.00
0.01-0.05	762555	19	0.02	0.01	17603	4.10	0.93	3.13	0.71
0.05-0.1	766679	16	0.07	0.01	57051	13.21	1.17	10.13	0.90
0.1-0.2	1221058	8	0.13	0.01	158341	23.03	1.93	28.12	2.35
0.2-0.3	610274	10	0.23	0.02	143122	41.64	2.79	25.41	1.70
0.3-0.4	149043	7	0.34	0.02	50159	59.76	3.81	8.91	0.57
0.4-0.5	62699	1	0.42		26058	73.80	0.96	4.63	0.06
0.5 +	80063	6	0.59	0.04	47077	104.41	6.64	8.36	0.53
Total	**3.91**	**79**	**0.23**		**499410**			**88.68**	**6.82**

5.10.2 Size composition and mortality

Shell height distribution showed a single mode at 112-120mm shell height (Figure 18). Total annual mortality rate (Z), estimated from the linearised portion of the length converted catch curve from data in

Figure 18 and using growth parameters of 0.45 (k) and 121.5 (H_∞) (Lawler 1994) was 0.32. This is equivalent to a total loss rate from the fully selected portion of the population of 27% per year.

Landings in 2009 and 2010 from Kilkieran Bay were approximately 20,000 and 125,000 scallops or 2% and 35% of the 2010 biomass estimate respectively. There was no fishery in 2007 or 2008.

Notwithstanding the uncertainty in the survey biomass estimates and the steady state assumptions behind the catch curve estimates the mortality rates estimated by these independent methods are reasonably consistent and indicate a relatively low level of exploitation and mortality in this stock as suggested by the irregular annual fishing patterns. Recruitment potential is conserved by the high minimum landing size used to manage the fishery.

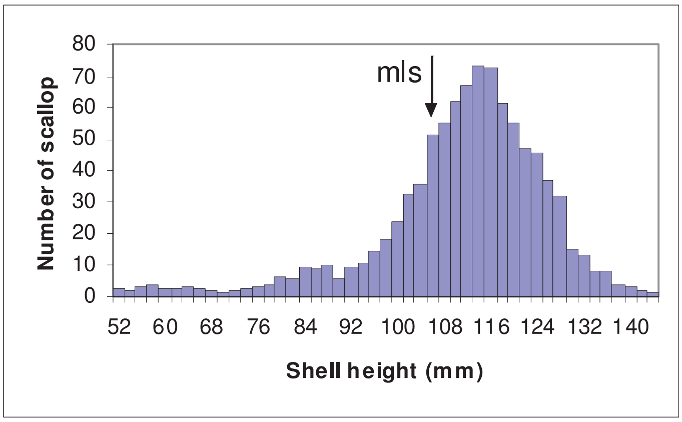


Figure 18. Shell height distribution for scallop from Kilkieran Bay in November 2010. The minimum landing size of 106mm (equivalent to 120mm shell length) is indicated.

5.11 Valentia Harbour scallop

Scallop occur throughout the Valentia Harbour area. The stock is wild but is supplemented by periodic re-seeding and management of broodstock.

5.11.1 Survey 2011

A total of 91 dredge hauls (Figure 19) were taken during January 2011 with a single fixed toothed dredge in Valentia Harbour. Dredge width was 1.3m, tooth length was 10cm and spacing between the teeth was 6.5cm. Dredge efficiency, estimated by comparison with dive counts on the survey track, was estimated to be 77%. As the number of dives was low and therefore uncertain the average of these estimates and those obtained during a survey in Kilkieran Bay was used to raise catch rate to densities. This average was 51%.

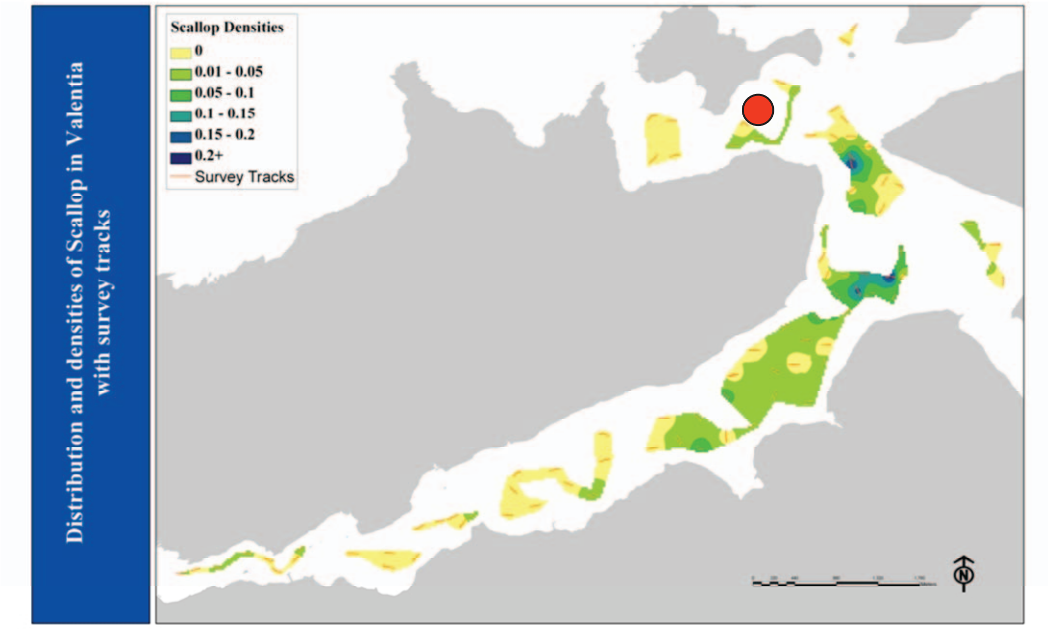


Figure 19. Dredge tow tracks and contoured densities of scallop expressed as numbers per square meter. The red area is the 'broodstock' bed.

The total dredge survey domain was 2.94km^2 (Figure 19). Scallop densities, were low particularly in the Valentia Harbour channel towards Portmagee. Densities generally ranged from 0 – 0.2 scallops per m^2. The total number and biomass of scallop in the area surveyed was 65795 and 18.2±3.7 tonnes respectively (Table 12).

Table 12. Population and biomass estimates for scallop in Valentia Harbour in January 2011.

Density Contour limits	Area (m^2)	N	Mean density m^{-2}	95% CL density	Number of scallops	Biomass (gms m^{-2})	95% CL Biomass m^{-2}	Total biomass (tonnes)	CL Biomass (Tonnes)
0	1254208	50	0	0	0	0	0.00	0	0
0.01-0.05	1298659	29	0.02	0.00	27590	5.86	1.23	7.61	1.60
0.05-0.1	261814	7	0.07	0.01	17695	18.65	3.20	4.88	0.84
0.1-0.15	103195	*5*	*0.17*	0.03	17027	*45.54*	9.99	4.70	1.03
0.15-0.2	20310	*5*	*0.17*	0.03	3351	*45.54*	9.99	0.92	0.20
>0.2	803	*5*	*0.17*	0.03	133	*45.54*	9.99	0.04	0.01
	2.94	**91**			**65795**			**18.16**	**3.68**

5.11.2 Size composition and mortality

Scallop shell height ranged from 58-170mm and averaged±s.d. 120±20mm. There were few scallops less than 90mm in the catch, indicating poor recent recruitment (Figure 20). The size distribution of scallops in the dredge survey was multi-modal.

Mortality (Z) of scallops calculated from the linearised part of the descending portion of modes in the size distributions was 1.04±0.29 for the upper mode in the dredge survey representing an annual loss of 63% from individual adult cohorts in the population. The fishing component of this is unknown.

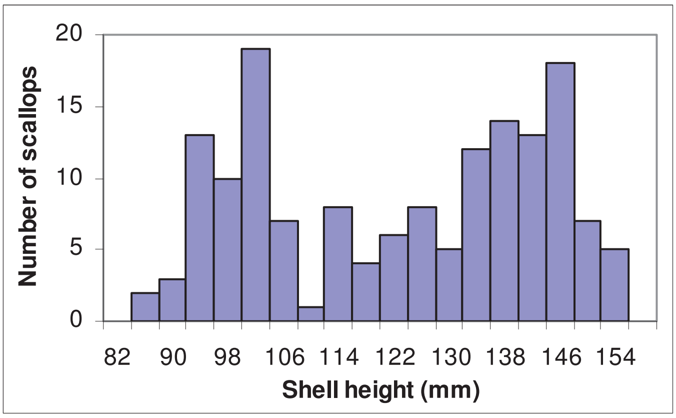


Figure 20. Shell height distribution of scallops in Valentia Harbour from the dredge survey.

5.12 Valentia scallop Survey 2001

The Valentia scallop stock was previously assessed in 2001. A summary of that assessment is presented here for comparison with 2011.

5.12.1 Survey 2001

A dive transect survey was completed throughout the Valenita Harbour area in autumn 2001. The total survey domain was 5.96km^2 compared to 2.94km^2 in 2011 (Figure 21). Scallop densities ranged from 0-110m^{-2} and the total population and biomass was 166210±37000. Densities in the Valentia Channel to

Portmagee were low and similar to that in 2011. The seeded area had densities, up to 21-30 scallops m-2, in 2001. Higher densities occurred on the western end of the survey domain at Portmagee in 2001 than in 2011.

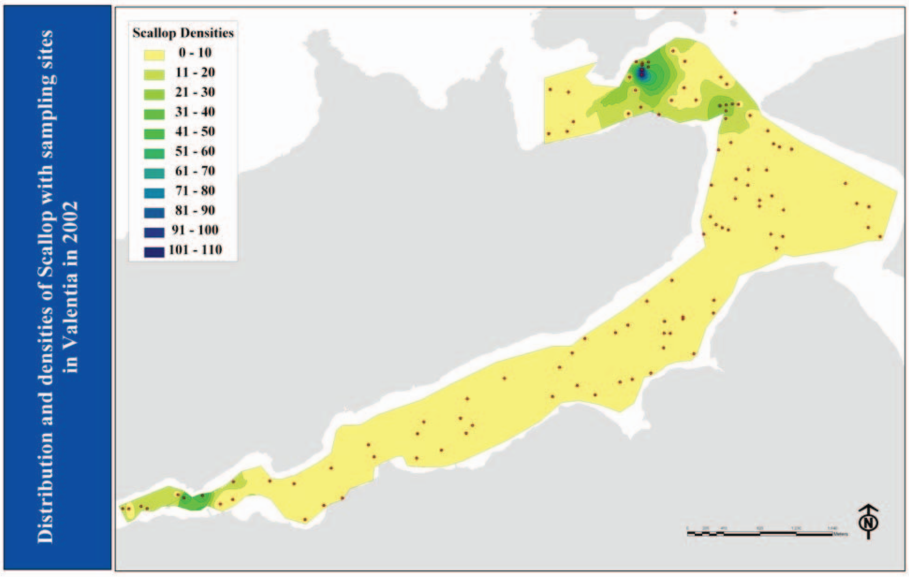


Figure 21. Distribution of dive transects (mid-points) and scallop density in Valentia Harbour in 2001.

5.12.2 Shell size composition and mortality

Size distribution of scallops in 2002 also indicated poor recruitment as few scallops less than 85mm were recovered by divers (Figure 22). Age based catch curve estimate of mortality of scallops aged between 6-10 years was 0.87 compared to 1.0 in the catch curve estimate for 2011. Estimates of F and exploitation rate in 2002 from analysis of the depletion in catch rate during the commercial fishery suggested a fishing mortality (F) of 0.67 and exploitation rate of 50% of scallops over 125mm shell length which was the local minimum landing size.

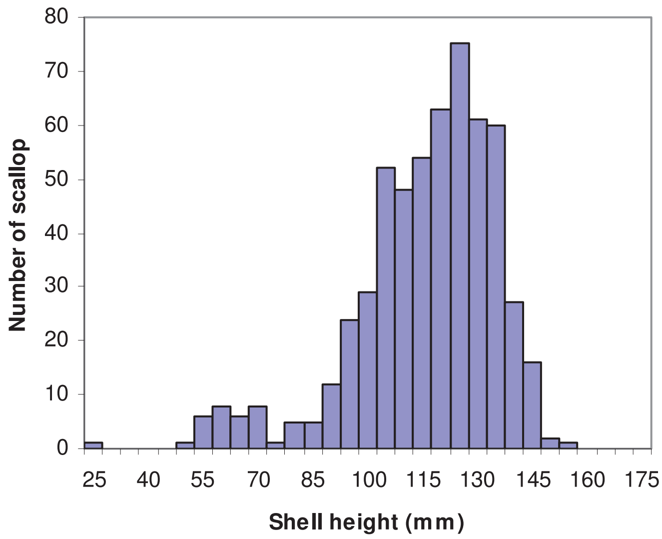


Figure 22. Distribution of shell height of scallops in Valentia in 2002.

6 Oyster (*Ostrea edulis*)

6.1 Management recommendations

Given that stock biomass is extremely low in all areas, except Tralee Bay, management measures to restore recruitment and re-build spawning stocks are necessary. Given that some stocks remain at a low level despite fishery closures for up to 5 years, active intervention to improve habitat conditions for settlement are probably necessary. Direct spawning stock enhancement, through translocation of stocks from *Bonamia* free areas, or relay of spat may be necessary where spawning stock is highly depleted and dispersed. Of the areas surveyed Tralee Bay contains 83% of the biomass and, as such, can be considered of national importance to the continued survival of native oyster stocks and fisheries in Ireland. Recruitment and biomass in the Tralee stock is strong. Given its importance the Tralee Bed should be monitored frequently to identify any negative trends in recruitment or mortality.

Generally, although seasonal quotas and minimum size regulations are in place for some fisheries reference points for these stocks should be developed and agreed with industry to ensure sustainable development of these fisheries.

6.2 Summary

Oyster biomass and mortality rates were estimated from dredge surveys, in 2010-2011 in Fenit (inner Tralee Bay), Outer Tralee Bay, Kilkieran Bay, Blacksod Bay and Clew Bay (Table 13). Eighty three percent of the biomass is held in inner Tralee Bay. Other stocks of oyster also exist in Lough Swilly, Achill and Inner Galway Bay but were not surveyed. Other than in Tralee Bay biomass estimates were low, relative to maximum historic production levels.

Although the surveys were not designed for the purpose, recruitment appears to be very low in all areas except inner Tralee Bay. The causes of low recruitment is unknown but is likely to be due to a combination of unfavourable environmental conditions, low spawning stock biomass and poor settlement habitat. The effect of *Bonamia* on population growth may also be a factor in Clew Bay and Blacksod Bay.

Mortality rates were estimated from linearised length converted catch curves and are probably biased and imprecise as they are based on poor growth data and steady state assumptions. Nevertheless mortality estimates are higher for stocks which have been commercially fished in recent years than for those which have not suggesting that these estimates may be useful indicators of recent exploitation rates (Table 13).

Table 13. Biomass, mortality and landings data for oyster fisheries in 5 areas surveyed in 2010-2011.

Oyster stock	Biomass 2010	Mortality (Z)	Sum of landings (tonnes) 2004-2009	Landings 2009
Inner Tralee Bay (Fenit)	982	1.3	1397	300
Outer Tralee Bay	99	0.6	0	1
Kilkieran Bay	53	1.4	48	6.7
Blacksod Bay	25	0.6	90	0
Clew Bay	15	0.8	14.5	0
Total	**1174**		**1549.5**	**307.7**

6.3 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 south east coast their distribution is now limited. The main stocks occur in Tralee Bay, Galway Bay, Kilkieran Bay in Connemara, Clew Bay, Blacksod Bay and Lough Swilly. Surveys were undertaken in Tralee, Kilkieran, Clew and Blacksod between September 2010 and January 2011. Resulting estimates of biomass and mortality rates are reported here.

6.4 Survey methods

Oyster beds were surveyed by dredge. Dredge designs vary locally and those locally preferred dredges were used in the current surveys (Figure 23). Dredge efficiencies were estimated 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. Oyster dredge efficiencies were estimated in Clew Bay and Kilkieran Bay but not in Tralee or Blacksod where the average of the two estimated efficiencies were used to raise the catch rate to densities m^{-2}.

Predetermined survey grids were used where the distribution of the oyster beds were well known. In other cases, such as Clew Bay and Blacksod, 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.

Figure 23. Dredges used on oyster surveys in Blacksod Bay, Kilkieran Bay, Clew Bay and Tralee Bay.

6.5 Tralee Bay

6.5.1 Fenit Survey 2010

The main oyster bed in Tralee Bay is east of Fenit in the inner Bay. A second bed, in two patches, exists in the outer Bay.

A total of 69 tows were taken in the Fenit Bed, with a single toothless dredge 1.20m in width, in September 2010 (Figure 23). Average±s.d. tow length was 69±14m. Dredge efficiency was not estimated and the average efficiencies, of 35%, of dredges used in Kilkieran and Clew Bays surveys were used to raise the catch rate to density. A total of 170 tonnes of oysters were taken by the Fenit oyster fishery following completion of the September 2010 survey. A second minor survey was completed on the Fenit Bed in January 2011 after the fishery had closed. Densities of oysters and estimates of exploitation rates, before and after the fishery, in areas sampled in both surveys, can be compared.

In September 2010 the total survey domain was 4.26km^2. Densities, corrected for dredge efficiency, ranged from 0-22.7 oysters m^{-2}. The total number and biomass of oysters in the survey area was estimated to be 13.62million oysters and 982±224 tonnes respectively (Table 14). Approximately 11% (113 tonnes) of this biomass was over the minimum landing size of 78mm. The biomass over the size is highly uncertain because of potential differences between linear calliper measurement and ring measurement used to determine legal size.

A limited survey of 11 tows in the eastern edge of the Fenit bed was completed after the fishery had closed in January 2011 (Figure 25). The tows were not taken on exactly the same tracks as sampled in September 2010. Average density of oyster in this area was 5.8±7.2 in September 2010 and 3.1±2.0 in January of 2011 or a reduction of 47% which is, coincidentally, the same loss rate due to the 2011 fishery, calculated from the catch curve analysis below.

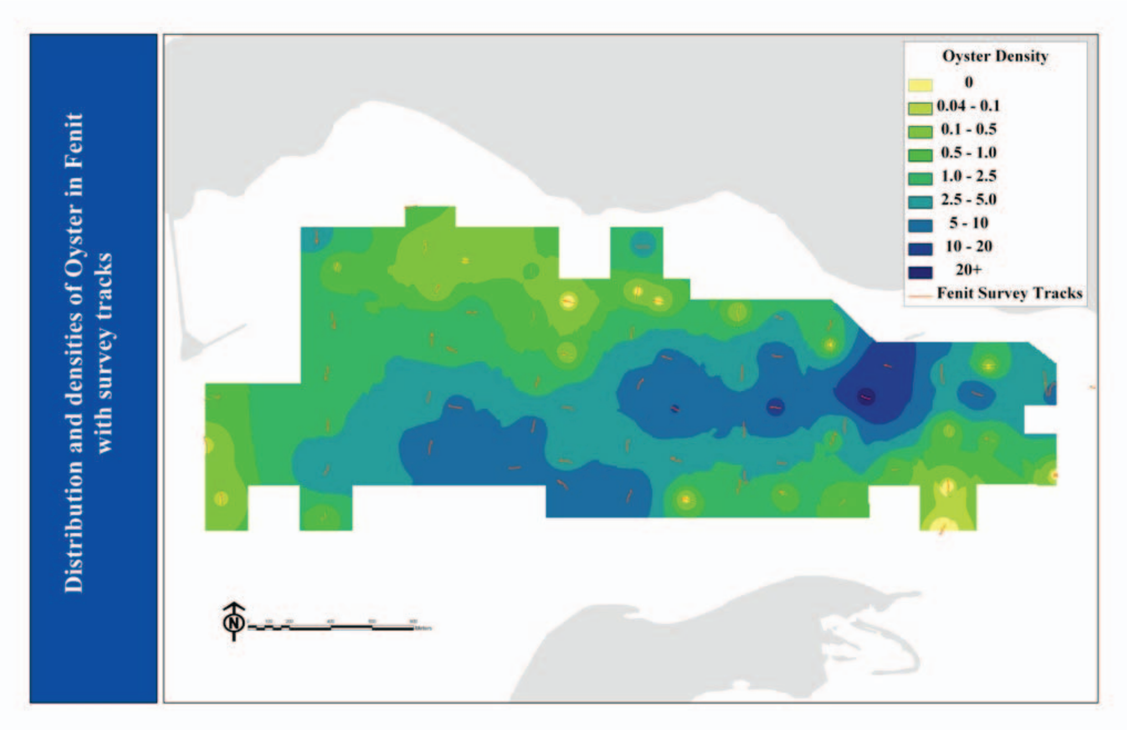


Figure 24. Dredge tracks and contoured densities of oyster in numbers per square meter in the Fenit oyster bed in September 2010.

Table 14. Density and biomass of oysters in Fenit in September 2010

Density Contour limits	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	15580	9	0.00	0	0	0.0		0.0	0
0.04-0.1	49732	3	0.06	0.18	3108	4.2	12.2	0.2	1
0.1-0.5	442916	7	0.29	0.30	127180	20.1	22.2	8.9	10
0.5-1.0	583898	8	0.67	0.30	390044	49.4	24.2	28.9	14
1.0-2.5	1147821	12	1.79	0.42	2051067	134.7	35.1	154.6	40
2.5-5.0	1097814	15	3.51	0.43	3850974	225.5	33.9	247.6	37
5.0-10.0	797949	11	6.58	0.65	5250504	532.4	128.8	424.8	103
10.0-20.0	114401	3	12.66	1.96	1448320	949.5	169.5	108.6	19
20.0+	6250	1	22.74	0	142129	1364.4	0.0	8.5	0
	4.26	**69**			**13263326**			**982.1**	**224**

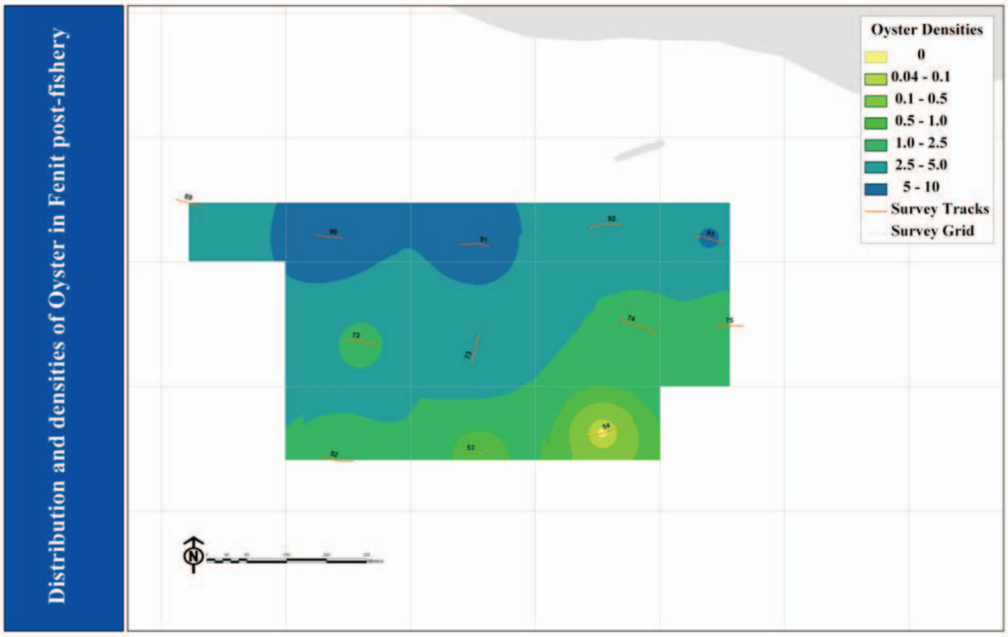


Figure 25. Dredge tracks and contoured densities of oyster in numbers per square meter in the eastern part of the Fenit oyster bed in January 2011.

6.5.2 Size composition and mortality, Fenit

In September 2010, prior to the fishery, oysters ranged in size from 15-102mm and averaged±sd 62±14mm. In January 2011, after the fishery had closed, size ranged from 23-94mm and averaged 64±10mm. The effect of the fishery on the size distribution on fully selected size classes is clear (Figure 26); a significantly lower number of oysters over 80mm were present in the 2011 survey.

Total annual mortality rate (Z), estimated from the linearised portion of the length converted catch curve from data in Figure 26 and using growth parameters of 0.31 (k) and 110 (H_{∞}) was 1.30±0.2 in September 2010 and 2.76±0.53 in January 2011. The difference, due presumably to the 2010 autumn and natural mortality over the 3 month period between surveys was 1.46 equivalent to a loss of 77% of fully selected oysters from the stock between September 2010 and January 2011. Taking annual M of 0.63, as estimated in the outer Tralee Bay (see below) and therefore an estimate of 0.15 for the 3 month period during the survey F due to the autumn fishery was 0.61 representing a 47% exploitation rate for fully selected size classes.

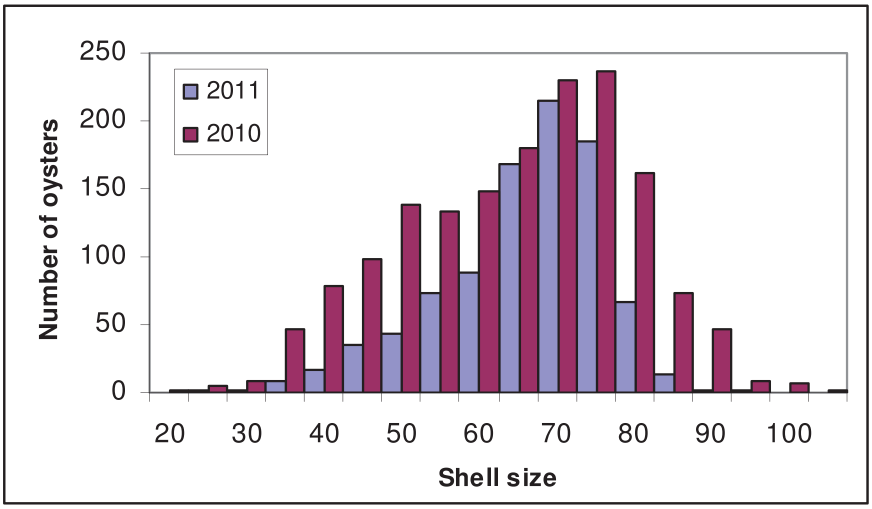


Figure 26. Size distribution of oysters in the Fenit oyster bed in October 2010 (pre fishery) and January 2011 (post fishery).

6.5.3 Outer Tralee Bay Survey 2010

A total of 47 tows were taken in the outer Tralee Bay oyster bed, with a single toothless dredge of width 1.20m, in September 2010. Average±s.d. tow length was 113±21m (Figure 27). Dredge efficiency was not estimated and the average efficiencies, of 35%, of dredges used in Kilkieran and Clew Bays surveys were used to raise the catch rate to density.

The total survey domain was 3.63km^2. Densities, corrected for dredge efficiency, ranged from 0-0.86 oysters m^{-2}. The total number and biomass of oysters in the survey area was estimated to be 771058 oysters and 99±61 tonnes respectively (Table 15). Practically all of this biomass was over the minimum size.

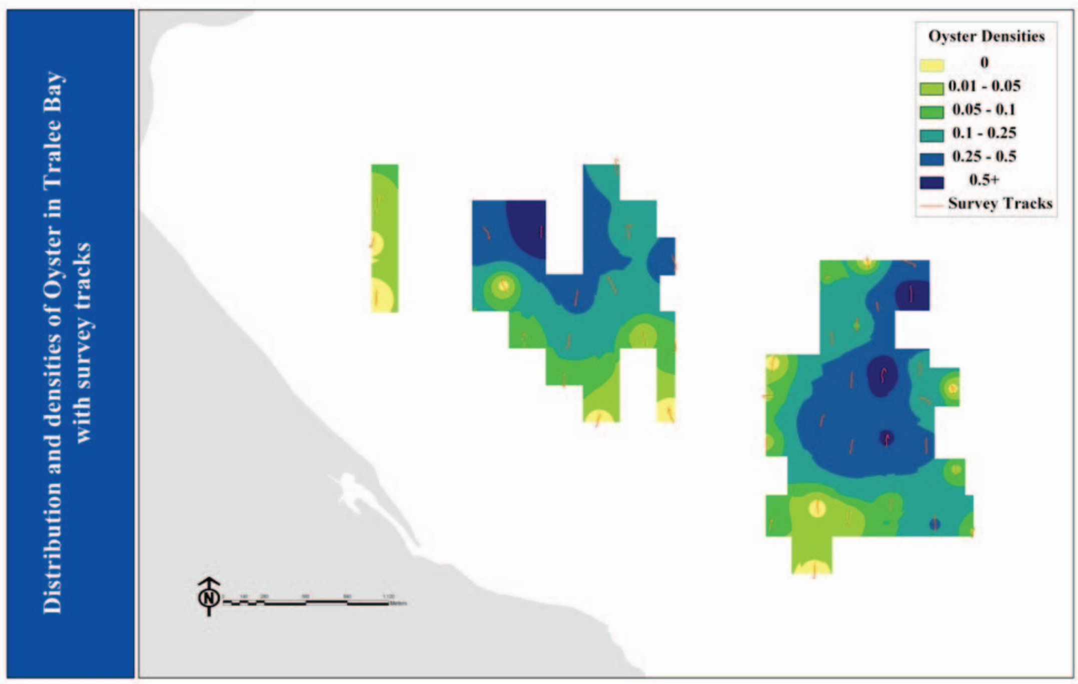


Figure 27. Dredge tracks and contoured densities of oyster in numbers per square meter in the Outer Tralee Bay oyster bed in September 2010.

Table 15. Density and biomass of oysters in Tralee Bay in September 2010

Density Contour limits	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	117909	12	0.000	0.000	0	0.00	0.00	0.00	0.00
0.01-0.05	454513	7	0.033	0.010	14993	4.26	2.84	1.93	1.29
0.05-0.1	557950	7	0.079	0.012	44218	10.22	6.22	5.70	3.47
0.1-0.25	1241553	7	0.166	0.032	206277	21.43	13.28	26.61	16.49
0.25-0.5	1072383	10	0.341	0.042	365701	43.99	26.45	47.18	28.36
0.5+	189217	4	0.739	0.152	139869	95.36	59.41	18.04	11.24
	3.63	**47**			**771058**			**99.47**	**60.85**

6.5.4 Outer Tralee Bay size composition and mortality

Oyster size ranged from 68-114mm and averaged 85±8.3mm (Figure 28). There was little evidence of recruitment in this area and very few oysters less than 70mm were caught.

Total annual mortality rate (Z), estimated from the linearised portion of the length converted catch curve from data in Figure 28 and using growth parameters of 0.31 (k) and 110 (H_∞) was 0.63±0.15 indicating an annual loss rate of oysters above the size at full selection of 47%. As this bed is largely unexploited this translates into an approximate estimate of annual loss due to natural mortality.

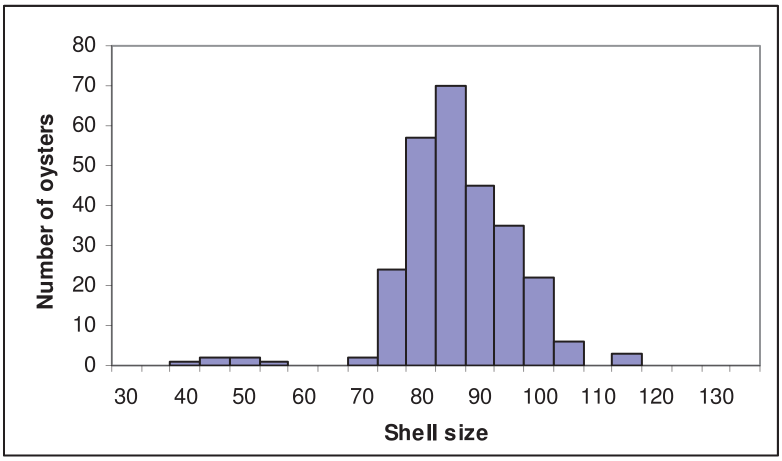


Figure 28. Size distribution of oysters in outer Tralee Bay in September 2010 and January 2011 combined.

6.6 Kilkieran Bay

6.6.1 Survey 2010

A total of 113 hauls (Figure 29) were taken during October 2010 and January 2011 in water depths of 5-25m with a single oyster dredge. The dredge bar width was 1.2m and the bag had a 10cm flexible diamond mesh on top and a fixed wire mesh on the bottom (Figure 23). Average tow track length was 62.2±9m. Dredge efficiency, estimated along 17 separate tracks was 32±32% resulting in a dredge efficiency raising factor of 3.12.

The total survey domain was 1.79km². Densities, corrected for dredge efficiency, ranged from 0-4 oysters m^{-2}. The total number and biomass of oysters in the survey area was estimated to be 831471 oysters and 53±7 tonnes respectively (Table 16). Approximately 30% (16 tonnes) of this biomass estimate was over the minimum landing size of 76mm.

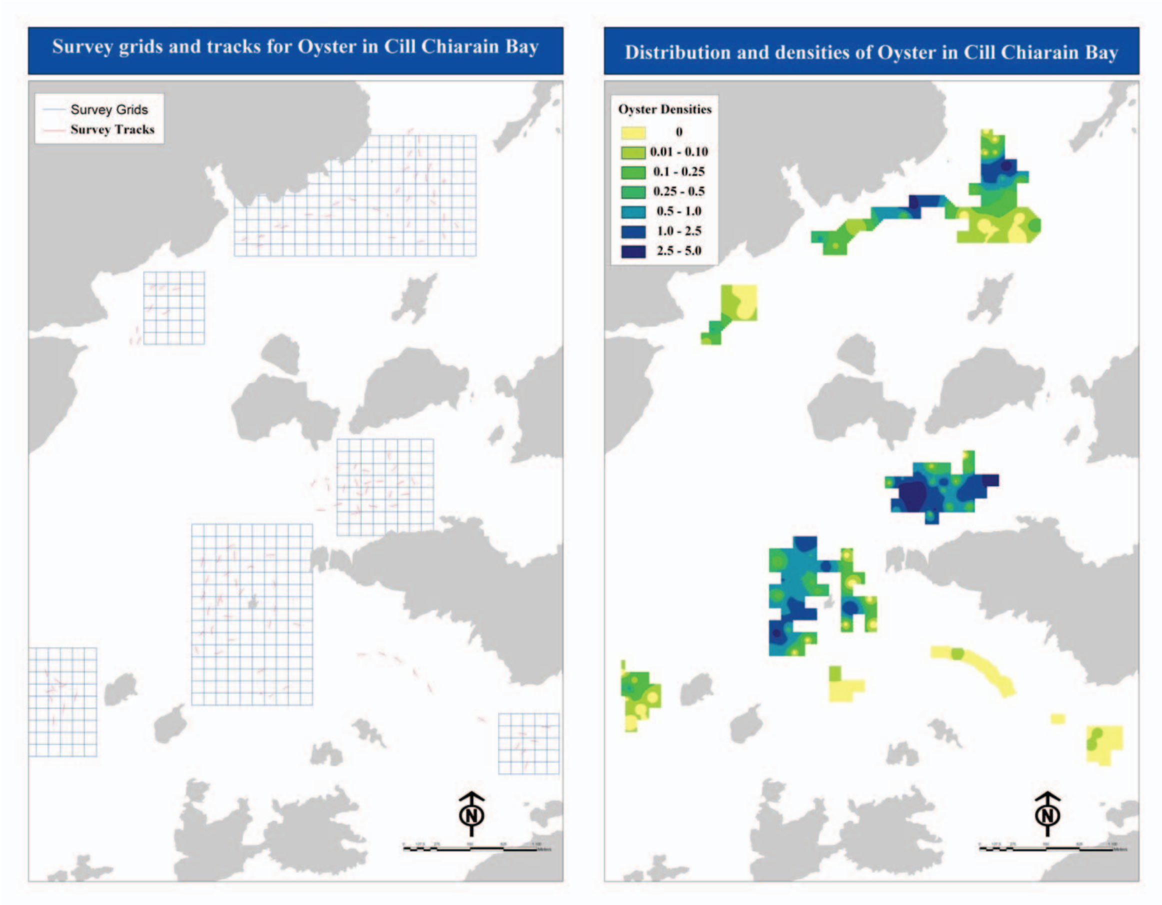


Figure 29. Survey grids, dredge tracks and contoured densities of oyster in numbers per square meter in Kilkieran Bay in October 2010.

Table 16. Density and biomass of oysters in Kilkieran Bay in October 2010.

Density Contour limits	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	202044	39	0.00	0.00	0	0.00	0.00	0.0	0.00
0.01-0.05	324193	10	0.04	0.00	13551	2.68	0.01	0.9	0.00
0.05-0.1	170691	7	0.08	0.01	13607	5.10	0.03	0.9	0.00
0.1-0.5	528379	22	0.20	0.04	107981	13.08	0.58	6.9	0.31
0.5-1.0	280171	13	0.64	0.08	178102	40.68	3.41	11.4	0.96
1.0-2.0	196308	11	1.46	0.14	286182	93.30	13.18	18.3	2.59
2.0-3.0	69112	3	2.50	0.22	172711	159.94	35.22	11.1	2.43
3.0-4.0	15823	7	3.75	0.31	59336	240.00	75.42	3.8	1.19
	1.79	**112**			**831471**			**53**	**7**

6.6.2 Size composition and mortality

Oyster size ranged from 30-100mm and was normally distributed around a modal shell height of 65mm (Figure 30). There was little evidence of significant recent recruitment.

Total annual mortality rate (Z), estimated from the linearised portion of the length converted catch curve from data in (Figure 30) and using growth parameters of 0.31 (k) and 110 (H_∞) was 1.38±0.22 indicating an annual loss rate of oysters above the size at full selection of 75%.

Total landings of oysters from Kilkieran Bay in 2009, prior to the survey and in 2010 after the current survey, was 6.7 and 7.7 tonnes respectively or 41- 48% of the exploitable (>76mm) biomass.

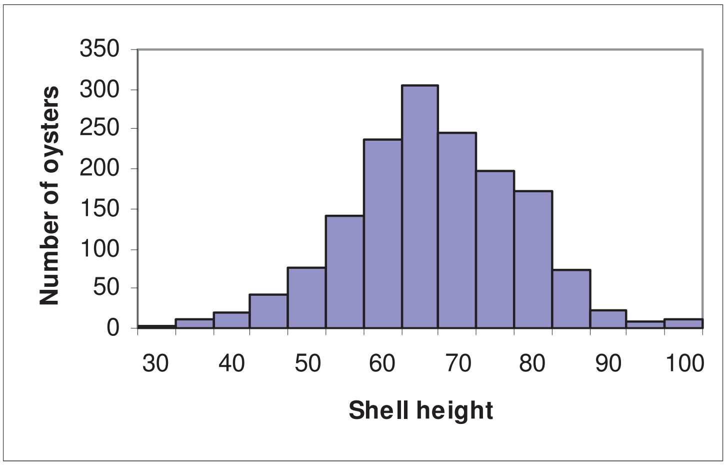


Figure 30. Size distribution of oysters in Kilkieran Bay in October 2010.

6.7 *Blacksod*

6.7.1 Survey 2011

One hundred and three dredge tows were taken in the Blacksod Bay oyster grounds in January 2011 with a single toothless dredge 1.2m in width (Figure 23). No dredge efficiency estimates were obtained. Dredge efficiency of 32%, obtained on the Kilkieran Bay survey, was used to raise survey catch rates to densities. A walk over survey of 7 of the Blacksod survey dredge tracks on Feb 21st 2011 also resulted in a dredge efficiency estimate of 32±11%. Average±s.d tow track length was 115±19m.

The total survey domain was 2.39km^2. Densities, corrected for dredge efficiency, ranged from 0-0.4 oysters m^{-2}. The total number and biomass of oysters in the survey area was estimated to be 235700 oysters and 26.3±7 tonnes respectively (Table 17). In addition, biomass in areas where density was >0.3m^2 was approximately 1 tonne but could not be estimated reliably because of the small number of tows taken in these areas. Approximately 30% (16 tonnes) of the biomass estimate was over the minimum landing size of 76mm.

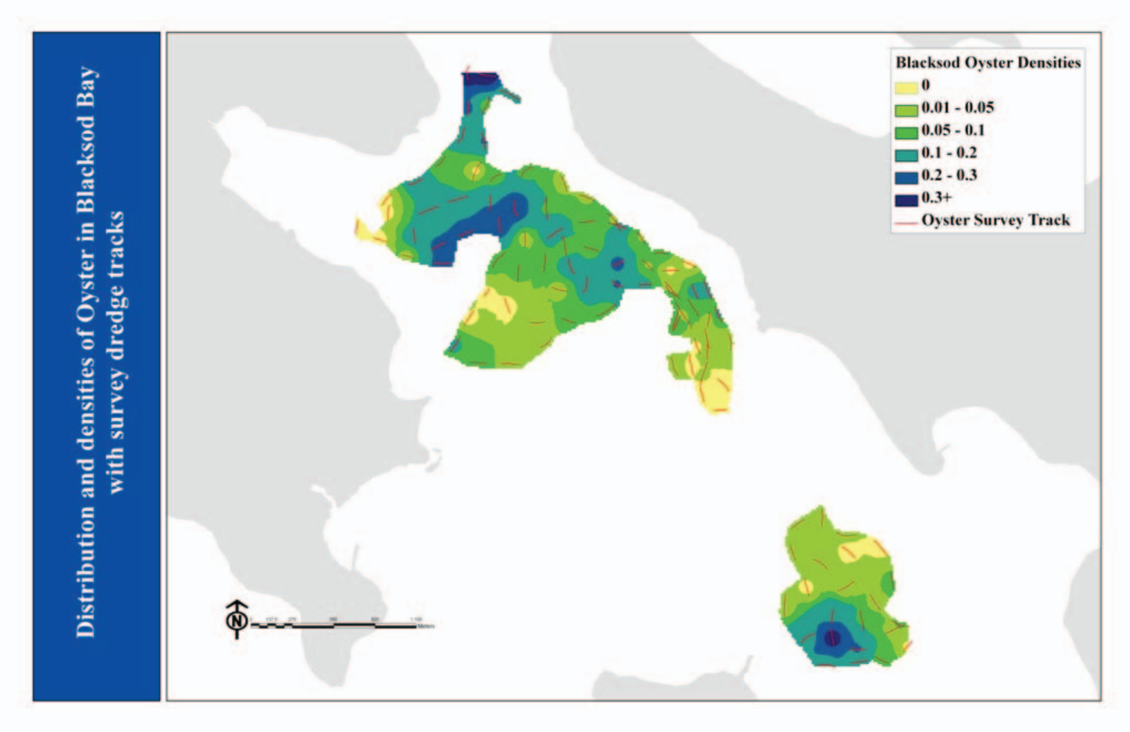


Figure 31. Dredge tracks and contoured densities of oyster in numbers per square meter in Blacksod Bay in Janurary 2011.

Table 17. Density and biomass of oysters in Blacksod Bay in January 2011.

Density Contour limits	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)	95% CL Biomass (Tonnes)
0	208568	19	0.00	0.00	0	0	0	0	0
0.01-0.05	767807	28	0.03	0.00	23051	5.09	1.77	3.91	1.23
0.05-0.1	696737	23	0.08	0.01	54536	10.46	2.17	7.29	1.07
0.1-0.2	705048	20	0.14	0.01	101351	14.29	1.93	10.07	1.61
0.2-0.3	194304	10	0.24	0.02	45914	20.97	3.56	4.08	2.28
0.3+	27174	3	0.40	0.05	10848	34.78	13.66	Not estimated	
	2.39	**103**			**235700**			**25.3**	**6.2**

6.7.2 Size composition and mortality

Oyster size ranged from 30-121mm and averaged 75±16mm with a modal size of 75-85mm (Figure 32). There was little evidence of significant recruitment especially in areas where density was lowest; mean size and mean density were negatively correlated.

Total annual mortality rate (Z), estimated from the linearised portion of the length converted catch curve from data in Figure 32, smoothed with a 3 point running average and using growth parameters of 0.31 (k) and 110 (H_∞) was 0.64±0.04 indicating an annual loss rate of oysters, above the size at full selection, of 47%. As the stock has not been fished for 5 years prior to the survey and although a proportion of larger oysters, in the fully selected size range, are probably older than 5 years the 47% represents an approximate annual rate of loss of oysters from the stock due to natural mortality.

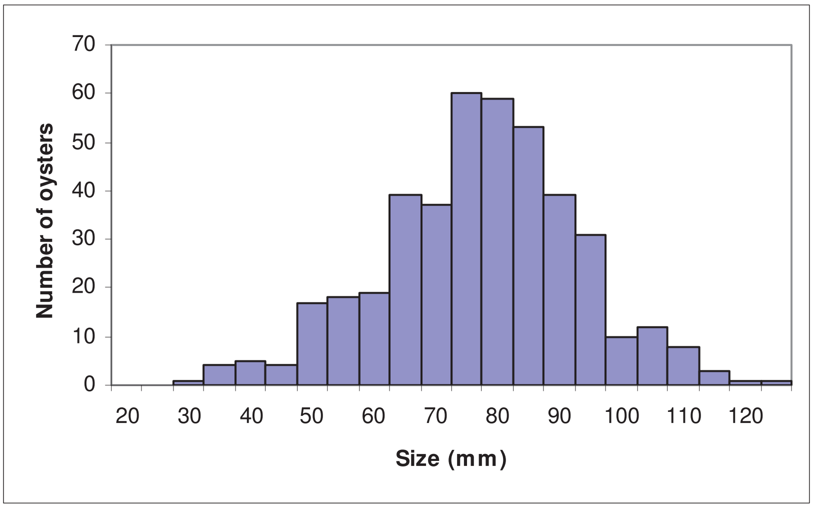


Figure 32. Size distribution of oysters in Blacksod Bay in January 2011.

6.8 Clew Bay

6.8.1 2010 Survey

One hundred and thirteen dredge tows were taken in Clew Bay oyster grounds in October 2010 with a single toothed dredge 1.2m in width on survey days 1-2 and a toothless dredge on survey day 3 (Figure 23). Dredge efficiency, for the toothed dredge, estimated by diving on 9 tow tracks following dredging, was 44±22%. An efficiency of 35% (average of Clew Bay and Kilkieran Bay estimates) was, however, used to raise the survey catch rates to densities. Average±s.d tow track length was 56±10m.

The total survey domain was 0.93km^2. Densities, corrected for dredge efficiency, ranged from 0-1.55 oysters m^2. The total number and biomass of oysters in the survey area was estimated to be 244871 and 14.8±2 tonnes respectively (Table 18Table 18). Approximately 64% of the biomass (8.1 tonnes) was above the minimum size.

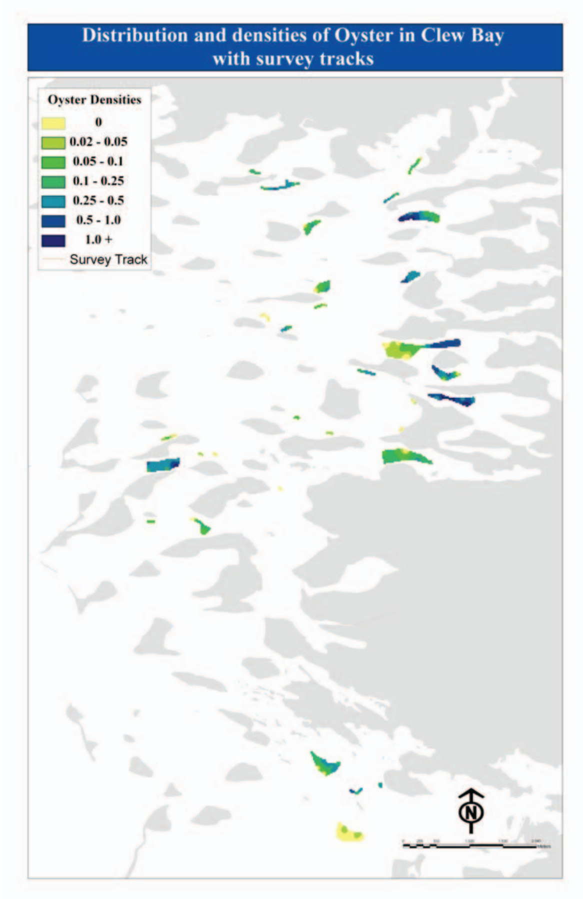


Figure 33. Dredge tracks and contoured densities of oyster in numbers per square meter in Clew Bay in October 2010.

Table 18. Density and biomass of oysters in Clew Bay in October 2010

Density Contour limits	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	117963	24	0.00	0.00	0	0	0	0	0
0.02-0.05	103896	9	0.04	0.00	4276	4.72	0.89	0.49	0.09
0.05-0.1	120949	14	0.08	0.01	9515	6.21	1.61	0.75	0.20
0.1-0.25	238766	22	0.17	0.04	40611	16.15	2.45	3.85	0.58
0.25-0.5	199888	26	0.33	0.06	66871	20.43	1.74	4.08	0.35
0.5-1.0	117493	12	0.65	0.13	75842	34.21	5.73	4.02	0.67
1.0+	34766	6	1.37	0.16	47756	48.63	6.06	1.69	0.21
	0.93	**113**			**244871**			**14.89**	**2.10**

6.8.2 Size composition and mortality

Oyster size ranged from 18-120mm and averaged 64±16mm with a modal size of 65-75mm (Figure 34). There was little evidence of significant recruitment.

Total annual mortality rate (Z), estimated from the linearised portion of the length converted catch curve from data in Figure 34, smoothed with a 3 point running average and using growth parameters of 0.31 (k) and 110 (H_∞) was 0.84±0.07 indicating an annual loss rate of oysters, above the size at full selection, of 57%.

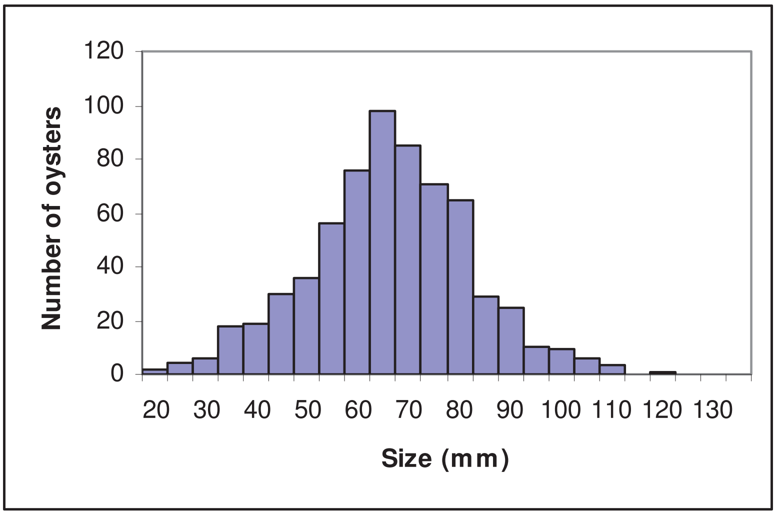


Figure 34. Size distribution of oysters in Clew Bay in January 2011

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8 Glossary

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

ANOSIN Analysis of similarity tests provides a way to test statistically whether there is a significant difference between two or more groups of sampling units.

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

Bonamia (ostreae) 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.

Community (benthic faunal) The assemblage of organisms living in a given seabed habitat.

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 a number 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

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