Shellfish Stocks & Fisheries Review

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Bord Iascaigh Mhara
Irish Sea Fisheries Board

Marine Institute
Foras na Mara

Shellfish Stocks and Fisheries

Review 2009

The Marine Institute and Bord Iascaigh Mhara

An overview of Shellfisheries legislation, management and economic value in Ireland and assessment of selected stocks

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1 Introduction

This review presents information on the status and activity of Shellfisheries in Ireland. Legislation, fisheries management and licencing regimes that impinge on the operation of shellfisheries are reviewed and data on landings, value and profitability are presented. Stock assessment data, for a selected number of species, is updated and management recommendations are presented where appropriate. The intention is to update the review annually and present stock assessment and scientific advice particularly 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 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 competence of the Common Fisheries Policy they are generally not regulated by quota 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. 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 in general.

The scope of the 'Shellfish Stocks and Fisheries' report extends into a description of fisheries and fleet activity and presents economic data for the fleet and separately for individual fisheries where available. It also presents details of legislation, in the area of fisheries, environment, and food safety that impinges on the activity of the fleet. This coupling of information on stocks (dealing with issues of biological conservation and sustainability) and fisheries (dealing with socio-economic issues and the viability of the fleet) is seen as important in the co-management framework, the overall objective of which is to develop, in parallel, sustainable and viable fisheries for shellfish within the Irish territorial limits. The production is, therefore, a joint effort between MI (research and scientific advice) and BIM (fisheries development). Its main customers are DAFF, the Advisory Groups of the Shellfish Management Framework and operators in the industry.

Not all shellfish species are included in the 2009 review. Although an overview of legislation, landings and economic data are given, that relate to all species, stock indicators are presented for a limited number of fisheries. The inclusion of species/stocks is based on data availability and in response to developments or initiatives in management. The annual review will evolve towards informing fishery management plans as they are developed and implemented by the Shellfish Advisory Groups.

2 Fishing Activity and Legislation

2.1 Stocks

Stocks of shellfish (crustaceans and bivalves) occur to some extent on all coasts. The availability of commercial shellfish stocks, the activity of the shellfish fleet and the diversity of fishing opportunity available to the fleet vary geographically (Figure 1). Fishing opportunity is also a dependent on the exposure of the coastline and weather conditions; some fleets may be active throughout the year while others may be restricted to less than 100 days per year. Fishing opportunities are higher on mid-west, south west and south east coasts than on east or north west coasts. Fisheries on the east and south east coast are mainly for bivalves while fisheries on the north west coast are mainly for crab and lobster. In the case of mussels and oysters there is combined and overlapping fisheries and aquaculture activity. Fishing for wild or naturally recruited seed mussel on the east and south west coasts and in other areas, which vary annually, provides the raw material for the bottom grown mussel aquaculture industry.

Figure 1. Distribution of shellfish stocks in Ireland. Species are listed in approximate order of local or regional importance. The list of species provides an indication of the diversity of fishing opportunity that is available to local fleets. The 6nm (red) and 12nm (blue) limits are shown.

2.2 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 under 13m in length. Vessels licenced for potting only, targeting crustaceans and whelk, are all under 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 1839 in September 2009 (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 target scallop off the south east coast. The number of vessels entitled to target shellfish increased by 52% between 2006 and 2009. This 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.

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 2009. Polyvalent potting vessels have higher engine capacities in proportion to their gross tonnage than polyvalent general vessels (Table 1).

2.3 Fishing activity patterns

Crab

The Irish crab fleet consists of an <13m, mainly dry hold fleet, and an >18m vivier fleet. The <13m fleet fishes inshore waters and seaward to 20 miles and exceptionally 30-50 miles offshore. The majority of these vessels are day trippers but 2-3 day trips are not uncommon. The vivier fleet usually fishes in offshore waters to depths of 200m and undertake trips of 5-7 days duration.

Lobster

The lobster fleet consists primarily of vessels under 10m in length all operating day trips usually within 20km of home port primarily between Mar-Sept but all year round on sheltered coasts.

Shrimp

The shrimp fleet is mainly comprised of vessels under 10m and mostly under 8m in length. This fishery occurs in the bays along the south coast and in Connemara, inner Galway Bay, west Mayo and north west Donegal and increasingly along the east coast from Howth to Clogherhead. The fishing season is August to March but varies, within this period, by area.

Spider crab

The main spider crab fishery is in Tralee and Brandon Bays and increasingly in Galway Bay, Mayo and the south coast. The fishery occurs mainly during late spring and summer. Vessels are 8-12m.

Whelk

The fleet consists of potters ranging in length from 8-12m operating in the south west Irish Sea. Fishing can occur throughout the year.

Scallop

The scallop fleet can be divided into vessels over 15m in length fishing stocks in the southern Irish Sea and eastern Celtic Sea and vessels under 12m in length fishing scallops in various Bays along the south west and west coasts. The offshore south east coast fishery is year round. Fishing in bays on the south and west coast may occur in summer or winter.

Surf clam

Surf clam occur in very discrete localised beds around the coast. The number of vessels targeting this species is usually less than 10 and various local voluntary and statutory measures apply that restrict the fishing season.

Cockle

The fleet comprises of hydraulic dredgers, 8-12m in length, operating for restricted periods of time on parts of the east coast. In recent years Dundalk Bay and Waterford Estuary have supported commercial fisheries.

Razor clam

The fleet comprises of hydraulic dredgers 8-12m in length operating in depths of 5-15m in the northwest Irish Sea. Fishing depth is limited by the operation of the hydraulic gear but can occur throughout the year.

Table 1. Length and capacity profile of the Irish Shellfish fleet (excluding 5 vivier crabbers and 4 scallopers)

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

2.4 *Fishing gears*

Four main gear categories are used in shellfisheries in Ireland (Table 2); towed dredges, fixed nets, pots and non-vessel based gathering methods. Various sub-categories of these gears are used to target different species and depending on the characteristics of the seabed.

2.4.1 Towed dredges

Non-mechanised dredges are used in scallop, oyster and clam fisheries. Dredges in the main scallop fishery off the south east coast have a spring-loaded, toothed raking bar. These dredges are designed for rough ground and allow the toothed raking bar to 'spring back' when they hit stones or rocks. Spring loading is unnecessary in homogenously flat grounds in some inshore scallop fisheries.

Where the target bi-valve is buried in the sediment mechanised hydraulic dredges are used to force a jet of water into the sediment in advance of the dredge which fluidises the sediment and washes out the target species. The target species and sediment may be brought into the vessel using suction or the target species may collect in the dredge and be hauled into the vessel in the case of non-suction dredging.

2.4.2 Fixed nets

Spiny lobster and to some degree spider crab are targeted using tangle nets. These nets are set on the sea bed and form a loosely hanging curtain of mesh which may vary in mesh size. Trammel nets are used to fish for bait for the pot fishery. These nets are not used to target shellfish.

2.4.3 Pots

The majority of the shellfish fleet use pots to target crustaceans (crabs, lobsters, shrimp). There are various designs, modifications and preferences depending on the target fishery. Soft eye side entrance creels are the most common gear in the lobster and crab fisheries. Various proportions of top entrance pots and parlour pots are in use. The shrimp fishery uses a specialised plastic pot with cone shaped entrances at each end. The whelk fishery uses 'self-made' pots consisting of plastic drums with a hard eye top entrance.

2.4.4 Non-vessel based methods

Hand gathering or gathering using rakes is used in the periwinkle, cockle and some clam fisheries. Tractors are deployed in intertidal clam farming.

Table 2. Fishing gears used to harvest crustaceans and bivalves in Irish fisheries.

Gear Categories	Gear Types	Gear Characteristics and Target Species	Standard Abbreviations	FAO/ ICES	Target species
MOBILE GEAR	**DREDGES**	Scrapes or sucks up the seabed.	**DR**	**04.0.0**	
	Towed dredges (general)	A metal framed basket with a bottom of connected iron rings or wire netting called a chain belly. The lower edge of the frame has a raking bar, with or without teeth.	DRT	04.1.1	Bivalves
	Box dredge	Consists of a metal frame with a holding bag of metal rings or meshes.			Scallop, Clams
	Fixed Dredge	With a fixed tooth bar.			Scallop, Clams
	Spring loaded Dredge	Used where seabed may be hard, rough or heterogeneous			Scallop
	Mechanised dredges (general)	Hydraulic jet dredges used to dig and to wash out bivalves that are buried in the seabed.	DRM	04.1.2	Cockles, Clams, Razor clams
	Hydraulic Suction	Involves a pump to suck bottom sediments on board ship where bivalves are screened out and the spoil discharged back to sea.			Cockles, Razor clams, Clams
	Hydraulic Non-suction	Involves jets of water to disturb the ground in front of a towed dredge (see above) to capture bivalves.			Cockles, Razor clams, Clams
PASSIVE GEAR	**GILLNETS AND ENTANGLING NETS**		**GN**	**07.0.0**	
	Trammel nets	Consists of two/three layers of netting with a slack small mesh inner netting between two layers of large mesh netting within which fish will entangle.	GTR	07.5.0	Bait fish for pot fisheries
	Tangle nets	Consist of a slackly hung wall of net on the seabed, which entangles fish.			Spiny lobster
	TRAPS		**TP**	**08.0.0**	
	Pots	A pot is designed in the form of cages or baskets made from various materials (usually metal or plastic) and have one or more entrances.	FPO	08.2.0	Crab, lobster, shrimp, whelk
NOT VESSEL BASED	**OTHER GEARS**		**OG**	**10.0.0**	
	Rakes	Hand-raking over the surface substrate to uncover bivalves.	ROG	10.3.0	Cockles and clams
	Digging	Digging substrate when tide is out to uncover bivalves.			Cockles and clams
	Tractor Dredging	A dredging system on a tractor. In Ireland used to harvest intertidal clams grown under aquaculture licence			Clams
	Hand Gathering	Collection of species			Periwinkle
	Diving	Collection of species when diving, i.e. bivalve and crustacean species. In Ireland restricted to licenced aquaculture sites	DIV	10.13.0	Scallop

2.5 Licencing, Regulation and Management

Various types of regulation and legislation impinges on the operation of the shellfish fleet. These are legislation in relation to licencing and access, specific measures to conserve the target species, regulation to protect the ecosystem and food safety legislation to protect the consumer.

2.5.1 Regulation in relation to licencing and access to shellfisheries

The majority of shellfish fisheries are effectively open access, within the limits set by the capacity ceilings of the fleet and its segments although various combinations of catch limitation, effort and capacity restriction and restrictive licencing is in place for some species or stocks (Table 3).

2.5.2 Regulation in relation to conservation of the target species

The main focus of legislation is in the application of various technical or operational limits applied on a species by species basis (Table 4).

The fishing effort of the edible crab and spider crab fleet, over 15m in length in Area VI and VII, is restricted to 465000kw.days (kw.days=days at sea * kws of vessels). Crab vessels over 15m in length operating outside the Biological Sensitive Area (BSA) in Area VII are limited to 40960kw.days. Vessels over 10m in length in the BSA are limited to 63198kw.days (Table 4).

The fishing effort of scallop vessels over 15m in length operating outside the BSA in Area VII is restricted to 525012kw.days (Table 4). Vessels over 10m in length in the BSA are limited to 109395 days. The capacity of the scallop fleet over 10m in length is also limited to 1229GTs and 4483kws, following a decommissioning scheme in 2005. This has a partial limiting effect on the number of licences but dis-aggregation of the capacity would lead to an increase in the number of licences. Eighteen vessels over 10m in length were issued scallop authorizations in 2009. There is no ceiling on the number of vessels less than 10m in length that can fish for scallop.

The number of vessels targeting cockles is limited for each stock. In Dundalk Bay 32 authorizations (Natura permits, see below) were issued in 2009. Track record rules applied. The total allowable catch (TAC) is also limited on a stock by stock basis annually. Spatial and other restrictions may apply.

Various rules apply in locally managed oyster and scallop fisheries. These rules include limited permits, individual vessel quota per day or per season and closed seasons.

Minimum landing sizes (MLS) are used in most, but not all shellfisheries, and are aimed at protecting juvenile fish and a proportion of spawning fish from fishing mortality (Table 5). Such regulations can be biologically effective as in the majority of shellfisheries fish that are under the MLS can be returned alive to the sea. This applies to all the pot fisheries in particular. Discard mortality does occur to varying degrees in dredge and tangle net fisheries. Economically, however, size limits add to the costs of fishing as a proportion of catch (undersized fish) must be returned to the sea. If used solely, as is the case in the majority of shellfisheries, such size limits would also need to be increased in response to increases in fishing mortality in order to protect the stock from over-fishing. This can further reduce the economic viability of fishing. The use of size limits in fisheries where discard mortality is significant is obviously less effective at controlling fishing mortality.

2.5.3 Regulation in relation to food safety

Although food hygiene regulations apply to all shellfish placed on the market regulations concerning food safety mainly affect the bi-valve fisheries (Table 4). Legislation, implemented through two codes of practice, define under what conditions fisheries can be opened or closed and how bi-valves can be placed on the market. These conditions relate to the levels of bio-toxins and bacteria that are present in shellfish at the point of harvest.

Shellfish can only be produced from areas that have a microbiological classification and are, therefore, approved production areas and if the level of biotoxin in the flesh of the shellfish is below legal limits. Fisheries that operate on a seasonal or other basis, therefore, have to retain classifications by adequate sampling and demonstrate that biotoxin levels are below legal limits before they can be opened.

2.5.4 Regulation in relation to ecosystem effects

In order to ensure compliance with the requirements of the Habitats and Birds Directives shellfisheries, which occur in Special Areas of Conservation or Special Protection Areas (collectively known as Natura sites), are increasingly subject to various management measures. These may take the form of a fisheries management plan, elements of which may be included in a legally binding 'Natura declaration' (SI 346/2009). The management plan in this context is a fishery proposal submitted by industry to the DAFF. The fishery management plan is subject to an impact or appropriate assessment (Article 6 Habitats Directive). The fishery plans and appropriate assessments are subject to statutory and public consultation. Vessels and operators may be required to apply for a 'Natura permit' to fish such areas (Figure 3). This regime was applied to cockle and seed mussel fisheries in 2009 and will be applied, incrementally, to all other fisheries in Natura sites by 2012.

The requirement to undertake appropriate assessment of fisheries in Natura sites means that both existing and new fisheries must be described and quantified in a proposal or fishery plan in order to assess their impacts. Agreed collective action by local stakeholders involved in such fisheries is, therefore, the first step in the process leading to appropriate assessment and compliance with the Habitats and Birds Directives. The institutional arrangements to achieve this are already established through the Shellfish Management Framework.

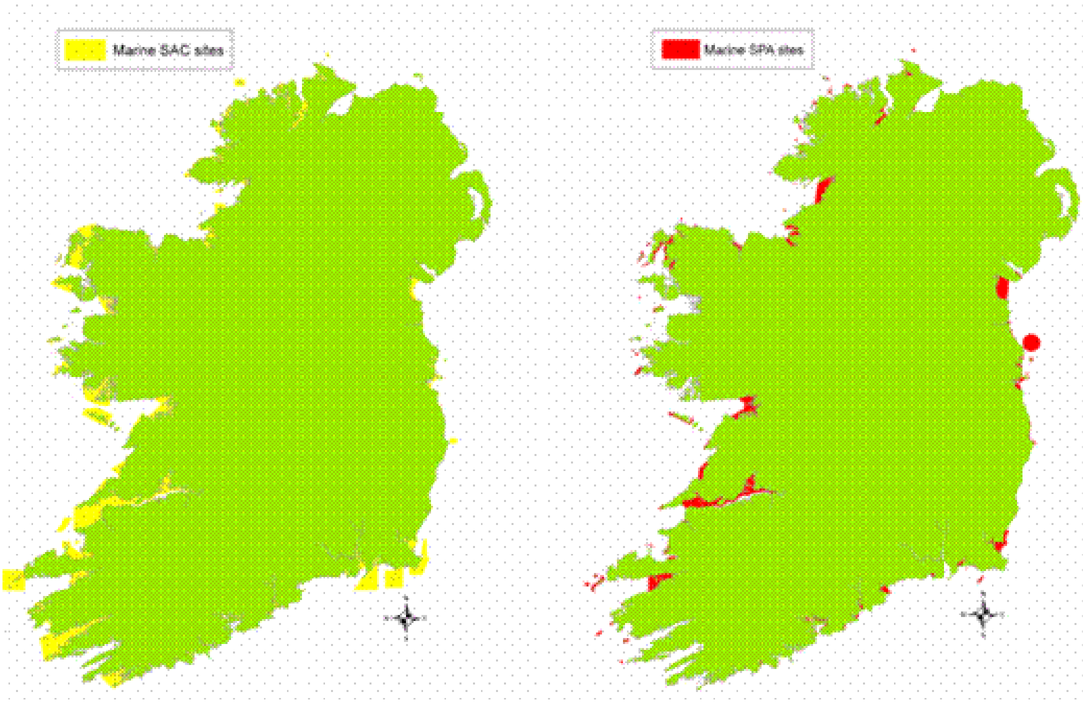


Figure 2. Distribution of Special Areas of Conservation (SACs) and Special Protection Areas (SPAs), collectively referred to as Natura sites, in Ireland.

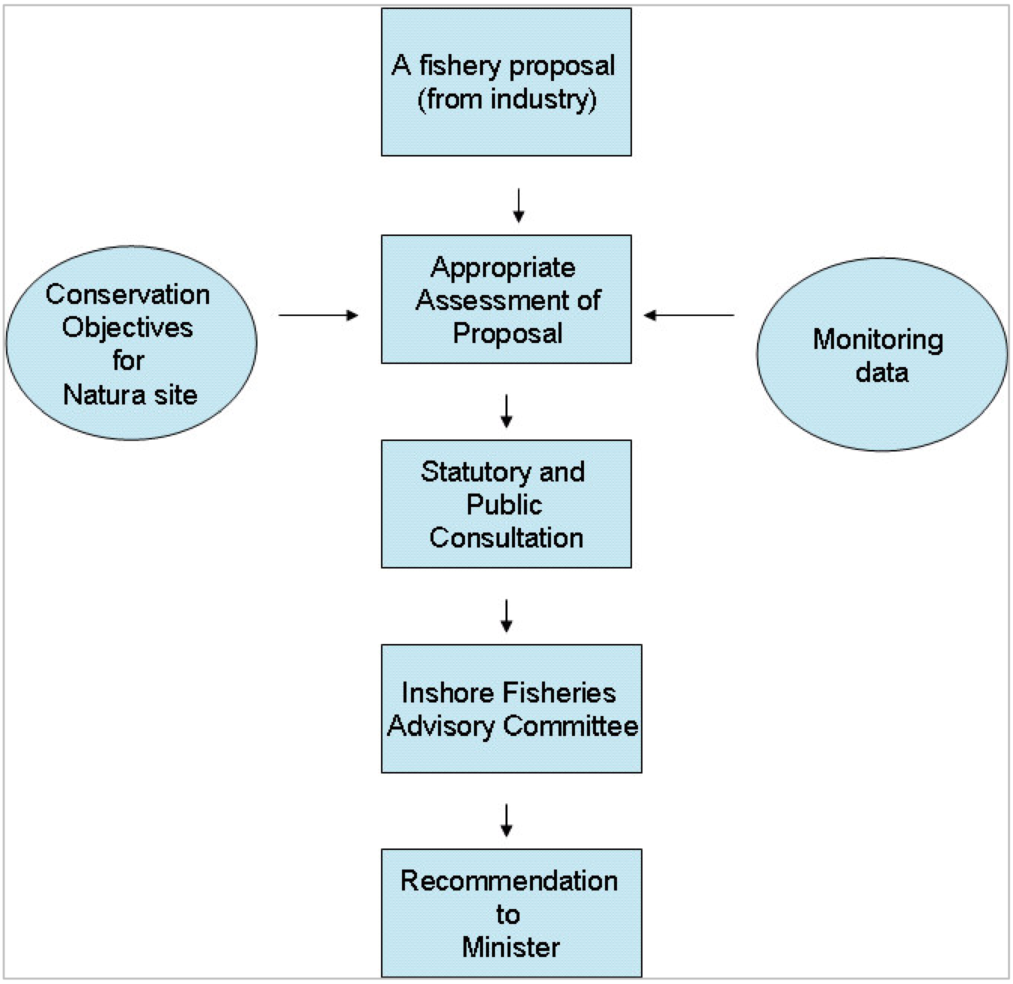


Figure 3. The process of evaluating the impact of fisheries in Natura sites. Appropriate assessment of the impact of current or new fisheries has to be undertaken if a fishery occurs in or close to a Natura site. This assessment evaluates the impact of the fishery against the conservation objectives for the site. In order to initiate the assessment a fishery plan or proposal has to be submitted to DAFF. The Marine Institute undertakes the appropriate assessment of such proposals which are subject to statutory and public consultation (www.fishingnet.ie). Observations on the assessment, from statutory and public consultation, are considered by The Inshore Fisheries Advisory Committee (IFAC), comprising DAFF, Department of Environment, Heritage and Local Government (DEHLG), MI, BIM, the industry proponents of the fishery proposal and Non Governmental Organisations (NGOs). A consensus is reached on whether the fishery proposal is consistent with the conservation objectives for the Natura site and a recommendation is made to the Minister.

Table 3. Effort, capacity and licencing regimes for shellfish species in Ireland. * = Biologically Sensitive Area (BSA) only. ** Not all fisheries

Common name	Species	Fleet segments	Restrictive licencing	Fleet capacity restriction	Fishing effort restriction	Catch restriction	Seasonal restriction	Spatial restriction (in individual fisheries)
Edible crab	*Cancer pagurus*	Polyvalent and Potting	No	No	>10m*	No	No	No
Lobster	*Homarus gammarus*	Polyvalent and Potting	Proposed	No	No	No	No	No
Pink shrimp	*Palaemonidae*	Polyvalent and Potting	No	No	No	No	Yes	No
Spider crab	*Maja brachydactyla*	Polyvalent and Potting	No	No	>10m*	No	No	No
Velvet crab	*Necora puber*	Polyvalent and Potting	No	No	No	No	No	No
Red crab	*Chaecon affinis*	Polyvalent and Potting	No	No	No	No	No	No
Spiny lobster	*Palinurus spp.*	Polyvalent and Potting	No	No	No	No	No	No
Shore crab	*Carcinus maenas*	Polyvalent and Potting	No	No	No	No	No	No
Whelk	*Buccinum undatum*	Polyvalent and Potting	No	No	No	No	No	No
Scallop	*Pecten maximus*	Bivalve and polyvalent	No	Yes	>10m	No	No	No
Cockle	*Cerastoderma edule*	Bivalve and polyvalent	Yes	No	No	Yes	Yes	Yes
Razor clam	*Ensis*	Bivalve and polyvalent	No	No	No	No	No	No
Native oyster	*Ostrea edulis*	Bivalve, polyvalent and Aquaculture	Yes	No	No	Yes	Yes	No
Surf clam	*Spisula*	Bivalve and polyvalent	No	No	No	Yes**	Yes**	Yes**
Periwinkle	*Littorina littorea*	None	No	No	No	No	No	No
Queen scallop	*Aequipecten opercularis*	Bivalve and polyvalent	No	No	No	No	No	No
Mussel	*Mytilus edulis*	Bivalve, polyvalent and Aquaculture	Yes	No	No	Yes	Yes	Yes

Table 4. Details of legislation impinging on shellfish fisheries in Ireland. ***Disclaimer: whilst every effort has been made to ensure the accuracy of the information presented in Table 4 the MI or BIM assume no responsibility for the accuracy, completeness or interpretation of the information provided and do not accept any liability whatsoever arising from any errors or omissions.***

In relation to licencing of shellfisheries		
Legislation and Guidance	**Purpose**	**Effect and implications for shellfisheries**
Council Regulation (EC) 2371/2002 (Common Fisheries Policy) Primary Fisheries Licencing (Sea Fisheries and Maritime Jurisdiction Act 2006)	To ensure all vessels engaged in sea fishing are registered and licenced to engage in particular fishing activities in particular areas and that entry/exit and other fleet capacity rules are adhered to	Limits the total capacity of the fleet or segments of the fleet that is engaged in particular types of sea fishing activity.
Secondary Fisheries Licencing (Authorizations) (Section 13, Sea Fisheries and Maritime Jurisdiction Act 2006) Natura permits (under S.I. 346/2009)	To limit the number of fishing vessels engaged in fishing for particular species or in particular areas	The number of vessels in fisheries or areas including Natura sites may be limited under this legislation.
Register of Sellers and Buyers 1077/2008/EC	To maintain a register of buyers and sellers of fish and to mandate the electronic transmission of data on first point of sale to the competent authority.	Commercial fishermen who catch and sell fish must sell only to registered buyers

Table 4.. continued

In relation to conservation of the target species		
Legislation and Guidance	**Purpose**	**Effect and implications for shellfisheries**
Control of annual fishing effort for certain fisheries (1415/2004/EC)	To limit the fishing effort of members states in certain areas and in certain fisheries	Irish annual kilowatt days are limited as follows: *Edible crab and spider crab*: ICES Area V,VI, Vessels over 15m, 465,000 kw.days ICES Area VII, Vessels over 15m, 40,960kw.days ICES Area VII(Biologically Sensitive Area), Vessels over 10m, 63,198 kw.days *Scallop* ICES Area V,VI, Vessels over 15m, 5,766kw.days ICES Area VII, Vessels over 15m, 525,012kw.days ICES Area VII(Biologically Sensitive Area), Vessels over 10m, 109,395kw.days
Seasonal restrictions on shrimp (*Palaemon* spp.) fishery S.I. 235/2006	To prohibit fishing during summer months to protect juvenile shrimp	Fishing for shrimp is prohibited between May 1st and August 1st.
Geographic restrictions on netting for spiny lobster (*Palinurus* spp.) S.I. 233/2006	To restore stocks of spiny lobsters in the controlled areas and to promote the transfer of fishing effort from nets to pots	The use of nets for capture of spiny lobster is prohibited in two areas off west Galway and off west Kerry.
Seasonal limits on fishing for cockles (*Cerastoderma edule*) S.I.s: various and specific to area and year Natura Declarations (under S.I. 346/2009): various and specific to Natura site and year	To give legal effect to conditions for the fishing of cockles as agreed in fishery management plans for cockles	Management plans for fishing of cockles vary with respect to conditions. Usually there is a total allowable catch, spatial and daily and seasonal restrictions on fishing time, size limits, daily catch limits and restrictions on numbers of vessels participating in the fishery
Seasonal limits on fishing for seed mussels (*Mytilus edulis*) S.I.s: various and specific to area and year Natura Declarations (under S.I. 346/2009): various and specific to Natura site and year	To give legal effect to conditions for the fishing of seed mussel including management plans for seed mussel fishing in Natura sites	The opening dates, total allowable catch and other operational details may vary annually and by area
Technical measures for protection of juvenile organisms (850/1998/EC) and various Statutory Instruments (S.I.)	To limit the minimum landing size and other technical measures for different fish species	See (Table 5) for details

Table 4. continued

In relation to Ecosystem Impacts		
Legislation and Guidance	**Purpose**	**Effect and implications for shellfisheries**
The Wildlife (Amendment) Act 2000	To give protection to various species of flora and fauna. Areas may be designated as Natural Heritage Areas (NHAs)	Certain flora and fauna in NHAs may be given special protection in relation to possible impacts that may be caused by fishing.
The Habitats Directive (92/43/EEC) European Union (Natural Habitats) regulations S.I. 94/1997 European Union (Natural Habitats) amendment regulations S.I. 233/1998 European Union (Natural Habitats) amendment regulations S.I. 378/2005	To protect the conservation status of particular habitats and flora and fauna in Special Areas of Conservation (SAC) designated under the Directive	The impact of fisheries on the habitats or species in the SAC must be assessed through appropriate assessment. The likelihood of significant impacts of the fishery in relation to the conservation objectives for the SAC must be excluded if a proposed fishing activity is to proceed
The Birds Directive (79/409/EEC) S.I. 94/1997	To protect the conservation status of bird species, their critical habitats and their populations in Special Protection Areas (SPAs)	The impact of fisheries on bird populations in the SPA must be assessed through appropriate assessment. Likelihood of significant impacts in relation to the conservation objectives for the SPA must be excluded if a proposed fishing activity is to proceed.
European Union (Habitats and Birds), Sea-Fisheries) Regulations 2009 , S.I. 346/2009	To enable planning and management of fisheries with respect to their impact on the environment where such fisheries occur within SACs or SPAs (collectively Natura sites) designated by the Habitats and Birds Directives.	Fisheries activities where they occur wholly or partially within SACs or SPAs and for the purpose of assessing their impact on the conservation status of those areas may be subject to fishery plans. Vessels operating under such plans may come under additional regulation as outlined in a Natura Declaration and may be required to hold a Natura Permit to operate in such a fishery.

Table 4. continued

In relation to food safety		
Legislation and Guidance	**Purpose**	**Effect and implications for shellfisheries**
Quality of shellfish Waters Directive (113/2006/EEC) S.I. 268/2006 S.I. 55/2009	To protect, improve and monitor the quality of water in areas which contain populations of molluscan shellfish destined for human consumption	Certain coastal areas are designated for the purpose of protecting and improving water quality these areas. 13 areas were designated in 2006 and an additional 49 sites were designated in 2009
The Code of Practice for the Microbiological Testing of Bivalve Mollusc Production Areas (www.sfpa.ie) 854/2004/EEC and 853/2004/EEC 2009 Classified bivalve production areas in Ireland (www.sfpa.ie)	Lays down specific hygiene rules and rules for the organisation of official control on placing of live molluscs on the market Identifies sea areas which are classified according to microbiological status for the production of bi-valve molluscs	Bi-valve molluscs can only be harvested from production areas which are classified as A, B or C on a long-term, short term or seasonal basis with respect to microbiological status and which subsequently determines how such shellfish are processed and placed on the market. Samples of shellfish must be submitted for testing as outlined in the Code of Practice Harvesters should complete documentation indicating the origin and date of harvest and health status of the production area.
The code of practice for the Monitoring of Marine Biotoxins in Bivalve molluscs (Code of Practice No 6, Draft, Food Safety Authority of Ireland). 854/2004/EEC and 853/2004/EEC 2074/2005/EC	Identifies the biotoxin limits and sampling requirements for assessment of biotoxins	Harvesting is only allowed to take place from production areas that are demonstrated to have biotoxin levels below the legally defined limits. The FSAI and SFPA consult with stakeholders and other agencies through the Molluscan Shellfish Safety Committee on opening and closing of areas in order to manage and reduce risk to public health.
European Communities Health of Aquaculture Animals and Products Regulations 2008 (SI No 261 of 2008)	To protect the health status of shellfish in aquaculture production businesses	This legislation applies to Aquaculture but oyster and scallop dredge fisheries operating in fishery order areas or under aquaculture licence must have a fish health authorization, adopt a shellfish health monitoring scheme, provide for good bio-security measures, maintain records and provide advance notification on movement of shellfish and notify of any unexplained mortalities or suspected disease.

Table 5. Minimum landing sizes for shellfish in Ireland

Species	Measure	National Legislation	National limit	Minimum EU limit (850/98/EC)	Geographic areas, Sex specific measures
Lobster (*Homarus gammarus*)	Carapace length (to base of eye socket)			87mm	All areas
	V-notch or mutilated tail	S.I. 234/2006	Prohibited		All areas
Edible crab (*Cancer pagurus*)	Carapace width			130mm	Area VII, Area VI south of 56°N
				140mm	Area VIIf,e,d (Channel), Area IV and VI north of 56°N
				115mm	Area VIIa, Area IV south of 56°N.
Spider crab (*Maja brachydactyla*)	Carapace length			120mm	All areas
		S.I. 236/2006	125mm		Female
		S.I. 236/2006	130mm		Male
Spiny lobster (*Palinurus* spp.)	Carapace length (to tip of rostrum)	S.I. 232/2006	110mm	95mm	All areas
Whelk (*Buccinum undatum*)	Shell width	S.I. 237/2006	25mm		All areas
	Shell height			45mm	All areas
Razor (*Ensis siliqua*)	Shell length			100mm	All areas
Scallop (*Pecten maximus*)	Shell length			100mm	Area VI and VII
				110mm	Area VIIa (north of 52°30'N), Area VIId
			120mm (local agreement)		Kilkieran Bay
			127mm (local agreement)		Valentia
Native Oyster (*Ostrea edulis*)	Shell length		76mm		All areas
Surf clam (*Spisula solida*)	Shell length	S.I. 419/2009	25mm	25mm	All areas
Cockle (*Cerastoderma edule*)	Shell width	Natura Declaration 02/2009	22mm		Dundalk Bay (2009)
Queen scallop (*Aequipecten opercularis*)*	Shell length			40mm	All areas

3 Landings 2004-2008

3.1 Overview

Annual landings of shellfish into Ireland in the period 2004-2008 varied from 29114 tonnes in 2004 to a low of 12247 tonnes in 2008 (Table 6). The main decline in volume occurred in brown crab, whelk and native oyster. All three species showed a declining trend during the period. Lobster landings declined from 2004 to 2007 but recovered in 2008. Shrimp landings were significantly lower in 2005 and 2008 than in other years during the period. Scallop landings declined between 2004 and 2006 but increased from 2006 to 2008. Landings of cockles peaked at 626 tonnes in 2007 and were less than 10 tonnes in 2006 and 2008.

The trend in landings is due to a number of factors including market conditions, changes in fleet structure, regulation and its effect on fleet activity or location of fleet activity and change in catch rate or stock status.

The decline in volume of crab is due to a combination of factors including direct landing of crab into non-Irish ports by the offshore vivier fleet, deteriorating market prices and profitability which has seen some vessels leave the fleet and declines in catch rates in some areas.

Decline in whelk is due to a reduction in the number of vessels in the fishery due to poor market prices.

Decline in native oyster are due mainly to low stock abundance due to effects of *Bonamia*, poor recruitment and increased attention to Pacific oyster by the main growers in extensive aquaculture licensed areas.

Table 6 Annual landings (tonnes) of shellfish into Ireland between 2004 and 2008. Source: The Sea Fisheries Protection Authority (SFPA)

Common name	Scientific Name	2004	2005	2006	2007	2008
Brown crab	*Cancer pagurus*	14072	9118	9987	7667	6284
King scallop	*Pecten maximus*	1679	918	689	947	1109
Lobster	*Homarus gammarus*	853	633	619	307	497
Whelk	*Buccinum undatum*	7575	4151	3033	3503	1871
Pink shrimp	*Palaemonidae*	405	151	319	324	180
Periwinkle	*Littorina littorea*	1674	1139	1210	609	1141
Razor clam	*Ensis*	400	404	547	356	451
Velvet crab	*Necora puber*	291	245	281	142	267
Spiny lobster	*Palinurus*	80	30	34	16	18
Native oyster	*Ostrea edulis*	1225	457	433	641	138
Spider crab	*Maja brachydactyla*	180	141	153	70	153
Surf clam	*Spisula*	28		26	14	55
Shore crab	*Carcinus maenas*	268	27	46	91	72
Cockle	*Cerastoderma edule*	207	107	7	626	9
Queen scallop	*Aequipecten opercularis*	97	66	159	17	2
Deep water red crab	*Chaecon affinis*	79	110	10	0	0
		29114	**17697**	**17551**	**15332**	**12247**

3.2 Geographic variation in Landings

Diversity and volume of shellfish landings varies around the coast as a result of the variable fishing opportunities and distribution of stocks. Annual landings of each species by county for the period 2004-2008, are shown in Figure 5. The landings data are compiled (source: SFPA) from a combination of logbook data, in the case of landings from vessels over 10m, and port by port assessment of the landings by vessels under 10m in length. Vessels under 10m in length do not complete logbooks.

The majority of lobsters are landed along the western seaboard from Donegal to Cork. There are also significant landings into Dublin and Waterford/Wexford. Edible crab is landed mainly into Donegal, Mayo and the south west. Spider crab landings are predominantly into north Kerry and Wexford but with notable increases in Galway and Mayo in 2008. Velvet crab is important in Dublin, Galway, Cork and Donegal. The majority of shrimp are landed into Cork with relatively lower volumes in Kerry and Galway. Spiny lobster is caught, almost exclusively, off the coasts of Cork and Kerry. Native oyster landings are mainly in Donegal. The important bivalve fisheries and landings are all on the east and south east coasts. Scallop is caught mainly in the south Irish Sea and north east Celtic Sea and landed into Wexford. Cockle is important in Dundalk Bay and Waterford Estuary. Whelk is landed from the south western Irish Sea into ports in Wicklow, Dublin and Wexford while Razor clams are landed into Dublin and Louth.

Table 7. Landings (tonnes) of shellfish into each coastal county in 2008. Source: The Sea Fisheries Protection Authority (SFPA)

Common name	Scientific Name	Clare	Cork	Donegal	Dublin	Galway	Kerry	Louth	Mayo	Meath	Sligo	Waterford	Wexford	Wicklow
Whelk	Buccinum undatum		1.1	191.2	148.5				0.1			2.4	22.5	1504.9
Brown crab	Cancer pagurus	172.0	312.1	4406.1	270.0	259.5	93.4	30.5	335.8		29.8	116.5	252.1	5.8
Shore crab	Carcinus maenas		0.6	71.4										0.1
Cockle	Cerastoderma edule			0.8				1.6	2.0		2.6		2.1	
Razor clam	Ensis				187.9	0.6		163.0		99.9				
Lobster	Homarus gammarus	105.4	8.1	102.2	42.4	134.4	18.1	0.1	56.5		20.5	1.3	7.0	0.7
Periwinkle	Littorina littorea	307.0	10.5	164.2		448.0	5.0		171.0		35.0			
Spider crab	Maja brachydactyla	16.2	5.0	1.4		63.8	19.0		24.5			0.1	21.5	1.0
Velvet crab	Necora puber	0.4	36.5	24.2	154.9	40.9	0.2	5.3	0.3			0.1	2.9	1.3
Shrimp	Palaemonidae	5.4	73.3	20.4		44.4	0.1	1.6	10.2		0.1		0.6	
Spiny lobster	Palinurus	0.1	4.9	0.7		8.6	3.1		0.9		0.1		0.0	
Scallop	Pecten maximus		28.4	23.0	113.3		6.2	1.5	0.9			9.7	926.5	
	Grand Total	606.4	480.6	5005.7	917.0	1000.2	145.2	203.5	602.1	99.9	88.2	130.1	1235.1	1513.9

4 Value of landings 2008

4.1 Monthly distribution of value and sales in 2008

To calculate the monthly and annual value of landings for each species, weighted according to monthly unit value and volume, the total annual landings for each species in the port report data (source: SFPA) was disaggregated to month using the monthly proportions of annual sales volume from the sales note data (source: SFPA). That is the monthly distribution of sales was regarded as more accurate than the monthly allocation of landings but the annual volume landed was regarded as more complete than the annual volume sold. The monthly value is then the product of the monthly unit value and the estimated monthly landings and the annual value is the sum of the monthly values. That is for each species

$$Value_{Annual} = \sum_{M=1}^{12} UnitValue_M * p(AL)_M$$

where p is the proportion of the annual landings, derived from the monthly (M) distribution of sales, and AL is the annual landings for the species at all ports.

Monthly sales value in 2008 fluctuated around €2m between January and July but rose to between €5-7m in August–October (Figure 4., Table 8). This is due to the autumn crab fishery and an allocation of most whelk sales to the August-September period. Important fisheries such as shrimp, are also mainly late summer and autumn fisheries.

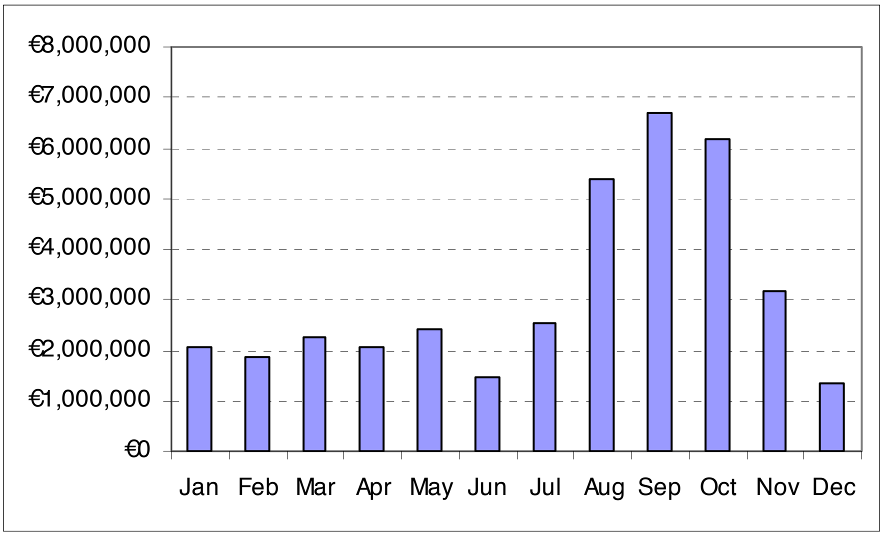


Figure 4. Monthly value of shellfish landings in 2008.

Table 8. Monthly distribution of value of sales for each species in 2008

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Edible crab	€218,526	€285,046	€180,056	€218,552	€290,718	€318,418	€568,924	€2,463,177	€1,068,381	€4,834,391	€444,403	€302,922	€11,193,513
Scallop	€999,660	€1,012,290	€842,448	€1,039,703	€516,487	€53,945	€514,170	€468,023	€675,651	€345,057	€431,289	€640,480	€7,539,204
Lobster European	€46,646	€66,913	€112,337	€447,261	€1,358,873	€894,525	€1,269,338	€1,111,595	€592,812	€250,130	€230,134	€240,752	€6,621,316
Whelk	€8,368	€9,591	€19,652	€887	€5,007	€2,322	€4,554	€931,122	€3,569,152	€5,118	€2,847	€2,745	€4,561,366
Periwinkle	€0	€0	€1,053,113	€0	€0	€0	€0	€0	€33,883	€92,916	€1,606,902	€0	€2,786,814
Shrimp	€179,816	€60,780	€3,765	€4,930	€127	€0	€2,233	€263,635	€676,087	€549,138	€343,774	€97,694	€2,181,980
Razor clams	€584,073	€427,421	€17,217	€172,747	€101,194	€0	€0	€10,283	€0	€0	€0	€0	€1,312,934
Velvet crab	€5,095	€3,253	€4,383	€43,973	€61,457	€92,953	€121,740	€79,386	€39,656	€67,813	€101,381	€71,275	€692,368
Native oyster													€579,600
Spiny lobster	€0	€6,564	€9,960	€27,489	€37,822	€65,803	€52,245	€19,640	€6,001	€7,357	€1,328	€0	€234,209
Spider crab	€0	€310	€10,012	€43,763	€43,411	€20,808	€16,457	€18,477	€16,325	€6,720	€6,085	€1,117	€183,484
Surf clam	€0	€218	€436	€601	€742	€655	€699	€26,668	€31,947	€2,190	€684	€415	€65,255
Green crab	€4	€1,504	€5,207	€45,188	€4,056	€1,221	€734	€19	€85	€265	€856	€387	€59,528
Cockle													€27,288
Queen scallop	€0	€0	€0	€0	€3,394	€0	€894	€85	€0	€0	€0	€0	€4,373
Crab deep sea red	€0	€0	€0	€0	€0	€0	€0	€0	€0	€0	€0	€0	€0
Total	€2,042,189	€1,873,890	€2,258,587	€2,045,095	€2,423,290	€1,450,651	€2,551,988	€5,392,108	€6,709,980	€6,161,095	€3,169,684	€1,357,788	€38,043,233

4.2 Annual value of shellfish 2004-2008

Annual value of shellfish was €85m in 2004 and €39m in 2008. These figures have been estimated by applying 2008 first point of sale unit values, which are not available for earlier years. However, this limitation probably does not inflate earlier year values as prices are thought to have been static or declining during the period. Value in 2004, which was the peak year in the period 2004-2008, may, therefore, actually have been higher than reported here.

Table 9. Annual value of shellfish landings 2004-2008 using 2008 unit prices.

Common name	First sale value per kg 2008	2004	2005	2006	2007	2008
Brown crab	€2.11	€29,626,311	€19,195,533	€21,025,618	€16,141,688	€13,228,812
King scallop	€6.79	€11,401,999	€6,237,173	€4,677,029	€6,431,314	€7,533,999
Lobster	€14.53	€12,393,769	€9,197,893	€8,986,848	€4,453,867	€7,216,304
Whelk	€1.61	€12,195,702	€6,682,328	€4,882,521	€5,640,210	€3,011,624
Pink shrimp	€13.05	€5,288,723	€1,966,946	€4,163,352	€4,231,826	€2,351,851
Periwinkle	€2.04	€3,419,407	€2,327,725	€2,472,150	€1,245,183	€2,330,603
Razor clam	€2.66	€1,063,782	€1,074,851	€1,453,710	€945,654	€1,199,955
Velvet crab	€2.55	€743,000	€626,097	€716,841	€363,657	€682,089
Spiny lobster	€35.73	€2,869,463	€1,079,418	€1,211,857	€585,658	€658,054
Native oyster	€4.20	€5,143,984	€1,920,608	€1,816,920	€2,693,048	€579,600
Spider crab	€1.22	€220,403	€171,924	€187,196	€85,528	€186,413
Surf clam	€3.00	€83,073	€0	€78,000	€42,495	€165,330
Shore crab	€0.60	€160,235	€16,137	€27,669	€54,460	€43,104
Cockle	€3.00	€622,245	€320,160	€19,560	€1,878,087	€27,288
Queen scallop	€1.77	€171,532	€115,869	€280,070	€30,723	€4,134
Deep water red crab	€7	€550,088	€767,550	€70,966	€0	€0
Total		**€85,953,715**	**€51,700,211**	**€52,070,307**	**€44,823,400**	**€39,219,160**

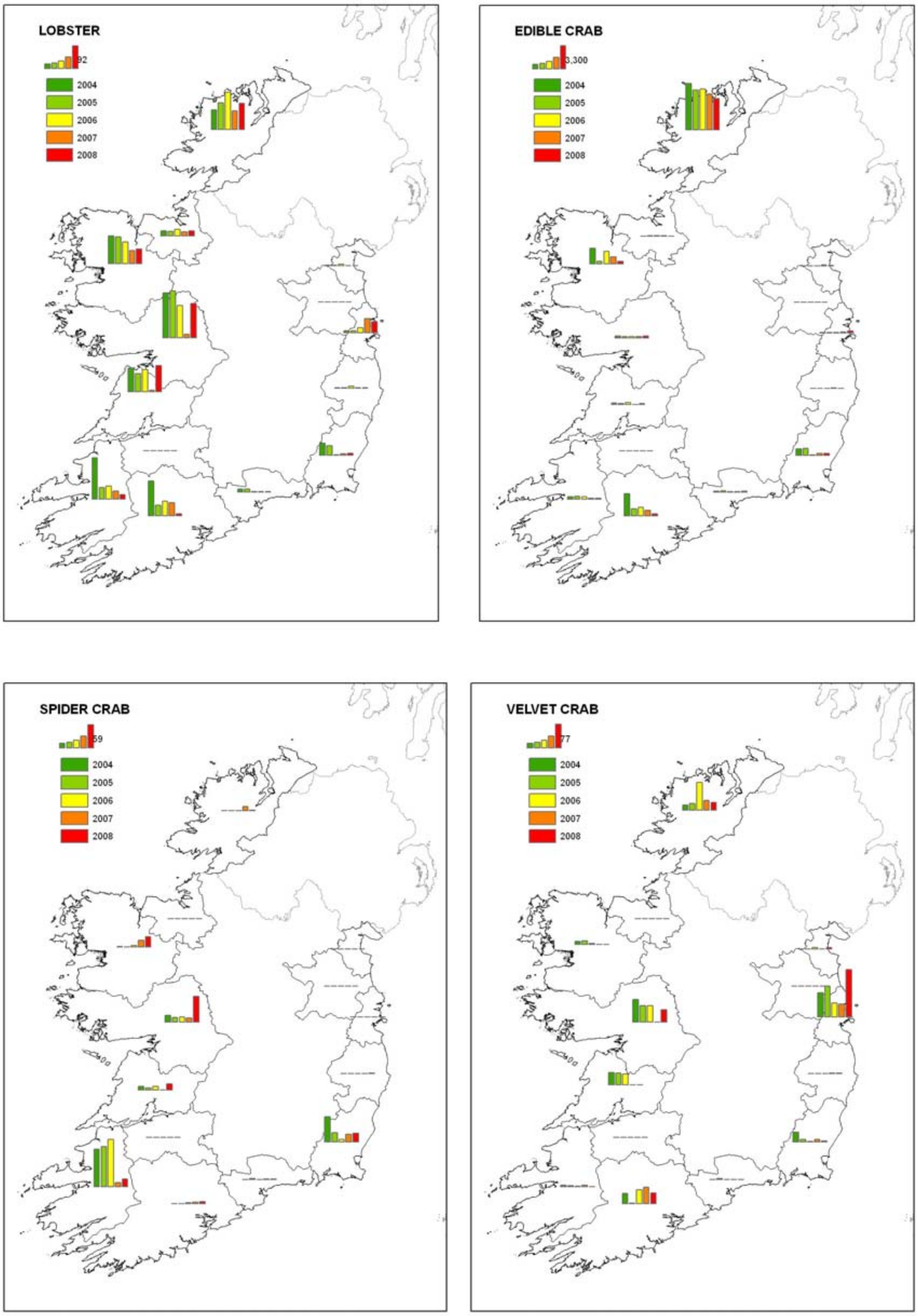


Figure 5. Landings of 14 species of shellfish, 2004-2008, by county.

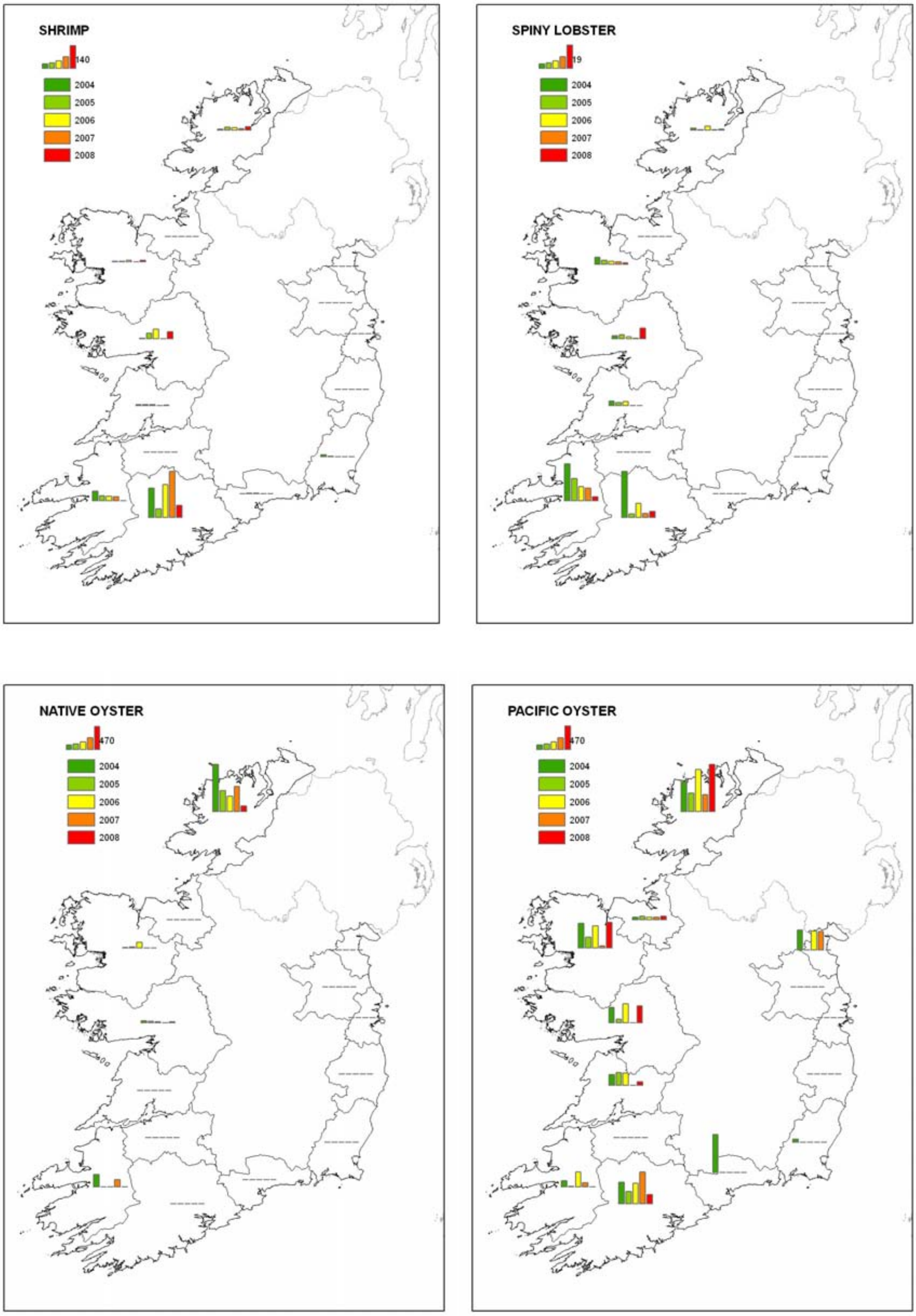


Figure 5. Landings of 14 species of shellfish, 2004-2008, by county - continued

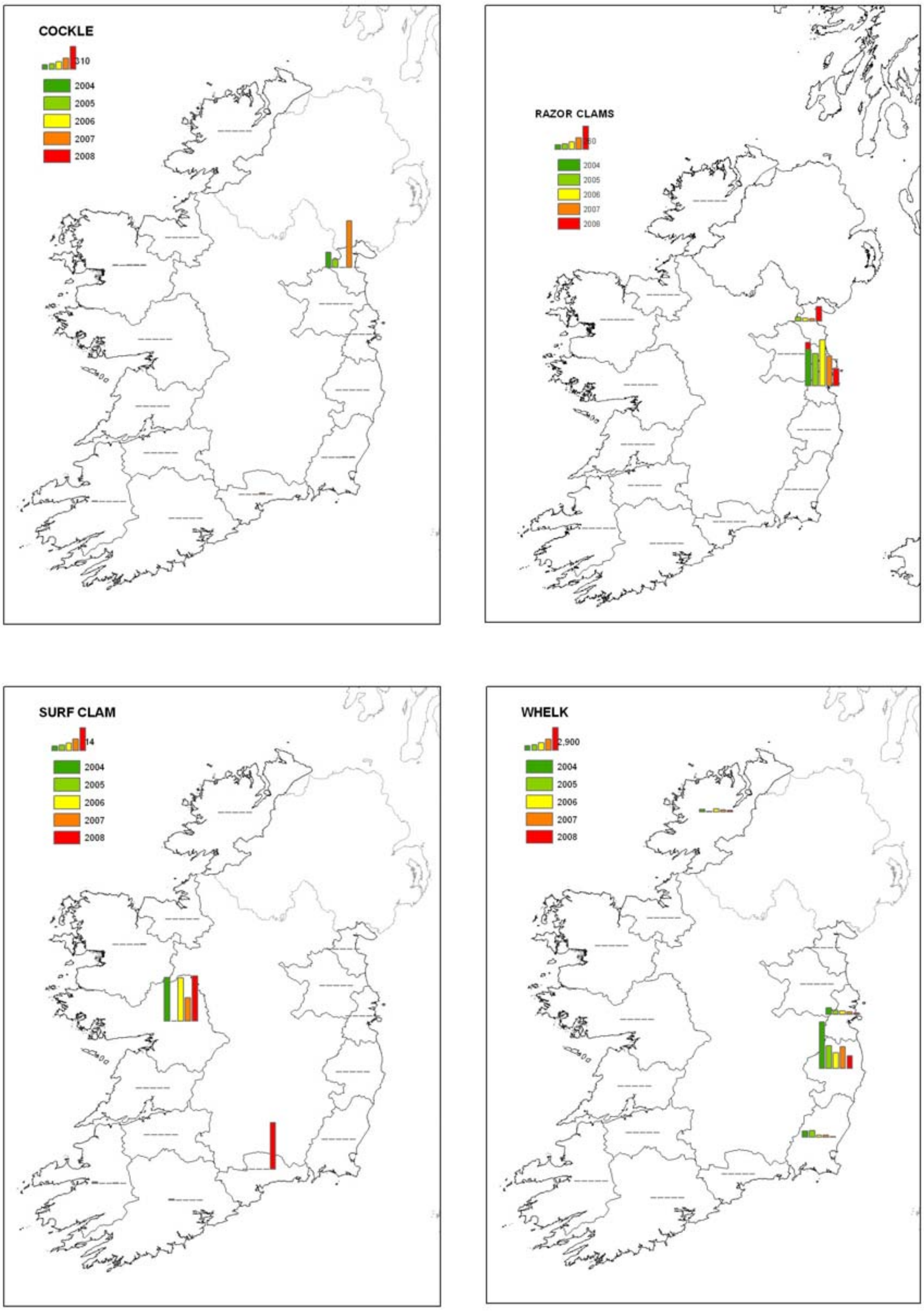
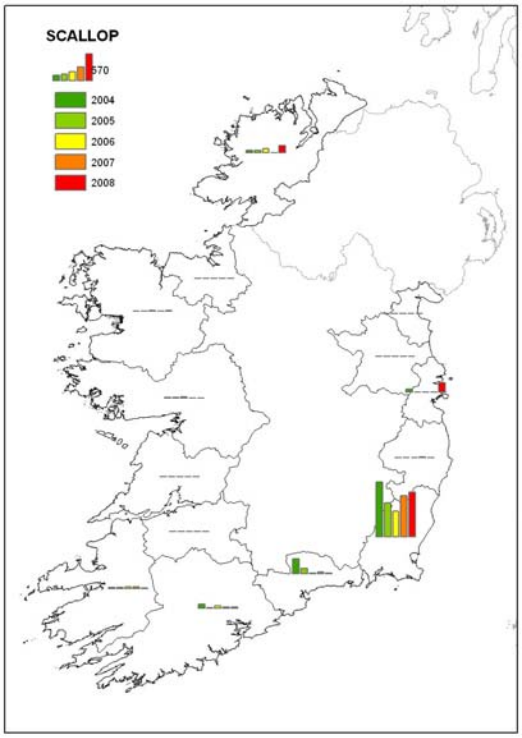


Figure 5. Landings of 14 species of shellfish, 2004-2008, by county - continued



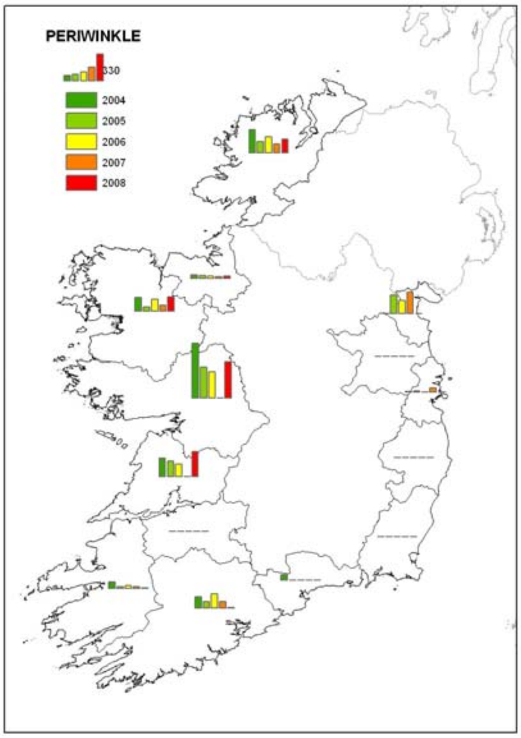


Figure 5. Landings of 14 species of shellfish, 2004-2008, by county - continued

5 Costs and Earnings

5.1 Data sources

Economic data for the <13m fleet comes mainly from the BIM sentinel programme which combines the acquisition of catch and effort data, biological data, through self sampling, daily operating costs and annual landings and costs. Data was collected in 2006-2008 and is aggregated across years for 102 vessels in this report. Complete records are not available for all vessels.

5.2 Invested capital

5.2.1 Capacity

Total value of vessel capacity (GTs and Kws) invested in the polyvalent <13m fleet, based on annual unit capacity costs, varied between €19.8m in 2006 to €33m in 2008. Annual outlay of investment per annum is unknown and depends on the level of trading in vessels and capacity at fleet level.

5.2.2 Vessels

Raising average vessel purchase price per GT (Table 12) to the capacity of the polyvalent under 13m polyvalent fleet (total = 4677GT) suggests an investment in vessels of €56m. Assuming that purchase price of vessels per GT in the specific segment is the same as that in the polyvalent <13m fleet then €38m is invested in vessels in the specific segment (total capacity = 3162GT).

5.3 Annual Gross Earnings

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

$$AnnualValueofCatch = \sum_{Species1}^{n} Averageprice / kg_{Sp} * Kgslanded_{Sp}$$

Some of the vessels also land small quantities of finfish. These earnings are not included here.

Earnings from shellfish vary from €41k for vessels primarily targeting shrimp to €145k for vessels primarily targeting crab (Table 13). Earnings per vessel, within each fishery, is highly variable.

5.4 Annual operating costs and cost earnings ratio

Annual operating costs vary from an average of €20k in the shrimp fishery to €75k in the crab fishery. Variability in annual costs within each fishery is also very high. Bait, fuel, gear replacement and vessel maintenance are significant costs in all fisheries. Bait and fuel costs are higher in the crab and whelk fisheries than in shrimp, lobster or mixed crustacean fisheries. Landings of these species are higher in volume than others and the volume of bait and gear used is consequently higher (Table 14).

Annual net earnings (excluding pay costs) vary from €21k in the shrimp fishery to €70k in the crab and €86k in the whelk fisheries. Crew size in the crab (mean = 2.70) and whelk fisheries (mean = 2.58) are higher than in lobster (mean = 1.75) and shrimp (mean = 1.5) fisheries. Labour input per boat per annum (days at sea*crew number * (steaming time+fishing time)) averages 3583±2250hrs. Net earnings per labour hour averages €14±13 and varies from €19 in the crab fishery to €9.5 in the shrimp and mixed crustacean fishery. The cost/earnings ratio is approximately 0.4-0.5 in the crustacean fisheries, being lower in the whelk fishery at 0.32.

5.5 Costs, earnings and fishing effort

Annual gross and net earnings and costs are strongly related to the amount of gear operated by the vessel and less so to the days at sea. Annual gross earnings, net earnings and costs per pot operated are on average €165, €76 and €79 respectively. However, variability between vessels is high and annual net profit of some vessels with less than 700 pots is zero.

Annual earnings, costs and net profit are poorly related to number of days fished per year. Some vessels fishing for a high number of days have relatively low annual earnings (essentially the value of the catch) and net profits (Figure 6). Although low annual net profit is a function of the cost:earnings ratio low annual earnings for vessels, expending high effort, can only be attributed to poor catches. Given that vessels which own higher numbers of pots also tend to spend a higher number of days at sea ($p<0.05$) poor catch performance by such vessels is of particular concern.

Table 10. Annual unit capacity prices in the period 2006-2009. Polyvalent is capacity required to become registered in the polyvalent segment of the fleet. Specific is bi-valve capacity to register in the specific segment of the fleet to fish for bi-valves only. GT = gross tonnage, Kws = kilowattage

GTs	**2006**	**2007**	**2008**	**2009**
polyvalent	1800	2000	2200	1650
specific	1500	1500	1500	1500
Kws				
polyvalent	350	500	700	450
specific	200	200	200	200

Table 11. Total capital invested in capacity by the <13m fleet based on annual unit capacity prices in Table 10

Segment	**2006**	**2007**	**2008**	**2009**
Polyvalent General	€19,870,221	€26,075,700	€33,275,733	€23,887,913
Polyvalent Potting	€ 0	€ 0	€ 0	€ 0
Specific	€9,226,391	€4,904,517	€5,090,025	€4,888,329
Total	€29,096,613	€30,980,217	€38,365,758	€28,776,242

Table 12. Sample of vessel purchase prices and purchase price per GT of capacity in the <13m polyvalent fleet

		Vessel Purchase price		Purchase price of vessel per GT	
Main Target fishery	**N**	**Mean**	**S.d.**	**Mean**	**S.d.**
Crab	15	€145,600	€119,418	€17,694	€10,801
Crustacean	20	€49,828	€65,988	€11,849	€2,535
Lobster	15	€61,027	€61,726	€12,265	€12,229
Shrimp	16	€25,181	€42,246	€8,582	€8,826
Whelk	10	€53,150	€35,274	€10,117	€7,401

Table 13. Landings and gross earnings profile per vessel categorised by the main fisheries the vessels engaged in.

				Landings (tonnes)									
Main target fishery		Annual Earnings		Brown crab		Lobster		Velvet crab		Shrimp		Whelk	
	N	Mean	S.d.	Mean	S.d.	Mean	S.d.	Mean	S.d.	Mean	S.d.	Mean	S.d.
Crab	16	€145,026	€115,594	59.5	44.3	0.9	1.1	0.3	0.5	0.2	0.4	8.3	24.8
Crustacean	36	€61,207	€58,963	11.5	19.2	1.4	1.3	0.4	0.8	0.2	0.5	4.4	22.4
Lobster	14	€49,761	€58,655	8.1	14.9	1.2	1.4	0.6	1.8	0.2	0.5	0	0
Shrimp	15	€41,235	€30,386	2.5	7.4	0.5	0.7	1.4	2.2	1.3	0.9	0	0
Whelk	11	€130,746	€74,539	5	11.5	0.2	0.3	0.3	1.2	0	0	75.8	56.8

Table 14. Average (±s.d.) operating costs for different cost categories and for each category of fishery.

		Target fishery				
Cost category		**Crab**	**Crustacean**	**Lobster**	**Shrimp**	**Whelk**
	N	*15*	*26*	*10*	*16*	*10*
Gear maintenance	Mean	€1,666	€1,096	€536	€1,448	€3,950
	S.d.	*€1,785*	*€1,397*	*€639*	*€2,195*	*€9,200*
Gear replacement	Mean	€18,051	€3,271	€4,479	€4,659	€5,177
	S.d.	*€9,672*	*€4,469*	*€6,254*	*€6,623*	*€6,958*
Vessel maintenance	Mean	€5,820	€1,785	€2,754	€2,153	€3,842
	S.d.	*€3,624*	*€5,247*	*€3,672*	*€2,367*	*€3,864*
Insurance	Mean	€4,982	€2,008	€1,915	€375	€2,567
	S.d.	*€2,259*	*€1,313*	*€1,549*	*€887*	*€3,426*
Fees	Mean	€1,658	€801	€709	€711	€1,753
	S.d.	*€1,127*	*€693*	*€794*	*€845*	*€1,208*
Loans	Mean	€13,957	€8,170	€6,936	€1,901	€4,305
	S.d.	*€9,081*	*€7,307*	*€12,696*	*€3,259*	*€5,159*
Fuel	Mean	€14,925	€4,590	€5,150	€3,369	€7,973
	S.d.	*€12,347*	*€5,207*	*€5,453*	*€3,330*	*€7,453*
Bait	Mean	€10,525	€2,718	€1,896	€3,123	€13,145
	S.d.	*€7,240*	*€3,433*	*€1,911*	*€3,842*	*€7,604*
Misscellaneous	Mean	€3,291	€1,404	€1,576	€2,269	€1,392
	S.d.	*€2,513*	*€2,287*	*€2,535*	*€4,936*	*€1,537*
Average total costs	**Mean**	**€74,876**	**€25,842**	**€25,951**	**€20,008**	**€44,104**
	S.d.	***€20,246***	***€12,214***	***€16,033***	***€10,800***	***€17,422***
Average gross earnings	Mean	€145,026	€61,207	€49,761	€41,235	€130,746
	S.d.	*€115,594*	*€58,963*	*€58,655*	*€30,386*	*€74,539*
Average net earnings	**Mean**	**€70,150**	**€35,365**	**€23,810**	**€21,228**	**€86,642**
	S.d.	***€113,807***	***€57,684***	***€56,421***	***€28,401***	***€72,475***
Cost earnings ratio		***0.52***	***0.42***	***0.52***	***0.49***	***0.34***

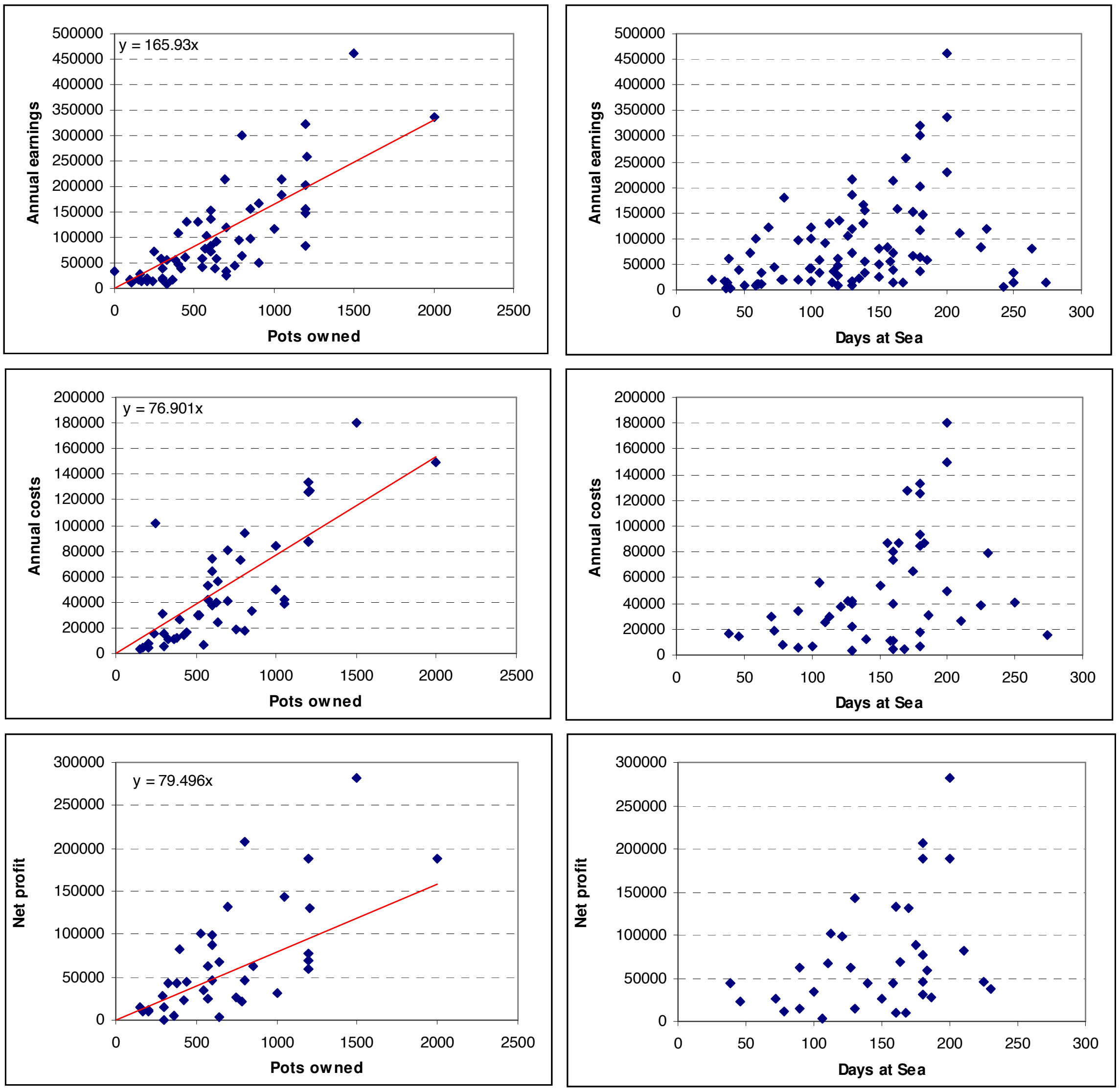


Figure 6. Relationships between earnings, costs, gear ownership and fishing activity in the crustacean fisheries 2006-2008.

6 Strengths, Weaknesses, Opportunities and Threats in the Shellfish Sector

Table 15. Strengths, weaknesses, opportunities and threats in Irish shellfisheries.

Strengths	**Weaknesses**
An embedded local industry supporting ancillary activities	Poor control of access to fisheries. Management plans are generally not developed
In some fisheries capital investment requirement is low relative to potential earnings.	Little representation of shellfish interests at national level
High unit value in some fisheries	Industry poorly organised at local level so that capacity for agreed collective actions is limited
	Marketing strategies poorly developed. Domestic consumption is low
	Onshore facilities for maintenance of live shellfish are poorly developed
	Stock assessment and provision of data on stocks and fleet activity is poorly developed
Opportunities	**Threats**
High quality products	Poor market prices
Potentially strong environmental image	Reducing diversity of fishing opportunity due to domino effect of stock failures resulting in increased specialisation.
A Management framework has been established.	Unregulated access to most stocks
Environmental legislation combined with fisheries management planning	Environmental legislation in the absence of fisheries management planning
Future demand for products expected to be strong	Depressed employment market and TAC regulations in other fisheries may lead to increased entry to shellfisheries
Development of the Shellfish brand, accreditation of fisheries and access to niche markets	
Majority of stocks are inside national territorial limits (12nm)	

7 Lobster

7.1 Management recommendations

The Lobster Advisory Group have made the following recommendations

1. **Access to the fishery be limited in each of 8 management units**
2. **A management plan with pre-agreed indicator reference points for decision making be developed (this was drafted in 2008)**
3. **The fishing effort (number of pots) of authorised vessels in each management be limited**
4. **A maximum landing size of 127mm carapace length be introduced**
5. **Landings, catch rate, recruitment, costs and earnings be monitored and reported in relation to agreed biological and economic indicator reference points.**

FSS agree with the recommendations of the Lobster Advisory Group. Management of effort will control and reduce costs and will potentially lead to increases in catch rates. The addition of a maximum landing size at 127mm will protect large spawning lobsters which have high fecundity, will improve egg production per recruit and will protect some of the investment that has been made in the national v-notch programme since 2002.

Data on catch and effort need to be scaled up significantly to inform the lobster management plan drafted by the Lobster Advisory Group. In particular vessels less than 10m in length should report information on catch and effort.

7.2 Summary

The population structure of lobster stocks, in the waters around Ireland is determined mainly by larval dispersal. The 8 management units proposed by the Lobster Advisory Group are an approximate best fit to the underlying population structure and are appropriate given the spatial scales of larval dispersal.

Catch rates in the fishery vary geographically and between the proposed management units. In areas for which there are data, the various catch rate indicators are stable, although, in some areas they are lower than historic levels.

Egg production is 5.7% of unexploited levels and below the precautionary 10% limit reference point. The national v-notch programme contributes up to (depending on proportion of the catch that is notched and released) 1% of the 5.7% i.e. about 17% of current egg production is due to v-notched lobsters. A maximum size of 127mm (see point 4 in management recommendations) and a 10% reduction in F or a maximum size of 127mm combined with a v-notching rate of 2.5% of landings, applied to lobsters between 87-125mm, would bring egg production to or above the 10% limit reference point.

Profitability between areas varies mainly due to differences in catch rate rather than lobster size or unit price. Profitability during the season varies due to change in catch rate, which usually declines as the fishing season progresses, and unit price which is highest early and late in the season. Gross profit ranges from €1-2 per pot haul. The cost earnings ratio is 0.52. The main operating costs are fuel, bait and gear replacement.

7.3 Proposed management units

In 2008, following recommendations of the Lobster Advisory Group, a public consultation on new management units for the lobster fishery was undertaken. The main recommendation was to manage access to the lobster fishery within 8 coastal regions or management units, each of which was to be divided into 2 sub-units. Each lobster fishing vessel would be authorised to fish for lobster in any 2 contiguous sub-units (Figure 7).

7.4 Stock structure in relation to proposed management units

Stock structure in lobster is determined mainly by the geographic scales over which lobster larvae are dispersed following hatching. Adult lobsters do not generally move or migrate over large distances. Larval dispersal will determine to what degree stocks in each of the proposed management units are connected and the geographic scale over which spawning and recruitment might be linked.

7.4.1 Simulated larval dispersal: Methods

Larval dispersal between management sub-units was simulated using the MarGIS_SILT (Marine Geographic Information System Simulated Larval Transport) model developed by Marcon Computations in 2008. This 3D bio-physical model computes current speed and direction for Irish coastal waters at a 0.5km^2 horizontal resolution, for each of 10 depth layers, and outputs and archives the prevailing conditions every hour. Larval populations are then seeded into the model at user defined densities, depth distributions and for a defined duration determined by larval development rates. The virtual larvae are also allocated behavioural properties such as swimming speed and diel variation in vertical distribution.

The dispersal of larvae from spawning areas within each management sub-unit was simulated under hydrodynamic conditions for July 2002 and forced by meteorological conditions for that time. July is the main larval period. Spawning areas were defined as areas from the coast seaward to 3nm as spawning stock is likely to be concentrated in this zone compared to waters seaward of 3nm. The majority of the fishery also occurs inside 3nm. The main assumption in the model is in relation to larval behaviour. Although larvae are known to be distributed at the sea surface their horizontal swimming capacity in response to environmental conditions is unknown and is here presumed to be zero.

7.4.2 Scales and directions of larval dispersal: Results

Larvae are dispersed in a net southward direction on the east coast, westwards on the south coast and northwards on the west coast (Figure 8) i.e. clockwise around the coast. The areas of the dispersed distributions are on average 12.6 times the area of the spawning distributions (Table 16). However, this varies from 6.8 in area 7b (Donegal Bay) to 24.9 in area 2a (Wexford coast).

7.4.3 Connectivity across proposed management units

The scale of larval dispersal is limited but extends beyond the borders of the management sub-units. Each management sub-unit is self-recruiting but also contributes larvae to 1 sub-unit downstream, except for sub-unit 8a (north Donegal), where dispersal is in an easterly direction (simulation not shown), in 11 cases to 2 sub-units downstream and in two cases (5a to 6b and 5b to 7a) to 3 sub-units downstream of the spawning area (Table 17). A quantitative analysis of the proportion of the larval populations dispersed to downstream sub-units has not yet been completed but the proportion of larvae reaching sub-units 2-3 units downstream of the spawning areas is lower than the proportion retained in the spawning area or dispersed to the neighbouring sub-unit.

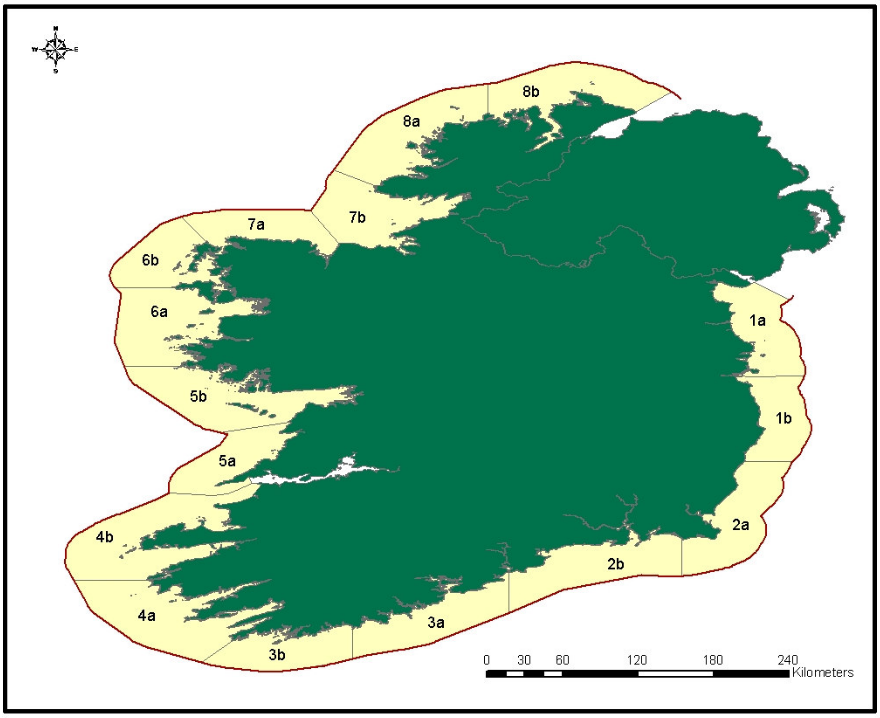


Figure 7. Management units, seaward to 12nm, proposed by the Lobster Advisory Group for the Irish lobster fishery.

Table 16. Ratios of the areas of spawning and dispersal for each management unit for conditions in July 2002. Spawning is presumed to occur inside 3nm.

Management Unit	Area of spawning (S) inside 3nm, km²	Area of dispersal (D) km²	Ratio of Dispersal to Spawning area
1a	509	5142	10.1
1b	402	7279	18.1
2a	537	13389	24.9
2b	1022	9792	9.6
3a	765	13097	17.1
3b	625	9079	14.5
4a	1529	14681	9.6
4b	1716	15116	8.8
5a	661	6097	9.2
5b	1748	12241	7.0
6a	1181	8976	7.6
6b	1186	11809	10.0
7a	499	11562	23.2
7b	1504	10218	6.8
8a	973	12302	12.6
8b	688		

Table 17. Connectivity, through larval dispersal, across proposed lobster management sub-units simulated for hydrodynamic and wind conditions in July 2002. All sub-units are self recruiting (blue) and also contribute larvae to 1 sub-unit downstream (light blue), 2 sub-units downstream (yellow) and exceptionally to 3 sub-units downstream (tan). A complete shading of the matrix would represent a true open population structure. The existing structure is also asymmetrical as evident from the more extensive shading above the diagonal. The proportions of the larval populations dispersing to different extent has not yet been estimated but is expected to decline with distance from the spawning area.

	1a	1b	2a	2b	3a	3b	4a	4b	5a	5b	6a	6b	7a	7b	8a	8b
1a																
1b																
2a																
2b																
3a																
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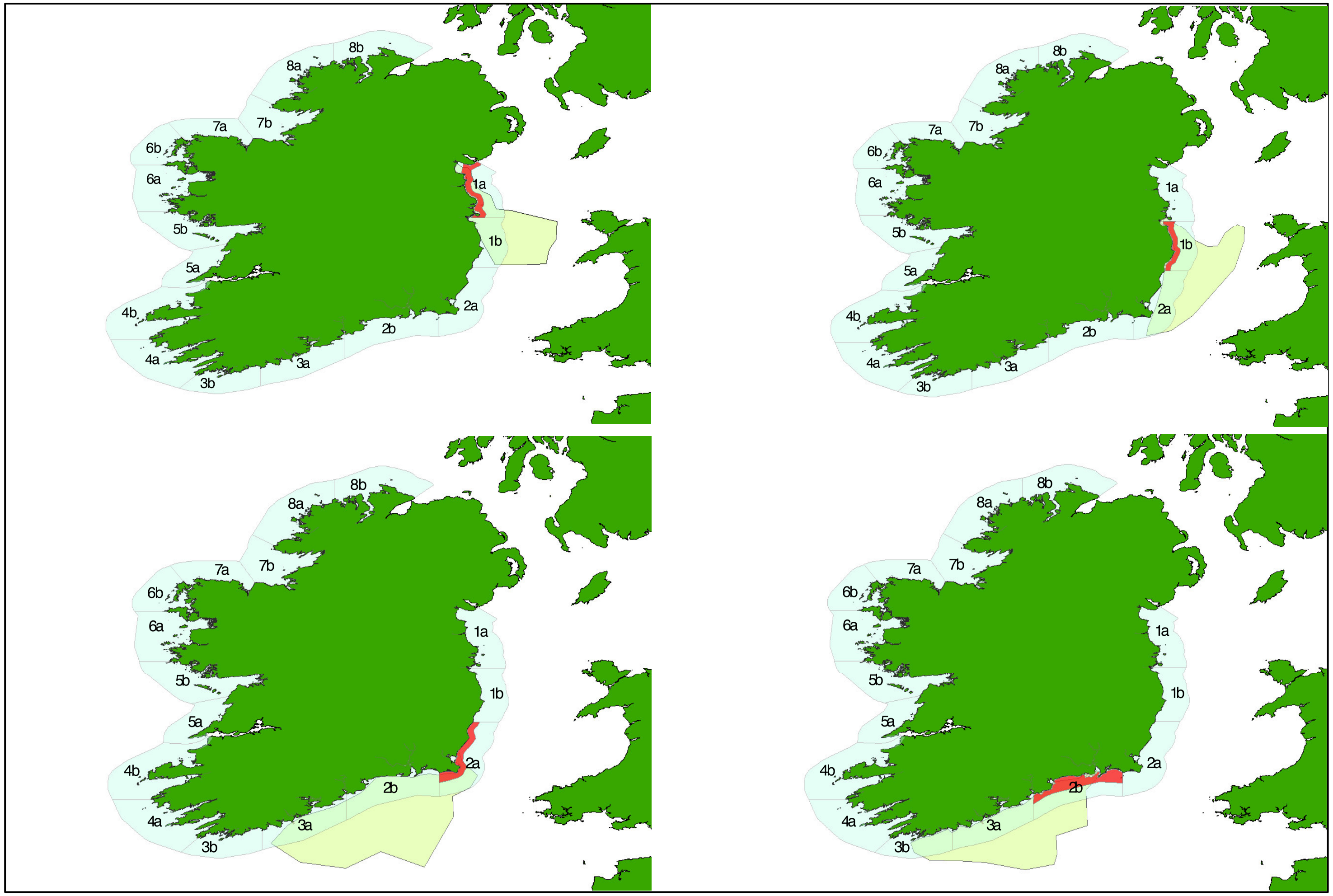

Figure 8. Simulated dispersal of populations of lobster larvae (olive) from putative spawning areas (red) within each proposed management sub-unit (labelled). Spawning is presumed to occur within 3nm of the coast. Simulations were run for 30 days under hydrodynamic and wind conditions for July 2002. Wind conditions (direction, days, mean beaufort strength) in July 2002 at Shannon: W,11,2.7; SW,7,3;NW,6,3.2;N,3,2.7;E,3,1.3,S,1,3.0.

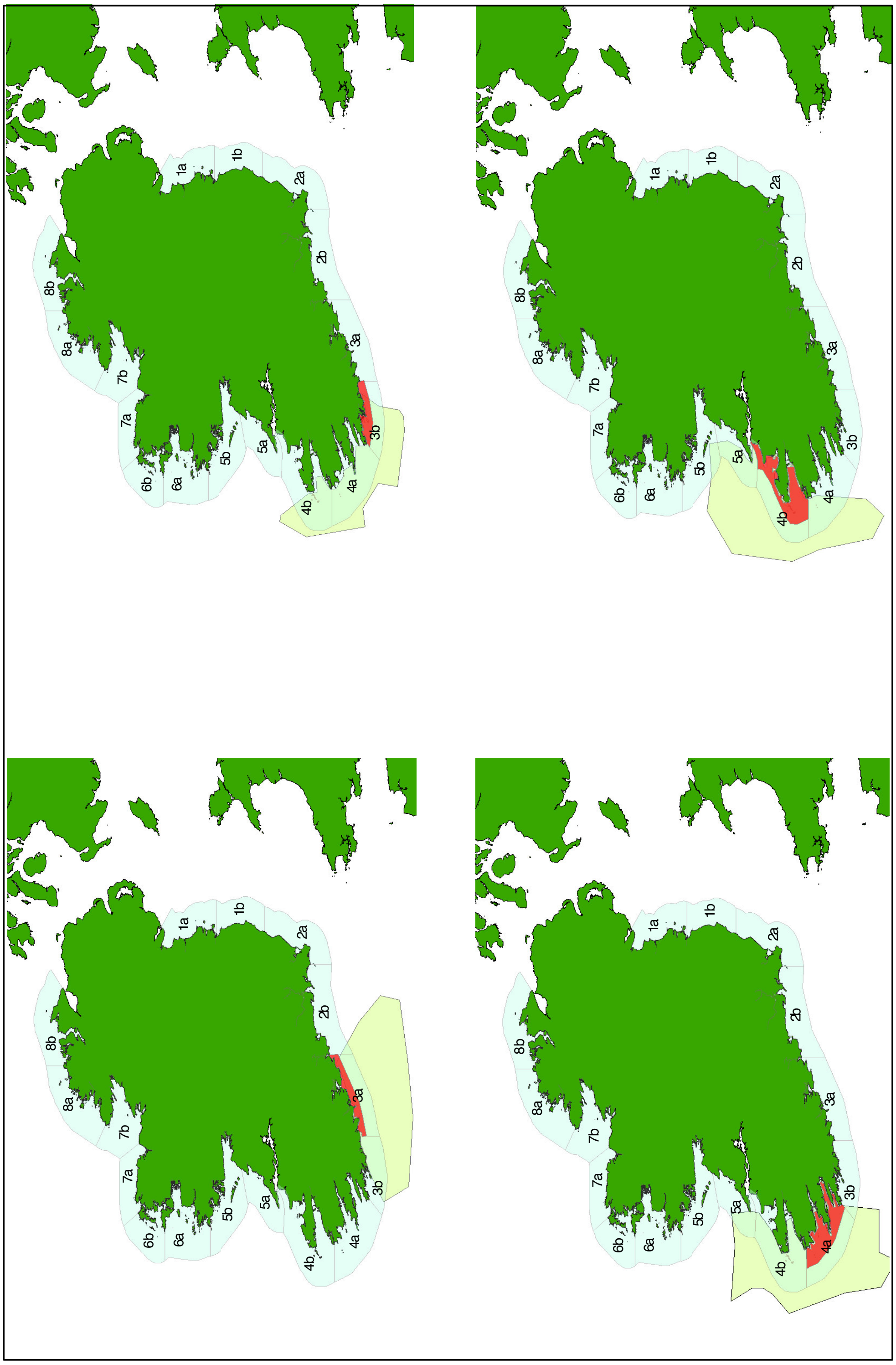

Figure 8. (continued)

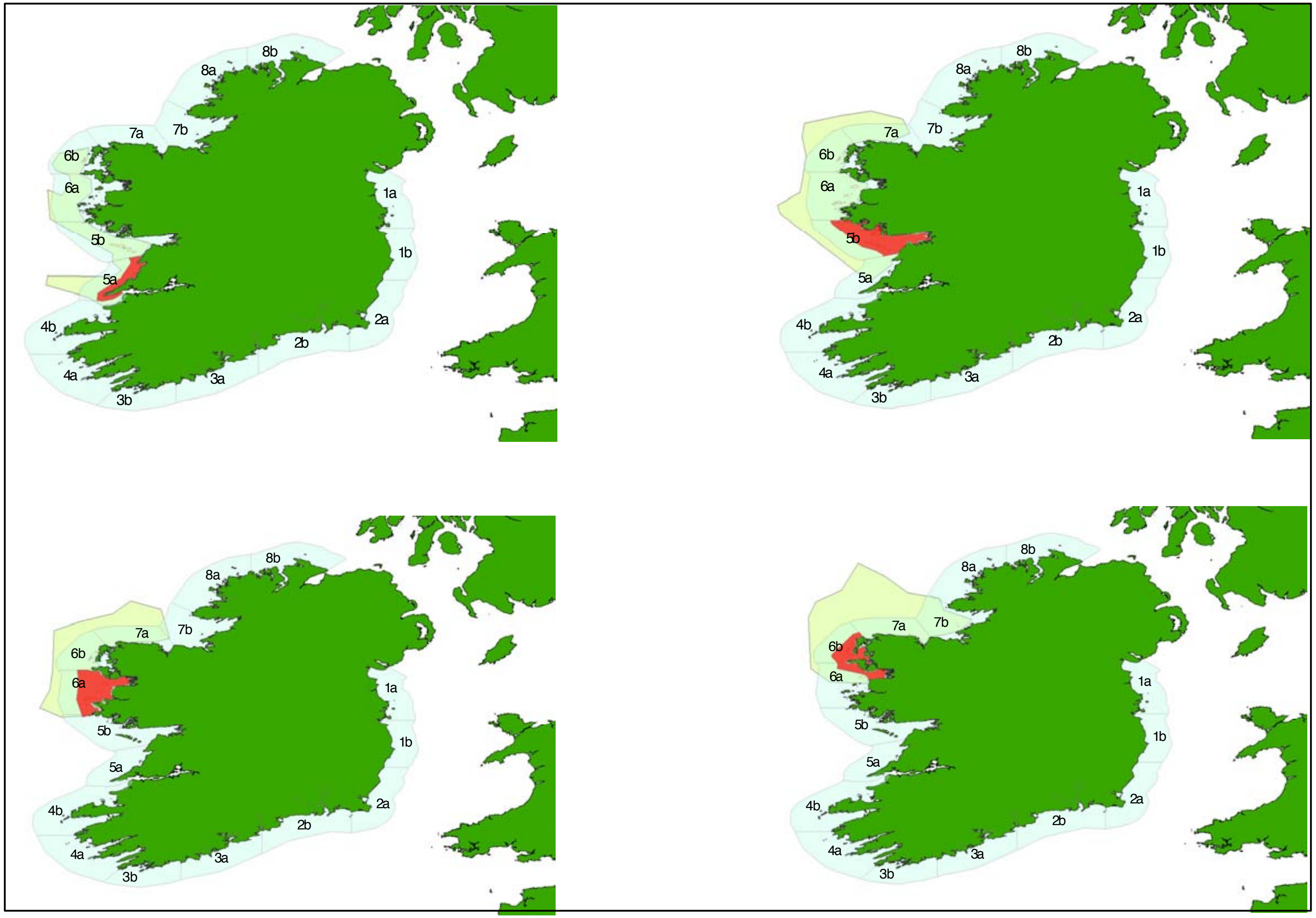

Figure 8. (continued)

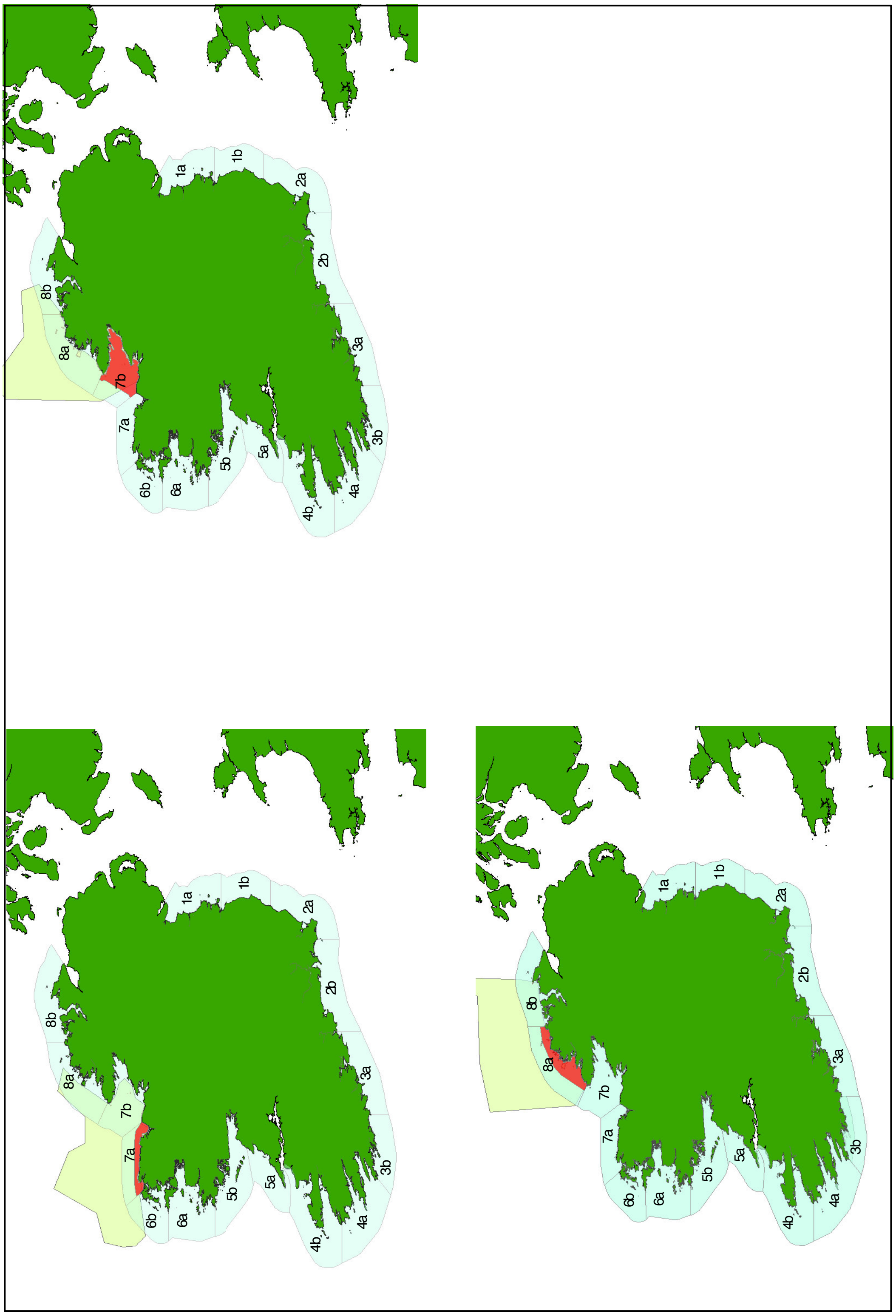

Figure 8. (continued)

7.5 *Catch Rate Indicators*

7.5.1 Data

Sources

Catch and effort data was obtained from various voluntary reference fleet schemes. Prior to 2002 data for Wexford and Kerry were compiled by Taighde Mara Teoranta and Trinity College Dublin respectively. Data for 2002-2006 are voluntary fishing activity records (FARs) submitted to BIM. Data for 2007 and 2008 are from sentinel vessels reference fleet programmes run by BIM. Data collected prior to 2002 did not distinguish between targeted catch rates of lobster and by-catch of lobster in the crab fishery. The pre and post 2002 data are not therefore directly comparable. Data are not available for all areas. Total effort is unknown.

Four nominal catch rate indicators are presented:

- LPUE: the number of legal sized (>87mm) lobsters landed for every 100 pots hauled.
- UPUE: the same index for lobsters <87mm. As approximately 50% of undersized lobsters caught in traps are within 1 moult of the 87mm size limit UPUE is an indicator of imminent recruitment to the fishery.
- VPUE: the catch rate of v-notched lobsters. This component of the stock is legally protected and is maintained by annual releases of v-notched lobsters through the national v-notch programme.
- CPUE: the number of all categories of lobsters caught in 100 traps hauled.

The indicators are presented as nominal values and have not been standardised. Previous General Linear Modelling of the data (Tully *et al.* 2006) indicated a strong vessel effect which was probably due to real variation in lobster abundance in the fishing ground of each vessel. Discontinuity in the vessels participating in the reference fleets and the limited number of vessels reporting makes meaningful standardisation of the catch rate indices difficult.

Precision and accuracy

Catch rate data for lobster are highly variable. Low accuracy or bias is potentially a significant problem because the data is from a small reference fleet only, which itself is not consistent over time. As there is significant variability in catch rate performance between vessels, due probably to local differences in ground type and stock abundance, the limited reference fleet may not be representative of the entire fleet at the scale of the proposed management units for instance. The data are accurate at 'local' scale for the geographic area fished by the reference fleets.

7.5.2 Clare 2002-2008

Monthly landings per unit effort (LPUE) during the period 2002-2008 peaked in 2004-2006 at approximately 33 lobsters for 100 pot hauls. The month of peak LPUE varied between years but usually occurred in the April-July period (Figure 9). Nominal annual average LPUE peaked during 2004-2006 (Figure 10).

Monthly catch rate of undersized lobster (UPUE) peaked in June 2005 at 66 lobsters per 100 pots. Peak catch rates usually occurred in June or July and declined during the season. Annual nominal UPUE peaked in 2005 at 54 but averaged approximately 20 during 2002-2003 and 2007-2008. The recruitment pulse of lobsters, which are mainly 1-3 moults below the minimum landing size, evident in the 2004-2006 data was not reflected in higher LPUE in 2007-2008.

The proportion of the catch that is undersized increased from 40% in 2002 to 60% in 2005 and declined to 37% in 2008.

Monthly patterns of catch of v-notch lobsters (VPUE) peaked in 2003-2004. Peak months varied across years. Monthly and annual nominal VPUE were stable between 2005-2008 suggesting that the v-notch release programme was maintaining the v-notched population and compensating for losses due to natural mortality and notch repair. The proportion of lobsters >87mm in the catch that were v-notched ranged from 50% in 2003 to between 18-24% in 2004-2008.

Monthly catch rates of all lobster categories combined (CPUE) peaked at 104 lobsters per 100 pots. CPUE usually peaked in June or July. Annual nominal CPUE increased from 38 in 2002 to 86 in 2005 but then declined annually to 46 by 2008.

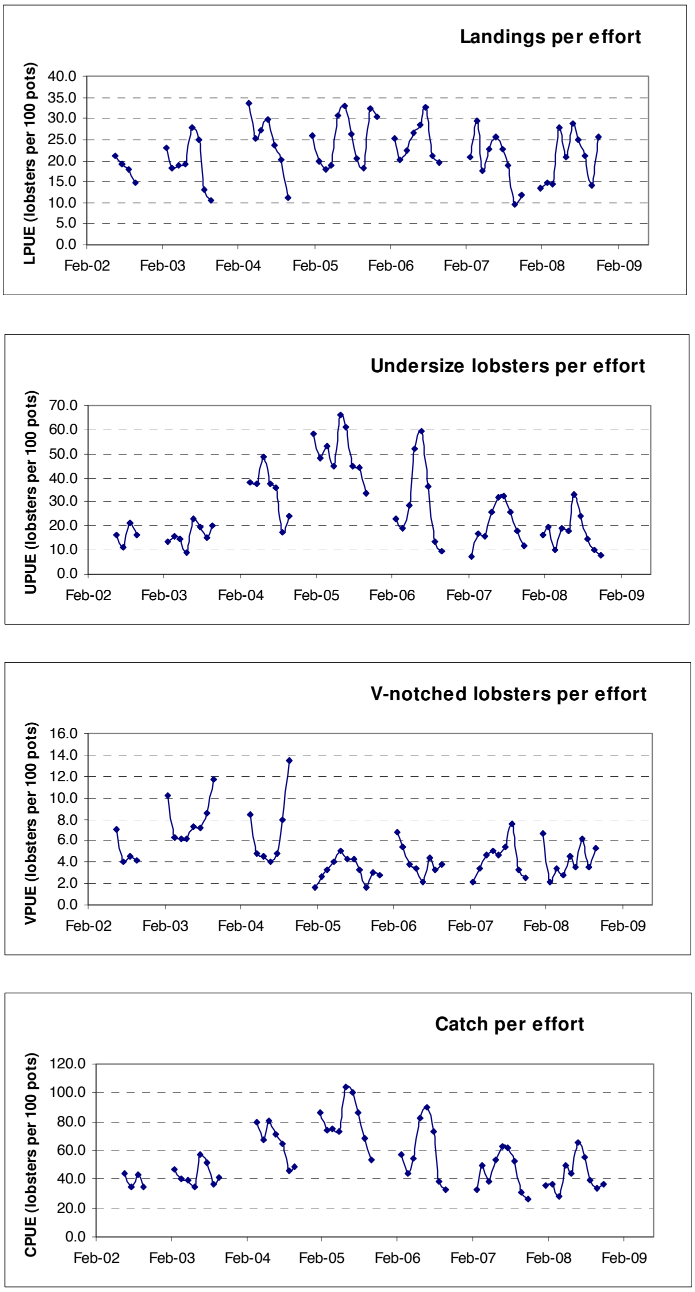

Figure 9. Monthly trends in the rate of catch of different components of the lobster population in the Clare lobster fishery (proposed management unit 5b).

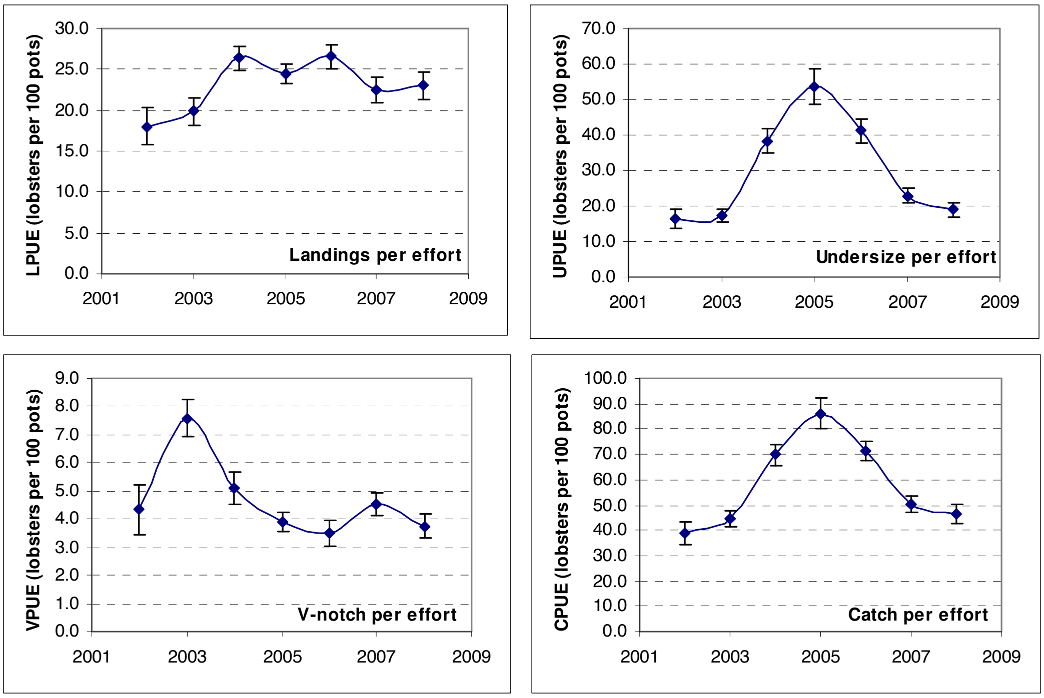

Figure 10. Nominal annual rate of catch of different components of the lobster population in the Clare lobster fishery. Vertical bars are 95% confidence limits.

Table 18. Nominal annual catch rates of lobster in the Clare fishery 2002-2008. N=number of vessel days reported, LPUE, UPUE, VPUE and CPUE =landings, undersize lobster, v-notch lobster and all lobster per 100 pot hauls respectively.

		LPUE		UPUE		VPUE		CPUE	
Year	**N**	**Mean**	**S.d.**	**Mean**	**S.d.**	**Mean**	**S.d.**	**Mean**	**S.d.**
2002	79	18.06	9.96	16.52	12.17	4.34	3.98	38.92	20.70
2003	176	19.92	11.15	17.25	11.66	7.59	4.43	44.63	22.30
2004	301	26.41	12.85	38.25	29.41	5.12	4.89	69.78	35.33
2005	361	24.49	11.95	53.76	47.78	3.89	3.39	86.22	57.04
2006	460	26.58	15.18	41.24	35.21	3.50	4.76	71.40	40.50
2007	273	22.56	13.22	22.90	16.71	4.54	3.35	50.36	27.08
2008	277	23.06	13.74	18.91	17.57	3.75	3.66	46.52	29.48

7.5.3 Kerry 1997-2008

Monthly LPUE usually peaked in June of each year although the peak monthly LPUE for the data series occurred in April 2007 at 24 lobsters per 100 pots (Figure 11). LPUE declined linearly during the season from the peak month. Nominal annual LPUE ranged between 8-12 lobsters per 100 pots during 1996-1999 and from 12-16 during 2002-2008. The earlier data includes lobster by-catch in gear targeting crab. Annual LPUE declined from 2002 to 2006 and was stable at approximately 13 during 2006-2008 (Table 19, Figure 12).

Monthly catch of undersized lobster usually peaked in June-July and declined linearly until October in each year to generally less than 1 lobster per 100 pots. There was an overall decline in annual nominal UPUE during the period 2002-2008, from 12 to 9 lobsters per 100 pots, with an outlying low of 6 in 2005.

The proportion of the catch that was undersized ranged from 26-53% in the period 1996-1999 and between 24-39% in the period 2002-2008.

Peak monthly catch rates of v-notched lobsters were unpredictable although there was a clear within year seasonal pattern. Annual VPUE ranged from 2 to 5 with the peak occurring in 2007.

The proportion of lobsters >87mm that were v-notched ranged from 17-37% in the period 1996-1999 and 17-41% in 2002-2008.

Monthly CPUE reflected the pattern in the legal, undersized and v-notch components of catch. The annual nominal CPUE declined from 2002-2005 and increased from 2005-2008.

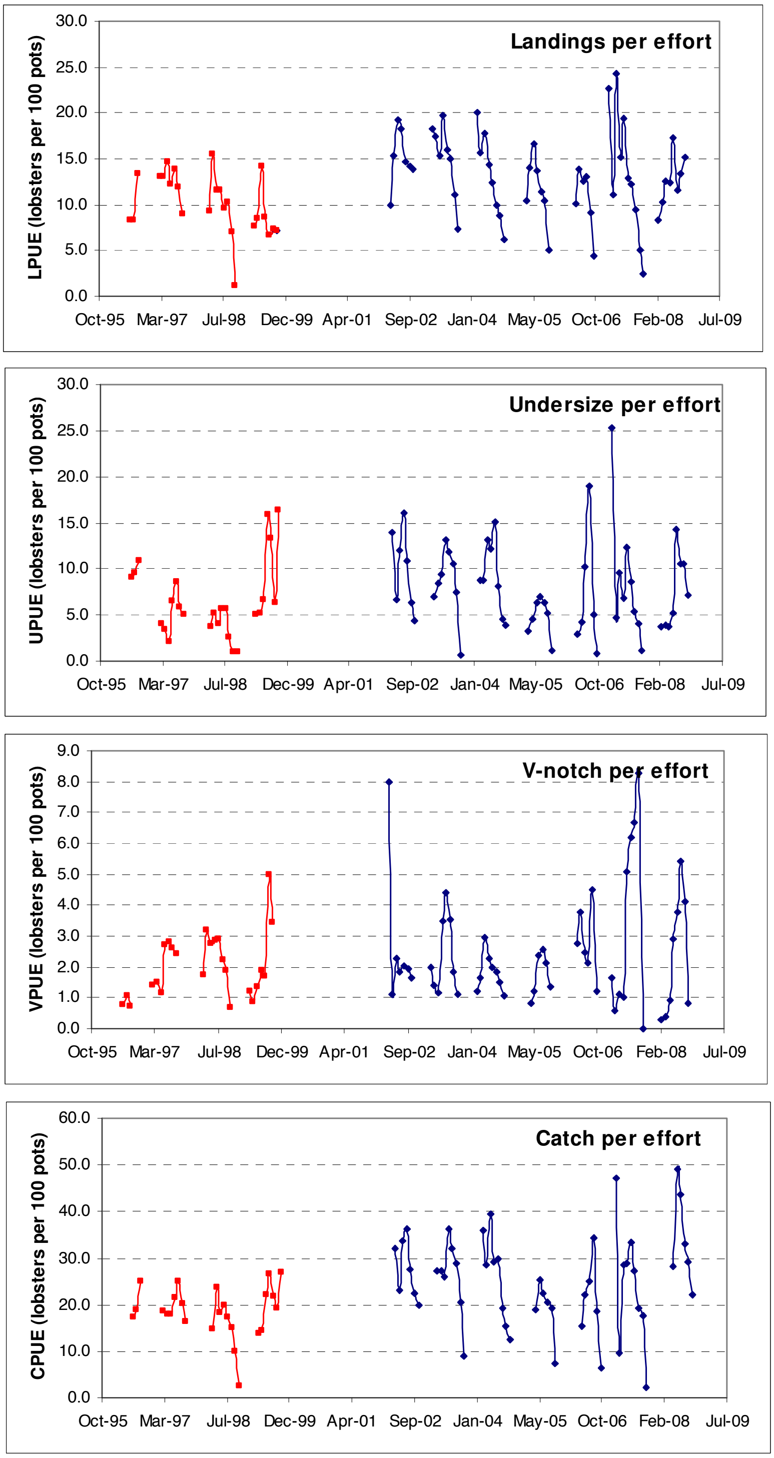

Figure 11. Monthly trends in the rate of catch of different components of the lobster population in the Kerry lobster fishery (proposed management unit 4). Data prior to and post 2002 are not directly comparable.

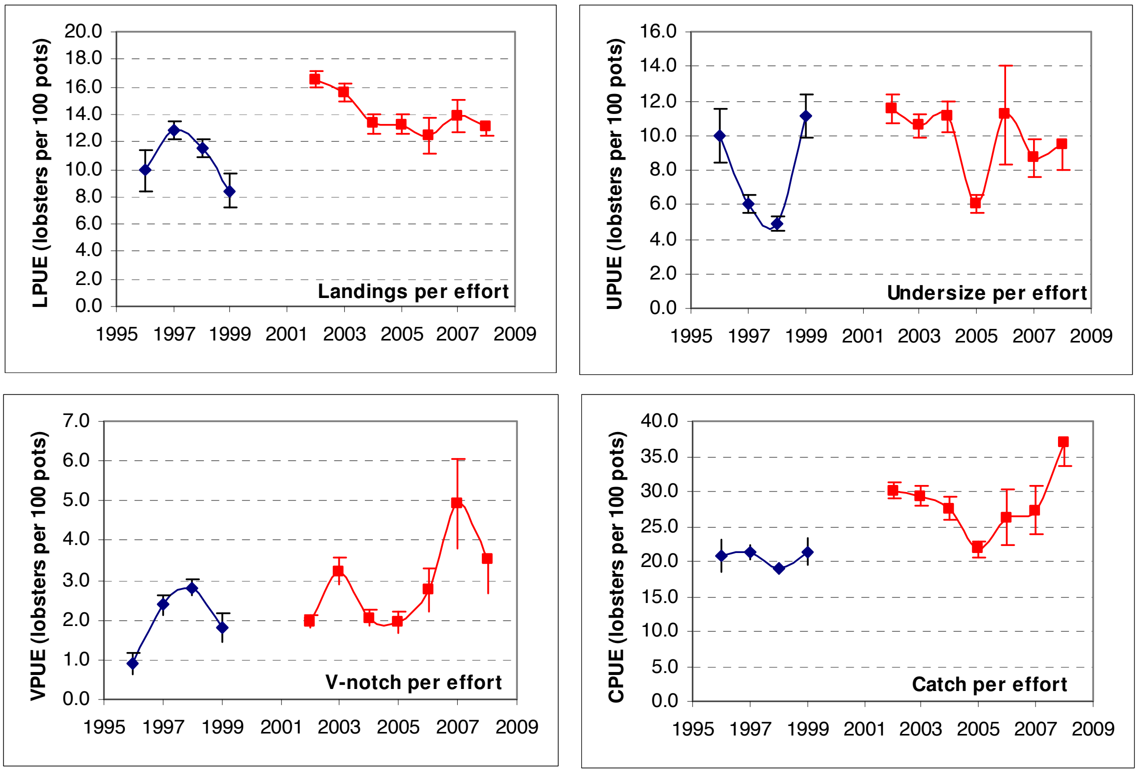

Figure 12. Nominal annual rate of catch of different components of the lobster population in the Kerry lobster fishery. Vertical bars are 95% confidence limits. Data prior to and post 2002 are not directly comparable.

Table 19. Nominal annual catch rates of lobster in the Kerry fishery 1996-2008. N=number of vessel days reported, LPUE, UPUE, VPUE and CPUE =landings, undersize lobster, v-notch lobster and all lobster per 100 pot hauls respectively.

	LPUE			UPUE			VPUE			CPUE		
Year	**N**	**Mean**	**S.d.**	**N**	**Mean**	**S.d.**	**N**	**Mean**	**S.d.**	**N**	**Mean**	**S.d.**
1996	130	9.93	8.52	133	9.96	8.78	133	0.90	1.47	130	20.77	13.34
1997	350	12.82	6.00	350	6.01	4.96	350	2.37	2.15	350	21.21	9.58
1998	478	11.48	6.87	490	4.87	4.17	490	2.81	2.19	478	18.95	9.07
1999	101	8.40	6.05	102	11.13	6.21	102	1.80	1.87	101	21.38	9.35
2000												
2001												
2002	643	16.52	7.98	643	11.57	10.47	643	1.95	1.96	643	30.04	14.62
2003	796	15.60	9.42	795	10.56	9.92	794	3.23	4.81	794	29.30	19.27
2004	631	13.29	8.84	470	11.09	9.59	543	2.04	2.40	409	27.46	17.05
2005	446	13.26	7.65	430	5.98	5.26	392	1.94	2.46	382	21.73	11.58
2006	154	12.44	7.95	118	11.21	15.47	154	2.75	3.29	118	26.26	20.92
2007	314	13.87	10.84	228	8.73	8.21	106	4.93	5.86	106	27.29	18.04
2008	403	13.09	7.34	202	9.42	9.84	157	3.51	5.37	93	36.80	15.99

7.5.4 Waterford-Wexford

Monthly LPUE usually peaked in June in Waterford-Wexford (Figure 13). Catch rate did not generally decline during the season. The monthly series between April 1995 and November 2006 was stable. The 2008 data showed substantially higher LPUE especially early in the season. Annual nominal LPUE declined between 1999 and 2001 and between 2002 and 2005 (Figure 14).

Monthly UPUE increased in the period 1995-1999 and also in the later data series 2002-2008. The annual mean UPUE increased from 1997-1999 and then declined until 2001. The pattern of decline continued in the post 2002 data series until 2004.

The proportion of the catch that was undersized increased from 35% in 1995 to 50% in 2000 and ranged between 47-54% in the period 2001-2008.

Monthly VPUE increased from April 1995 to Oct 1998 and then declined. Peak VPUE usually occurred during Aug-Oct. In the post 2002 series seasonal peaks were erratic. Annual VPUE increased from 1995 to 1998 and was relatively stable in the 2002-2006 period. VPUE was significantly higher in 2008 than in any previous year.

The proportion of lobsters >87mm that were v-notched increased from 3% in 1995 to 20% in 1999 and ranged between 10-23% in the period 2000-2008.

Monthly CPUE usually peaked in June-July. Seasonal patterns in the data varied across years. Annual nominal CPUE increased from 1995-1999 and declined to 2001. The decline continued in the post 2001 data series until 2006. CPUE was significantly higher in 2008 than in any previous year.

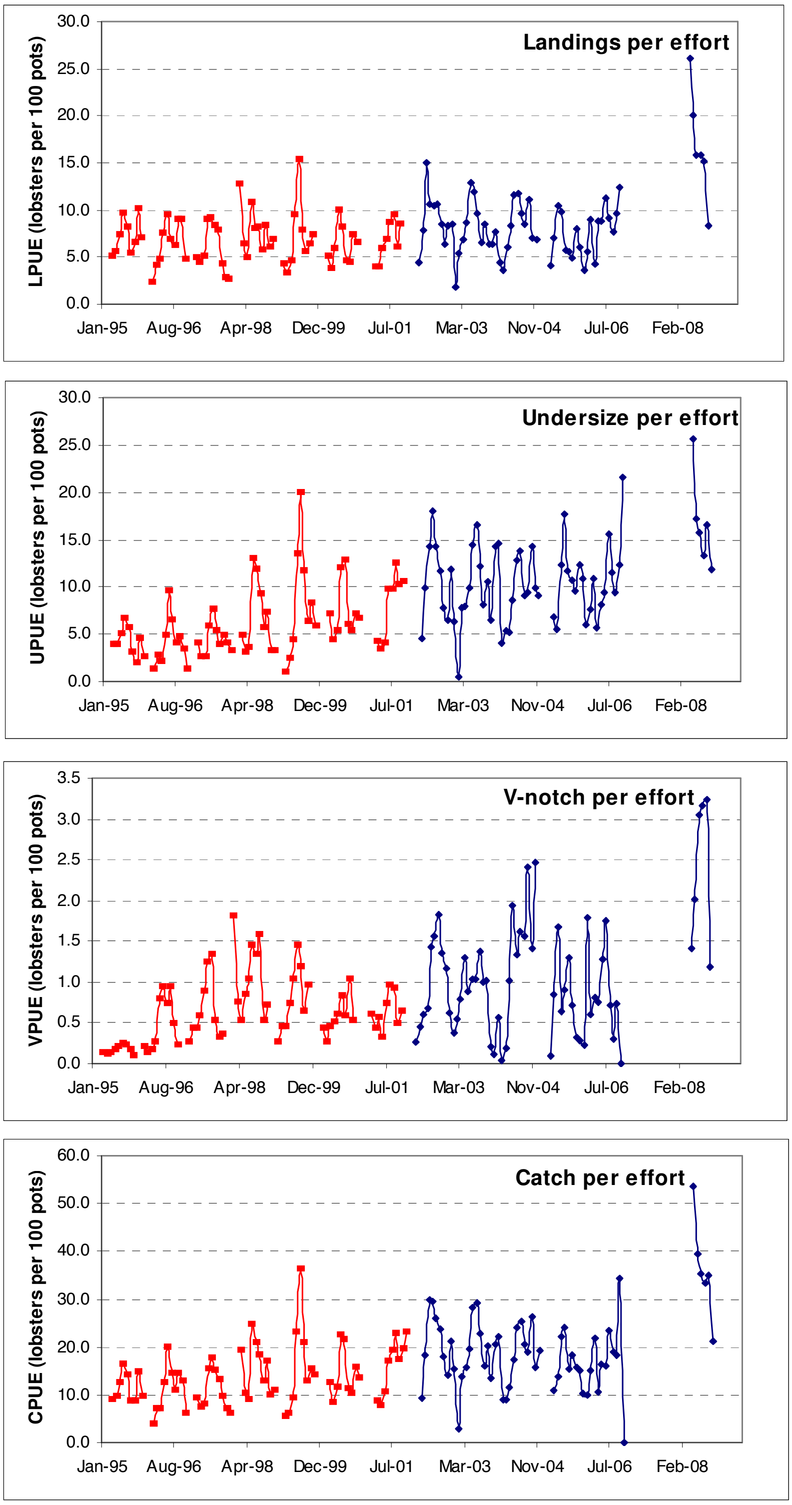

Figure 13. Monthly trends in the rate of catch of different components of the lobster population in the Waterford-Wexford lobster fishery (proposed management unit 2). Data pre and post 2002 are not directly comparable.

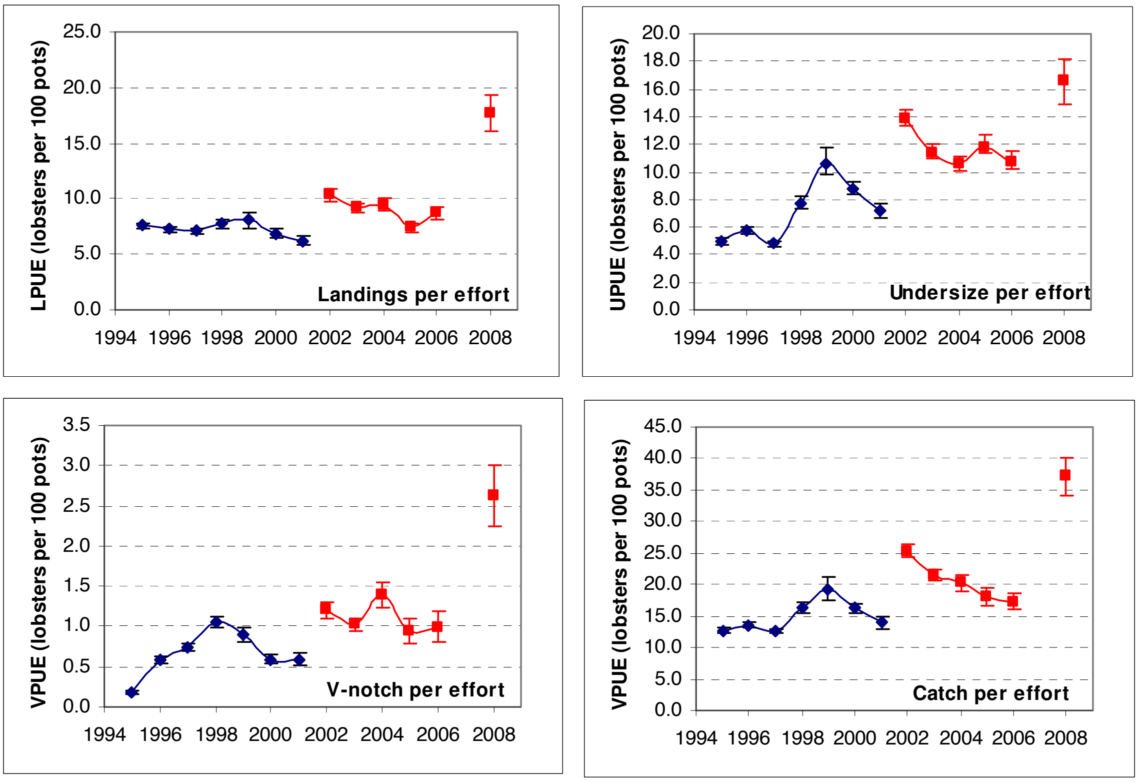

Figure 14. Nominal annual rate of catch of different components of the lobster population in the Waterford-Wexford lobster fishery. Vertical bars are 95% confidence limits. Data pre and post 2002 are not directly comparable.

Table 20. Nominal annual catch rates of lobster in the Waterford-Wexford fishery 1995-2008. N=number of vessel days reported, LPUE, UPUE, VPUE and CPUE =landings, undersize lobster, v-notch lobster and all lobster per 100 pot hauls respectively

	LPUE			UPUE			VPUE			CPUE		
Year	N	Mean	S.d.	N	Mean	S.d.	N	Mean	S.d.	N	Mean	S.d.
1995	1928	7.57	5.17	1930	4.95	4.95	1930	0.18	0.41	1926	12.70	8.44
1996	1985	7.23	5.30	1984	5.70	5.90	1984	0.58	1.02	1983	13.51	9.60
1997	1536	7.06	4.65	1537	4.79	4.48	1537	0.75	0.96	1536	12.60	8.00
1998	1042	7.75	5.92	1061	7.71	9.11	1061	1.05	1.21	1042	16.40	12.76
1999	577	8.06	9.27	590	10.55	15.27	590	0.89	1.09	577	19.32	22.33
2000	662	6.86	4.63	662	8.75	7.08	662	0.59	0.68	662	16.20	10.10
2001	402	6.24	4.24	401	7.14	5.96	401	0.59	0.72	401	13.99	9.51
2002	1368	10.31	9.67	1368	13.81	11.91	1368	1.20	1.78	1368	25.33	17.59
2003	1291	9.19	7.98	1287	11.44	10.09	1259	1.03	1.32	1256	21.53	14.70
2004	650	9.44	7.09	640	10.58	7.18	419	1.39	1.52	414	20.23	12.06
2005	503	7.45	4.42	501	11.79	10.58	354	0.95	1.47	352	18.06	14.65
2006	310	8.72	4.77	309	10.72	7.34	203	1.00	1.29	203	17.26	9.57
2007	0											
2008	157	17.68	9.97	157	16.56	9.81	145	2.62	2.27	145	37.23	18.10

7.6 Egg production per recruit

Spawning potential in lobster stocks is protected by the minimum landing size (87mm) and the v-notch regulation which prohibits the landing of v-notched lobsters. The number of lobsters v-notched is not regulated and depends on participation in the voluntary national v-notch programme. Fishing mortality (F) is not controlled by either catch or effort limitation.

Assessment of the relative benefits of different conservation measures on egg production per recruit was assessed using an individual based model developed for the Irish fishery (Bell 2007) following estimation of F by Length Cohort Analysis (LCA).

Egg production per recruit (EPR) declines monotonically with increasing relative fishing effort (Figure 15). At current F (relative fishing effort = 1) EPR is below the limit reference point of 10% for relative egg production ($R_{E/R}$) which is the current egg production relative to what it would be in an unfished stock. A 30% reduction in F is required to achieve $R_{(E/R)}$ of 10% with MLS of 87mm if the v-notching rate was zero.

7.6.1 Contribution of v-notching to egg production per recruit

The contribution of v-notching to spawning potential depends on a range of biological and fishery parameters including fishing mortality or fishing effort, the proportion of the catch that is v-notched, the number of moults the v-notch is visible and lobster growth rate.

V-notch releases

The numbers of v-notched lobsters released annually varied from 9581 in 2007 to 13761 in 2002. Total releases in the period 2002-2008 were 78593. An unknown but small proportion of these releases were male (Table 21).

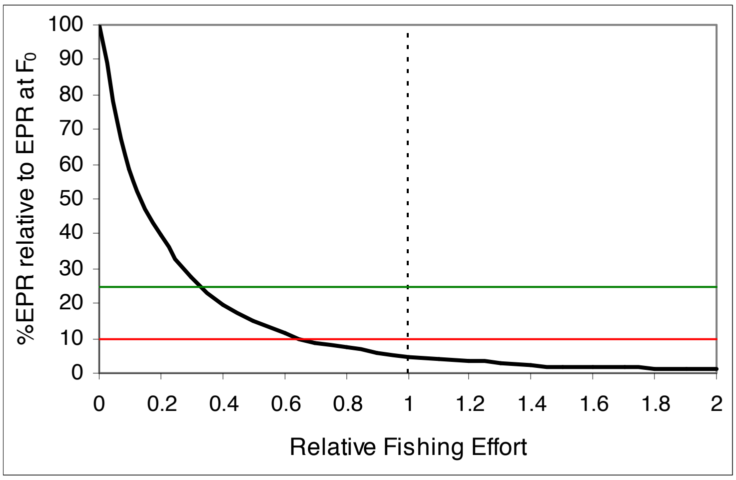

Figure 15. Relative egg production in relation to relative (to current) fishing effort in the Irish lobster fishery. Current position (1) is based on length cohort analysis of the size composition of the landings in 2005. The red and green lines are the 10% 25% limit and target reference point respectively.

Table 21. Annual releases of v-notched lobsters 2002-2008 by county.

County	2002	2003	2004	2005	2006	2007	2008	Total
Clare	1900	1539	1804	1929	2088	2079	2508	13847
Cork	2560	1141	1524	723	909	1358	1240	9455
Donegal	1861	1500	1624	1615	1671	1500	758	10529
Galway	2079	850	1153	505	1631	1730	1565	9513
Kerry	1923	2176	1892	1828	998	1449	1812	12078
Mayo	1274	1103	1002	965	528	691	2381	7944
Sligo	426	859	1067	984	470		124	3930
Waterford	1449	1007	1150	799	879	1125	1182	7591
Wexford	289	60	812	765	407	202	668	3203
East Coast							503	503
Annual total	**13761**	**10235**	**12028**	**10113**	**9581**	**10134**	**12741**	**78593**

The v-notching rate

The significance and contribution of v-notched lobsters to EPR is determined primarily by the v-notching rate or the proportion of the legal sized catch that is v-notched and released each year.

The average v-notch rate over the period 2004-2008 was 8.8%. However, there are a number of outliers in the data (figures in bold, Table 22) which in itself suggests that the landings are significantly underestimated in these instances. Exclusion of the outliers suggests an average v-notch rate of 1.7% per annum nationally ranging from 1.0% in 2006 and 2.6% in 2008.

Contribution of v-notched lobsters to EPR

V-notching at a rate of 2.5% of the legal sized catch results in a marginal increase in EPR in absolute terms. At current effort levels $R_{(E/R)}$ increases from 4.7% to 5.6% and increases to 8.6% at a v-notch rate of 10% (Figure 16). In relative terms however the gain from v-notching at 2.5% at current effort levels is 15% and at a v-notching rate of 10% is 79%. $R_{(E/R)}$ gains from v-notching increase as fishing mortality on the remaining stock increases (Figure 17). Although v-notching, at rates that have been used between 2002-2008, has not increased $R_{(E/R)}$ above the 10% limit reference point it has been a significant safety net for spawning potential in the lobster fishery in which neither effort or total catch is regulated.

Relative benefits to EPR of changes in MLS, v-notching and maximum landing sizes

The draft lobster management plan, developed by the Lobster Advisory Group, proposes to introduce a maximum landing size of 127mm carapace length in addition to continuation of the v-notch programme. Other options for changes in technical measures, being considered in UK and French lobster fisheries, which share a common market with Irish lobster exports, includes an increase in the MLS to 90mm or higher.

Increasing MLS from 87mm to 90mm results in an increase in $R_{(E/R)}$ from 4.7% to 5.7% at current effort. The $R_{(E/R)}$ gain factor at current effort is 1.21 (Figure 19). A maximum size of 127mm and minimum size of 87mm and no notching would result in an increase in $R_{(E/R)}$ from 4.7% to 8.4% or an EPR gain factor of 1.7 at current effort levels. The EPR gain factor due to the MaxLS, however, decreases at higher levels of effort as fewer lobsters reach the maximum size. Combining the MaxLS with v-notching at a rate of 2.5%, between sizes of 87-127mm, results in further gains in $R_{(E/R)}$, at current effort, from 4.7% to 9.9% and an EPR gain factor of 2.1. The benefit of this combination of conservation measures is especially significant at higher levels of fishing effort as the number of lobsters reaching the MaxLS is increased due to the protection afforded by the v-notch (Figure 19).

Table 22. Percentage of legal catch v-notched and released by year and county 2004-2008. High values (bold) are due to under estimation of landings

County	2004	2005	2006	2007	2008
Clare	1.2	1.7	1.5	**18.5**	1.5
Cork	0.7	1.0	1.0	1.6	**9.7**
Donegal	1.3	1.0	0.7	1.3	0.5
Galway	0.4	0.2	0.8	**7.7**	0.7
Kerry	0.7	2.5	1.2	2.9	6.3
Mayo	0.6	0.6	0.4	0.8	2.7
Sligo	3.2	3.2	1.1	0.0	0.4
Waterford	6.1	4.5	**67.9**	**157.8**	**57.0**
Wexford	1.1	1.3	**10.2**	2.3	6.0
Average	1.7	1.8	9.4	21.4	9.4

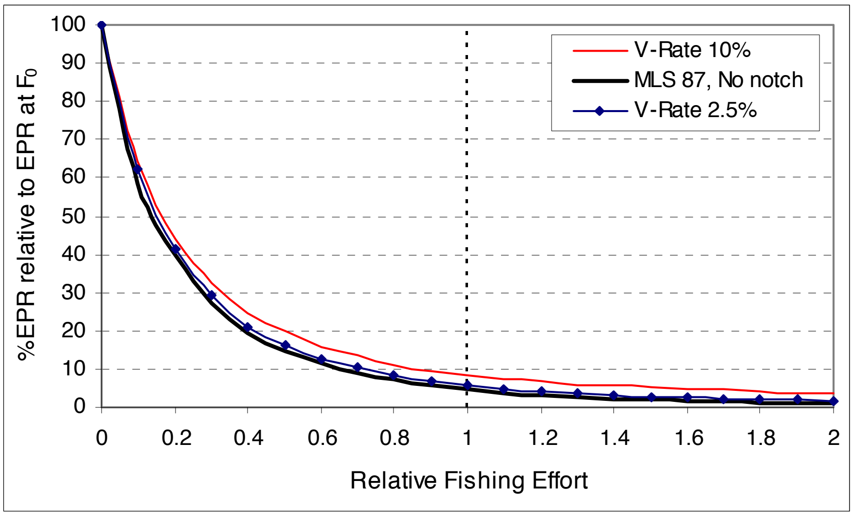

Figure 16. $R_{(E/R)}$ in relation to relative (to current) fishing effort with no notching, and v-notching rates of 2.5% and 10%.

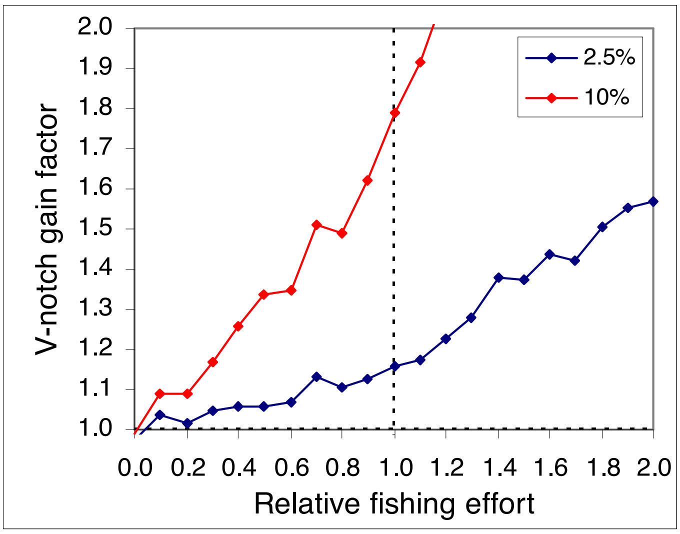

Figure 17. Gains in $R_{(E/R)}$ in relation to v-notch rate and relative (to current) fishing effort.

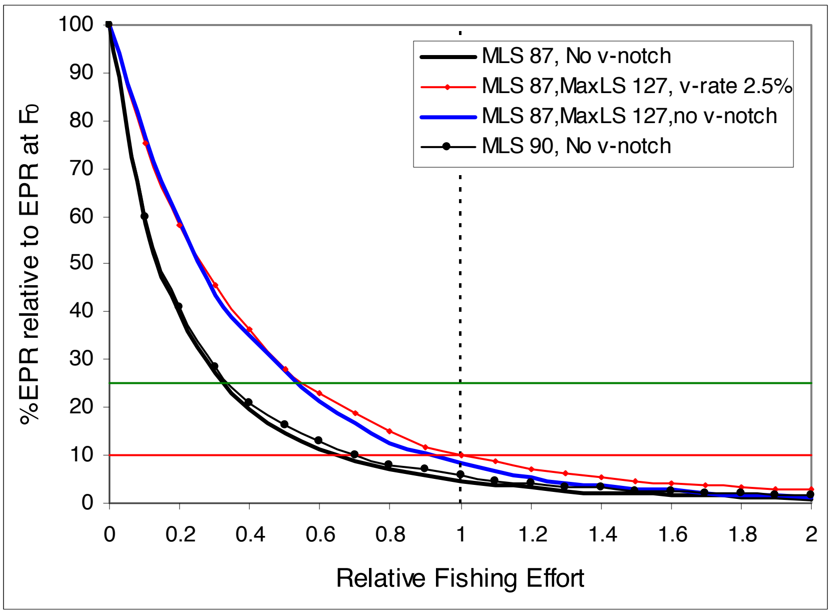

Figure 18. Relative egg per recruit in relation to relative (to current) fishing effort and different combinations of technical conservation measures in the lobster fishery. MLS=minimum size, MaxLS= maximum size.

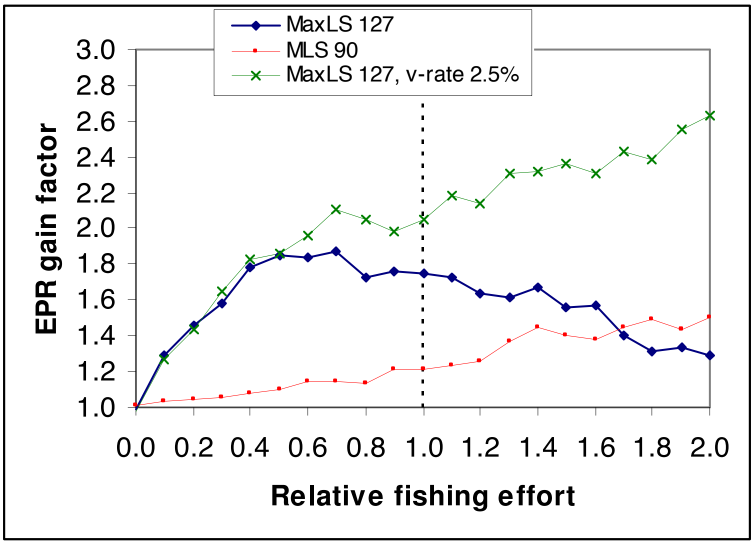

Figure 19. Gains in relative egg production, relative to $R_{(E/R)}$ at MLS of 87mm, resulting from changes in conservation measures. MLS=minimum size, MaxLS= maximum size.

7.7 EPR assessment summary

The egg per recruit model assesses the relative merits of different conservation measures, including changes in F on egg production per recruit. There is considerable uncertainty with respect to the current F as this is estimated from a length based cohort analysis using generally poor growth information, equilibrium assumptions and unknown natural mortality. Nevertheless for any reasonable value of F the relative merits of different conservation measures can be quantified.

The EPR gains due to each technical measure are also differentially sensitive to the biological parameters in the model. Gains from increases in MLS are sensitive in particular to the maturity ogive as the size at which the slope of the ogive is steepest generally corresponds to the various MLS options being considered. The gains due to MaxLS are insensitive to the maturity ogive (all lobsters are mature at 125mm) but are sensitive to the size fecundity relationship and the spawning frequency at large body size. Gains in v-notching depend on the proportion of the catch that is notched, primarily, but also on the moult frequency and the number of moults required to fully repair the v-notch, here assumed to be 3. An accurate estimate of moult frequency in particular is therefore important.

The EPR assessment shows that it is difficult to achieve target $R_{(E/R)}$ of 25% using technical conservation measures alone without adjusting F for the exploited portion of the stock. Also gains brought about due to technical measures can be eroded by increases in F which in turn reduces the options for and benefits of the technical measures. Reduction in F of approximately 10% and parallel introduction of a maximum landing size (i.e. climb back up the EPR curve) would increase $R_{(E/R)}$ above the 10% limit reference point. This could also be achieved by v-notching at a rate of 2.5% of landings and a maximum size of 127mm with no reduction in F.

7.8 Profitability in 2008

7.8.1 Data sources

First sale price was obtained from sales note data for ports in each area (Table 23). Average weight of lobsters per month, aggregated across areas, was obtained from port sampling data (Table 24). LPUE is as reported above. Gross profit from lobster landings per unit of effort is:

Monthly (M) Gross Profit per pot lift =

$$\frac{LPUE_M}{100} \times €.kg_M \times averageweight_M$$

where LPUE is the landing per 100 pot hauls and M is the month. Earnings from by-catch, in the same gear units, are not included.

Geographic variation in profitability is mainly due to differences in catch rate. Geographic variation in lobster size and prices is, by comparison, insignificant. Profitability is higher in Clare than in Kerry or the south east and ranges from between €1-2 per pot haul. The cost earnings ratio, excluding wage costs, is assumed to be similar in all areas. Net profit per pot haul was €0.86 in Clare and approximately €0.60 in Kerry and the south east in 2008 (Table 25).

Table 23. Monthly first sale price of lobster in 3 coastal areas in 2008.

Month (2008)	Kerry	Clare	Waterford_Wexford
February			€20.50
March	€21.57		€21.17
April	€18.07	€18.33	€19.41
May	€12.89	€11.91	€14.18
June	€10.95	€10.90	€11.13
July	€12.85	€12.58	€12.63
August	€12.28	€12.07	€11.58
September	€12.85	€12.91	€12.73
October	€13.02	€13.11	€13.01
November	€23.49	€14.17	€14.84
December	€23.00		€19.05
Average	**€16.10**	**€13.25**	**€15.48**

Table 24. Average length and derived weight of lobsters in the landings by month for the period 2004-2007.

Month	Length	Wt (kgs)
May	96.41	0.63
June	95.00	0.60
July	94.09	0.59
August	95.98	0.62
September	97.38	0.65
October	98.45	0.67
Average	95.59	0.61

Table 25. Monthly gross profit per unit effort in the lobster fishery in 3 coastal areas. Average net profit per unit of effort is calculated from the average gross profit and a cost: earnings ratio of 0.52 (Table 14).

Month (2008)	Clare	Kerry	Waterford-Wexford
January			
February	€1.67	€1.05	
March	€1.92	€1.35	
April	€1.63	€1.39	
May	€2.08	€0.98	
June	€1.36	€1.16	€1.77
July	€2.13	€0.91	€1.56
August	€1.87	€1.00	€1.12
September	€1.77	€1.19	€1.24
October	€1.22	€2.13	€1.21
November	€2.21		€0.75
December			
Average gross profit per effort unit	**€1.79**	**€1.24**	**€1.28**
Average net profit per effort unit	**€0.86**	**€0.59**	**€0.61**

8 Brown Crab

8.1 Management recommendations

The current kilowatt days effort management regime in Area VI and VII is inadequate and has not stabilised effective effort.

STECF previously proposed that effective control of effort could be achieved by limiting the number of pots and the number of pots hauled in the fishery if applied to all vessels rather than to vessels over 15m or over 10m only. As annual LPUE is highly correlated with annual effort, control of effort should lead to lower costs, increase in LPUE and higher profitability in the fishery.

The Crab Advisory Group and the North West Local Advisory Committee have recommended that access to the fishery be managed in order to establish conditions under which effort or catch control could be introduced and that this would apply to all fleets fishing the stock. The Advisory Group also considers that catch control would stimulate market price. It should also lead to higher stock biomass, higher LPUE, lower costs and higher profitability.

FSS agrees with the STECF and Advisory Group recommendations and that the following management measures are introduced in sequence

1. **Access to the fishery be managed through a restrictive licencing regime in each of the 4 crab management units. Ideally this would apply to all fleets fishing the stock. However, as crab stocks in the eastern Celtic Sea and south west coast are fished almost solely by Irish vessels unilateral management of access in the Irish fleet would result in significant benefits for those stocks. Overlap between Irish and Northern Irish fleets is significant off Malin Head and in the north west Irish Sea.**
2. **Management plans including effort and/or catch control measures should be developed for each management unit.**
3. **Monitoring of biological and economic indicators should be scaled up to inform pre-agreed management response points in the management plan.**

8.2 Summary

The stock structure of edible crab is determined by adult migration and larval dispersal, is regional rather than local in scale and for management purposes can be divided into 4 stocks; north west and Malin Shelf, south west coast, south east Celtic Sea and north west Irish Sea.

Landings per unit effort (LPUE) in the NW offshore fishery declined during the early 1990s and again in 2001. Recent data north of 58°N shows a further decline. The offshore fleet fishes on the Malin Shelf out to 200m depth, north of Scotland and in the south east North Sea.

LPUE in the north west <13m fleet was stable between 2002-2008 but LPUE declined linearly in the south west during the same period.

Gross profit per unit effort is determined by monthly crab price and monthly catch rate and is higher in the south west than in the north west because of very low discarding rates. The cost: earnings ratio, excluding wage costs, in the <13m fleet is 0.52.

8.3 Stock structure in waters around Ireland

Stock structure of 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 (Figure 20). On the basis of tag return data and the distribution of fishing and landings four stocks may exist.

The Malin Shelf stock is the largest in extent. Tag return data shows extensive return migrations from north Donegal to Mayo and between inshore coastal waters northwest to the 200m depth contour (Tully *et al.* 2006). These data also shows some connection between west of Mayo and the Clare coast. The northern boundary is unknown but fishing activity and landings are low in offshore waters between 56-57°N.

The south west stock occurs mainly in inshore waters out to the 12nm limit. Surveys in 2006-2007 between 6-20nm 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 no significant fishery in the southern Irish Sea. There is a limited inshore offshore migration and a westward migration of female crab from the Wexford coast (Fahy et al. 2004). Although migration from the Irish south coast may extend as far south as the Scilly Isles fishing effort and probably crab abundance in offshore waters in the Celtic Sea is low.

Landings in the western Irish Sea have increased recently 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 the area.

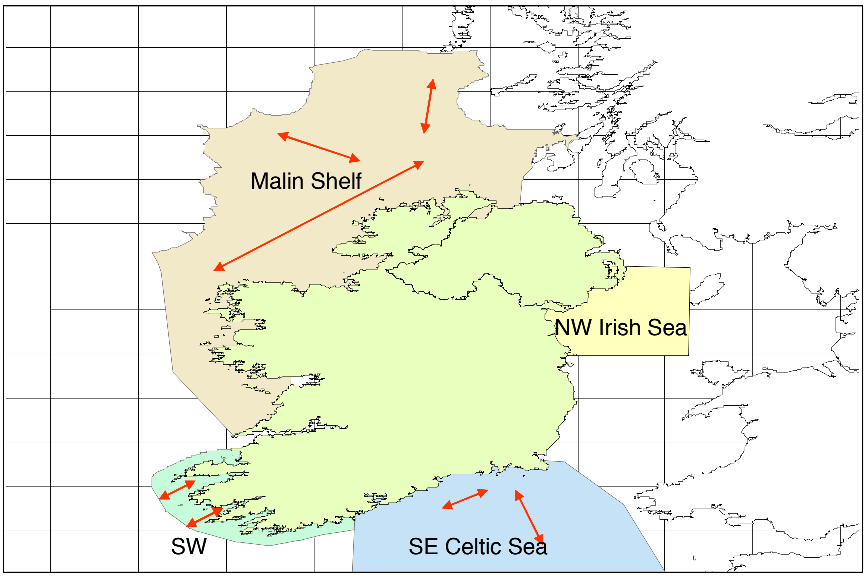

Figure 20. Management units for edible crab in waters around Ireland. Arrows indicate the general scale and direction of migration of adult crab where known.

8.4 Landings by ICES rectangle

8.4.1 Ireland 2004-2008

Irish vessels fish for crab in ICES Area IV, VI and VII. The majority of landings originate from Sub-Area VIa south of 56°N (Figure 21) although the proportion of annual landings originating from VIa declined from 90% in 2004 to 60% in 2007. There was no change in the spatial pattern of landings within VIa during the period 2004-2008 except for an increase in landings north of 58°N (north of Scotland) in 2006 and 2008 in particular. Landings are relatively small in Area VII by comparison. Area VIIb and VIIj accounted for approximately 20% of national landings in 2007 (Figure 22). Landings from Area IVb increased in 2007 and 2008 in particular and accounted for 16-17% of total landings.

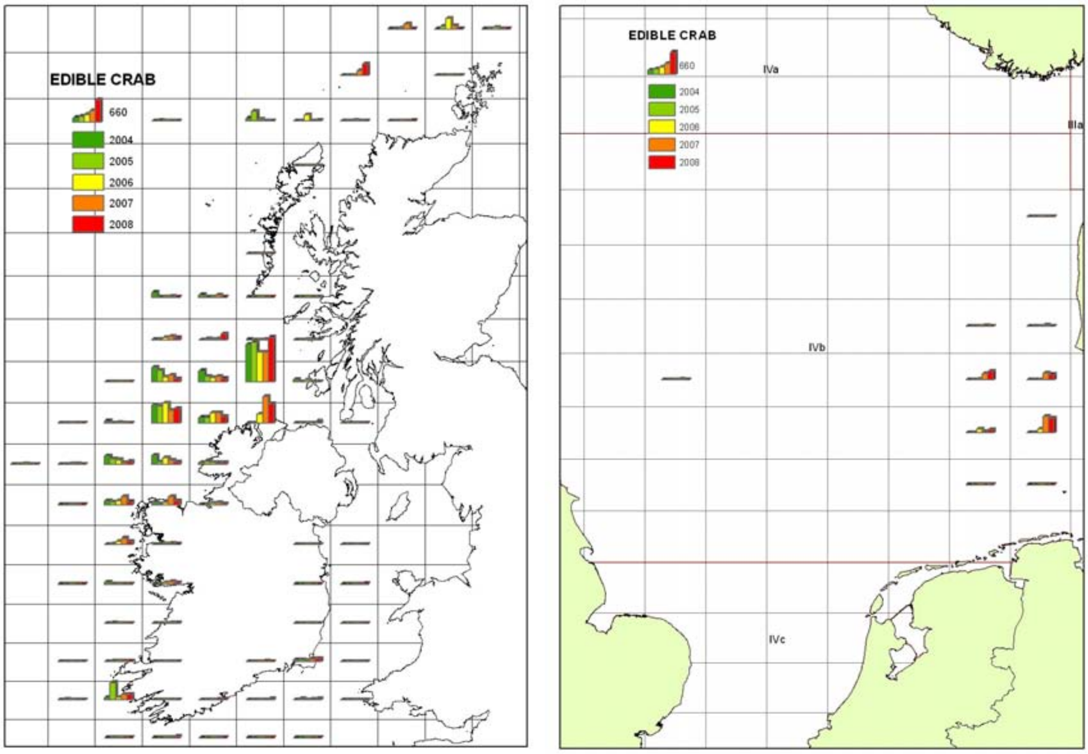

Figure 21. Origin of landings into Irish ports of brown crab, by ICES rectangles, by vessels of all jurisdictions, from 2004-2008.

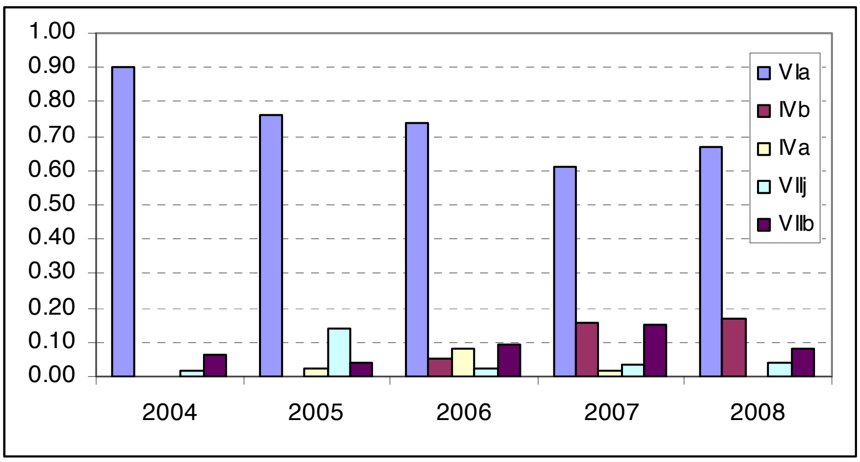

Figure 22. Annual proportion of brown crab landed from each ICES sub-division by vessels all jurisdictions landing into Irish ports.

8.4.2 Overlap of Irish, Northern Irish and Scottish fleets

The Irish and Scottish crab fleets overlap only on the north coast of Scotland (Figure 23). Landings by the Irish fleet north of Scotland are low compared to landings on the Malin Shelf and have generally occurred in 1-2 ICES rectangles, only, in any year since 2004 (Figure 21). The Irish and northern Irish fleets overlap off north Donegal in the Malin fishery. Landings of the Northern Ireland fleet are concentrated in this area and more recently in the North West Irish Sea.

8.5 *Catch Rate Indicators*

8.5.1 Data

Sources

Data on landings per unit effort (LPUE) are sourced from private diaries of the offshore vivier vessels. This series extends from 1990, when the vivier fleet was first established, to 2008. Data for the <13m fleet originates from private diaries and reference fleet programmes. Data series for the <13m fleet for the period 2000-2008 exist for the south west (VIIj) and northwest (VIa).

Precision and accuracy

The offshore data series is a significant data set capturing up to 60% of all fishing activity by the Irish offshore fleet in any year and typically represents the landings from up to 1 million pot hauls per year. The diary records are aggregated to the landings per day for gear with similar soak times for the average fishing position on that day. As the majority of fishing activity and its distribution is captured in the index in most years the data are thought to be an unbiased indicator of LPUE. The LPUE is reported in nominal values. Previous standardisation for changes in catchability using GLM did not significantly affect the nominal index.

The main weakness in the data set is the lack of information on the proportion of the catch that is not retained on board but returned alive to the sea because of size limits or poor quality. Grading practice varies between vessels and may also be variable over time.

8.5.2 Area VIa and IVa

Vivier fleet

The geographic distribution of activity covered by the LPUE data reflects the main distribution of fishing activity by the fleet (Figure 24) as indicated by the landings data (Figure 21).

Monthly variability in LPUE was high up to 2004 with peak LPUE generally occurring in Autumn and Winter during this period. This pattern changed somewhat during 1995-2000. Seasonal variability and peaks in LPUE were lower later in the series (Figure 25).

The annual index declined from 2.6-2.8kgs per pot haul in 1990-1992 to 1.8kgs per pot haul by 1994 (Figure 26, Table 26). LPUE was stable between 1.6-1.8kgs during 1994-2000 but declined in 2001. The index was stable between 1.4-1.5kgs from 2001 to 2004, increased to 1.7 in 2005 but fell to a record low of 1.25 in 2006. No data are available south of 58°N for 2007-2008.

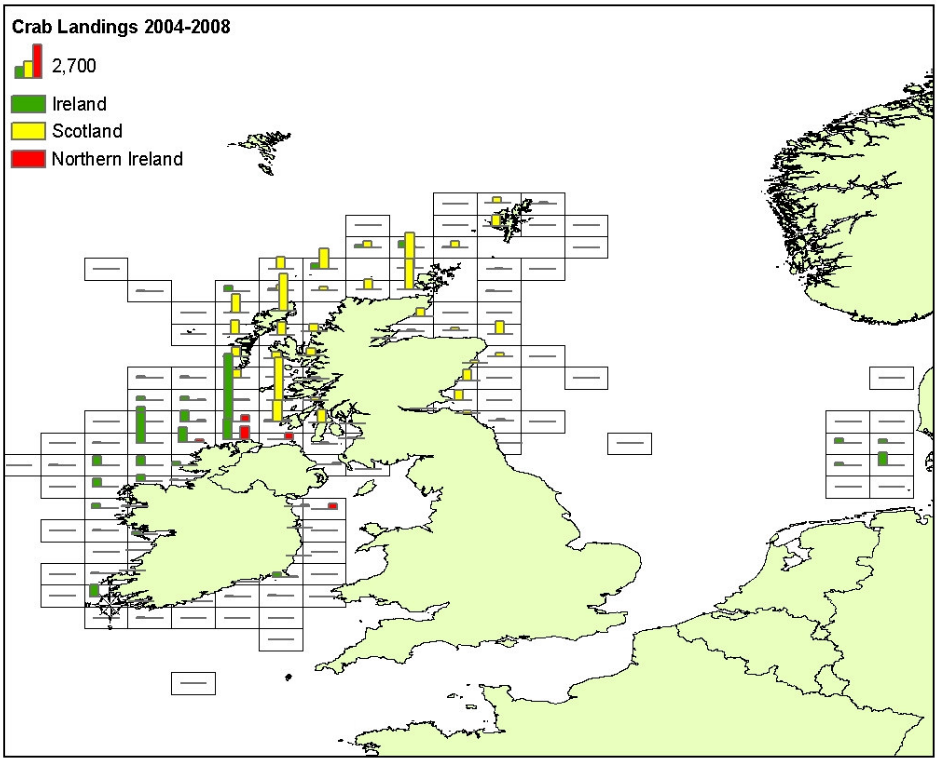

Figure 23. Distribution of landings (cumulative 2004-2008) by the Irish, Northern Irish and Scottish fleets by ICES rectangle. Sources: SFPA (Ireland), Marine Scotland Science (Scotland), Department of Agriculture Northern Ireland (DARD) (Northern Ireland).

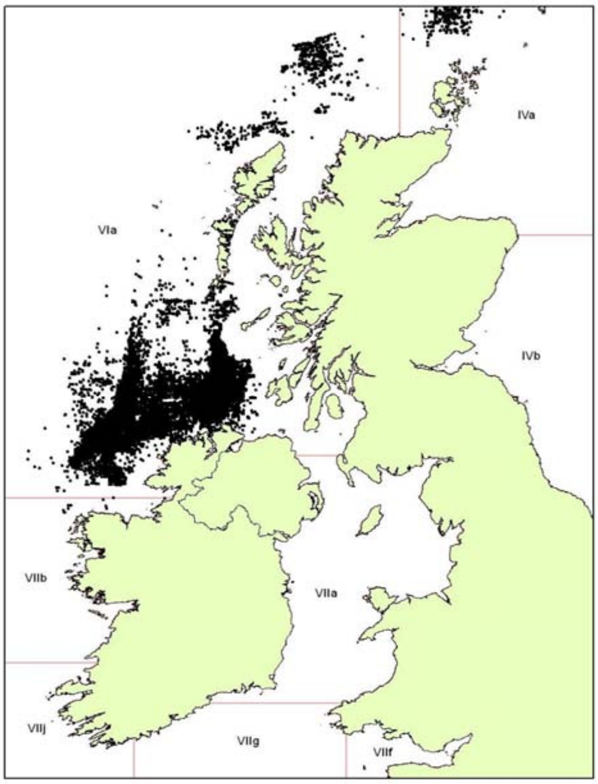

Figure 24. Distribution of fishing activity in the Irish vivier reference fleet used to calculate LPUE from 1990-2008. Data north of Scotland is for 2004-2007 only.

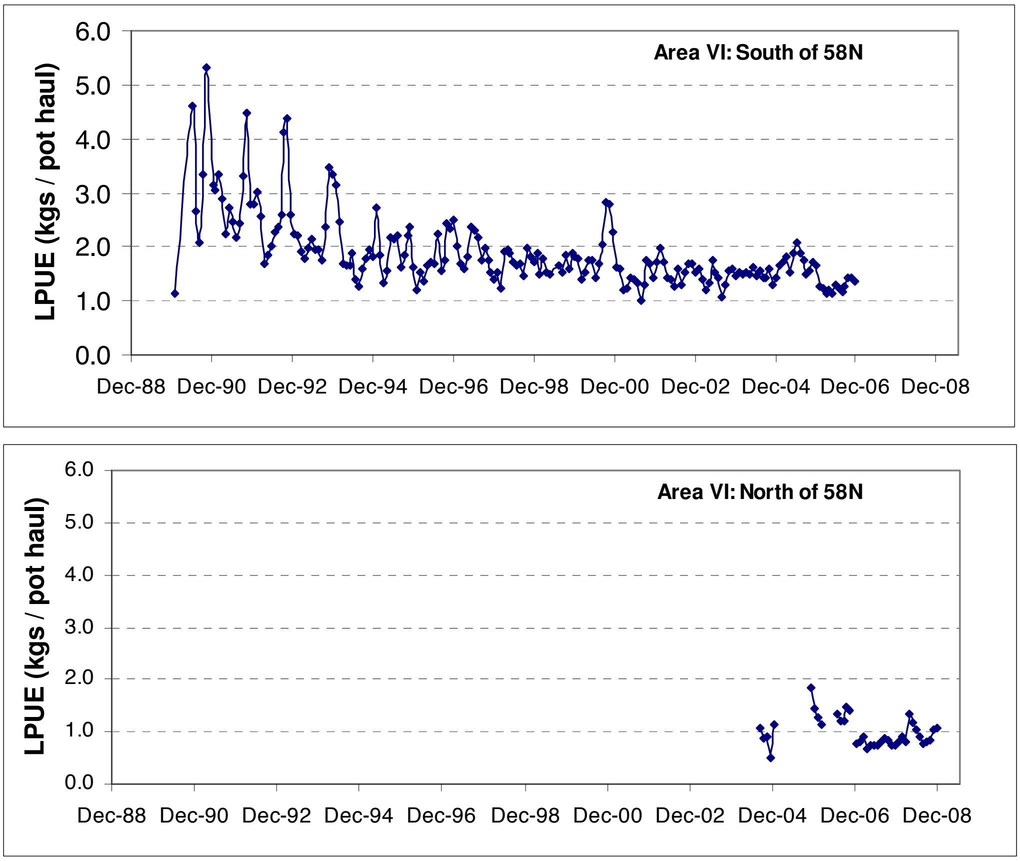

Figure 25. Monthly LPUE (kgs per pot haul) for the Irish vivier reference fleet north and south of 58°N in Area VI.

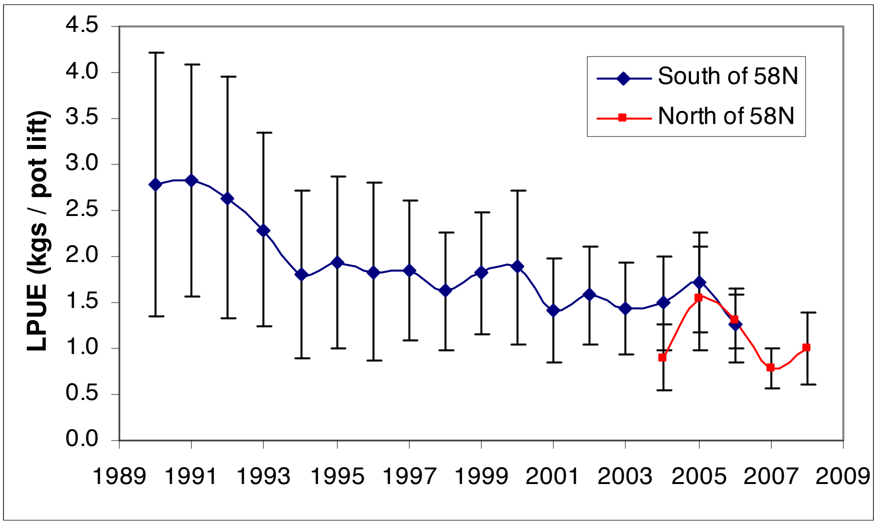

Figure 26. Annual average (±s.d.) LPUE in the Irish vivier reference fleet in Areas VI north and south of 58°N.

Table 26. Annual average (±s.d.) LPUE and associated effort (pot hauls) in the Irish vivier crab reference fleet. N = fishing events standardised to gear with common soak times within days.

	South of 58N				North of 58N			
Year	N	Mean	S.d.	Pot hauls (reference fleet)	N	Mean	S.d.	Pot hauls (reference fleet)
1990	55	2.79	1.43	28000				
1991	348	2.82	1.26	155700				
1992	636	2.64	1.31	214500				
1993	1181	2.29	1.06	471614				
1994	1338	1.81	0.92	664520				
1995	1432	1.93	0.94	666288				
1996	5012	1.83	0.97	586568				
1997	1214	1.85	0.75	665240				
1998	1415	1.63	0.64	812025				
1999	1120	1.82	0.67	629050				
2000	1275	1.88	0.84	703470				
2001	1213	1.41	0.57	928375				
2002	1432	1.58	0.54	1213350				
2003	1100	1.43	0.51	837925				
2004	1353	1.49	0.52	1207850	177	0.90	0.36	95500
2005	1344	1.71	0.55	937609	71	1.54	0.56	38750
2006	1369	1.25	0.40	1135200	310	1.30	0.29	259350
2007					498	0.78	0.22	237576
2008					346	1.01	0.39	210822

<13m fleet

The geographic distribution of fishing activity represented in the catch and effort reference fleet data for the <13m fleet is mainly north Donegal from Malin Head to Tory Island in the west and north to approximately 20 miles offshore. The 2008 data also includes information for the north Mayo fishery west of Donegal Bay.

Landings per unit effort (LPUE)

Seasonal peaks in LPUE occurred mainly in October of each year with secondary peaks occurring in July in some years. Seasonal minimum LPUE occurred in the March-May period (Figure 27).

Annual LPUE was stable during the period 1993-2007 fluctuating around a long term average of 1.47kgs per pot haul. In 2008 the combined Mayo and Donegal fishery average LPUE was 0.84. The average in Donegal and Mayo was 0.72±0.55 and 1.31±1.39 kgs per pot haul respectively (Figure 28).

Discards per unit effort (DPUE)

Monthly LPUE was positively correlated with monthly DPUE and both indices showed the same seasonal pattern; that is high rates of discarding occurred when landings per unit effort are also high (Figure 27). The seasonality in LPUE is, therefore, unlikely to be due to changes in discard rates.

Monthly DPUE peaked in August and September and was lowest in April and May. On average approximately 30% of the catch was discarded. This varied seasonally from 20-40% but occasionally up to 60% of the catch was discarded (Figure 29).

8.5.3 Area VIIj (south west)

<13m fleet

The geographic distribution of the catch rate data extends along the Cork and Kerry coast (Figure 30). Various surveys were completed during 1999-2007. Survey data are reported separately to data obtained under normal commercial conditions. The resolution of the data is a mixture of individual fishing events (individual strings of pots) and fishing events aggregated to boat day level.

Catch rate data from the private diaries of reference fleets, operating under normal commercial operations, corresponds well with survey data which generally had observer coverage (Figure 31). Peak LPUE occurred in the period August-October. LPUE was lowest in April and May. LPUE declined during the period 1999-2008. Annual average LPUE declined from 2.29kgs per pot in 2000 to 1.57kgs per pot in 2004 and was stable from 2004-2007. The average for 2008 was 0.23kgs per pot (Figure 32). Discard rates were practically zero which is in marked contrast to the north west fishery. The catch from this fishery is processed rather than exported live which is the main market for the North West fishery.

8.6 Profitability

Monthly gross profit per pot haul, calculated from unit value at first sale and LPUE (kgs per pot haul) in 2008 was higher in the south west compared to the north west due to higher first sale value, although catch rates were lower than in the northwest (Table 29). Profit per effort increased in both areas between March and June-July and declined from July to December due to falling first sale value and, in the south west, falling catch rates.

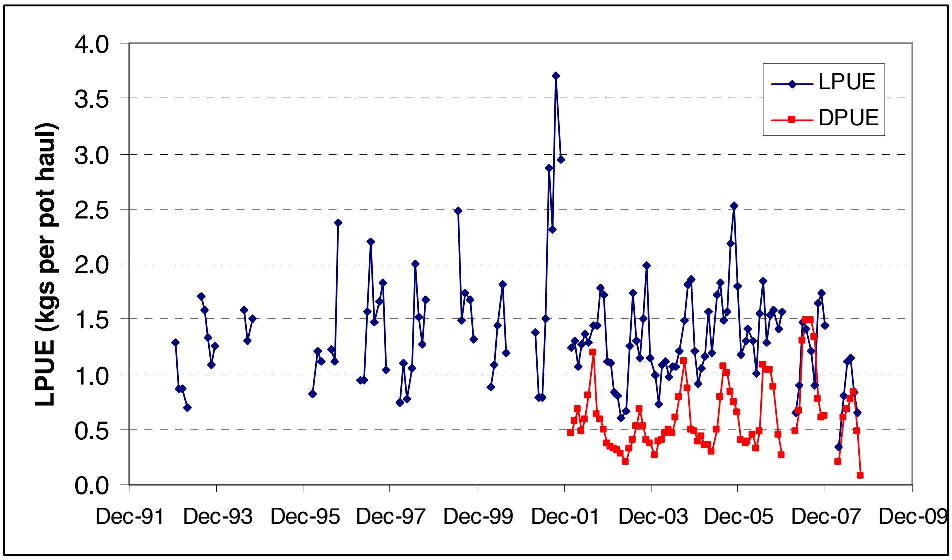

Figure 27. Monthly LPUE and DPUE in the <13m crab fishery north of Donegal and for 2008 Mayo and Donegal.

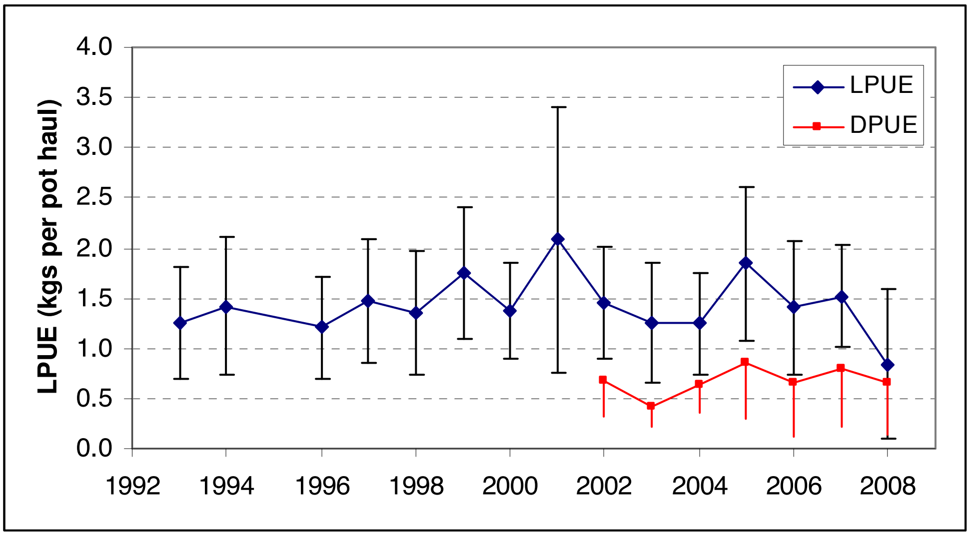

Figure 28. Annual LPUE (±s.d.) in the <13m crab fishery north of Donegal and for 2008 Mayo and Donegal.

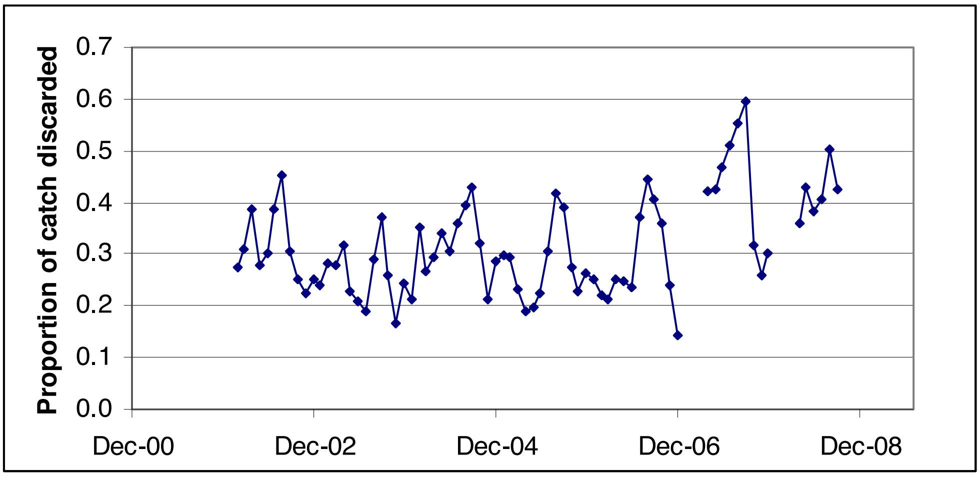

Figure 29. Monthly proportion of the crab catch discarded by the <13m fleet in Area VIa 2001-2008.

Table 27. Annual LPUE and DPUE (±s.d.) and reference fleet effort in the <13m crab fishery north of Donegal between 1993 and 2007 and off Mayo and Donegal in 2008. N = number of vessel days.

	LPUE				DPUE			
Year	**N**	**Mean**	**S.d.**	**Pot hauls**	**N**	**Mean**	**S.d.**	**Pot hauls**
1993	87	1.25	0.56	56895				
1994	29	1.42	0.68	31725				
1996	85	1.21	0.51	43650				
1997	91	1.47	0.61	51000				
1998	84	1.35	0.61	40650				
1999	99	1.75	0.65	46050				
2000	62	1.37	0.48	32550				
2001	131	2.08	1.33	45550				
2002	448	1.45	0.56	232650	182	0.67	0.35	69905
2003	1274	1.26	0.60	317797	128	0.42	0.20	68137
2004	339	1.24	0.51	212510	161	0.64	0.28	104060
2005	1414	1.84	0.77	742152	1143	0.85	0.56	623175
2006	872	1.40	0.67	481902	604	0.66	0.55	364256
2007	373	1.52	0.51	207300	373	0.80	0.59	207300
2008	147	0.84	0.74	79505	127	0.66	0.51	44590

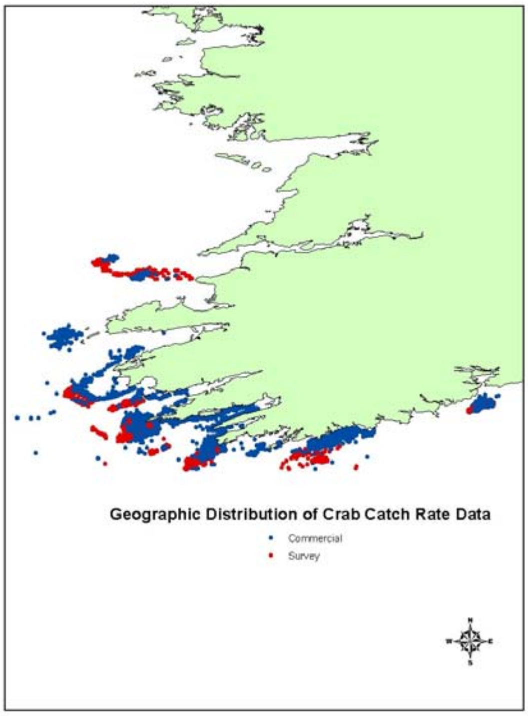

Figure 30. Geographic distribution of crab catch rate data off the south west coast 2000-2007 under normal-commercial conditions and during survey.

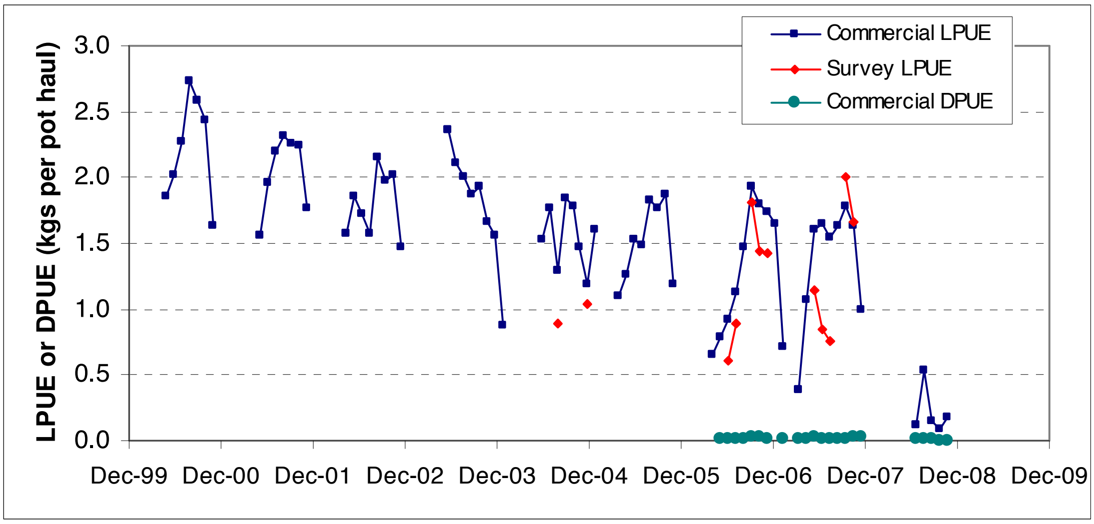

Figure 31. Monthly LPUE and DPUE of crab in the <13m reference fleet off the south west coast of Ireland between 2000-2008.

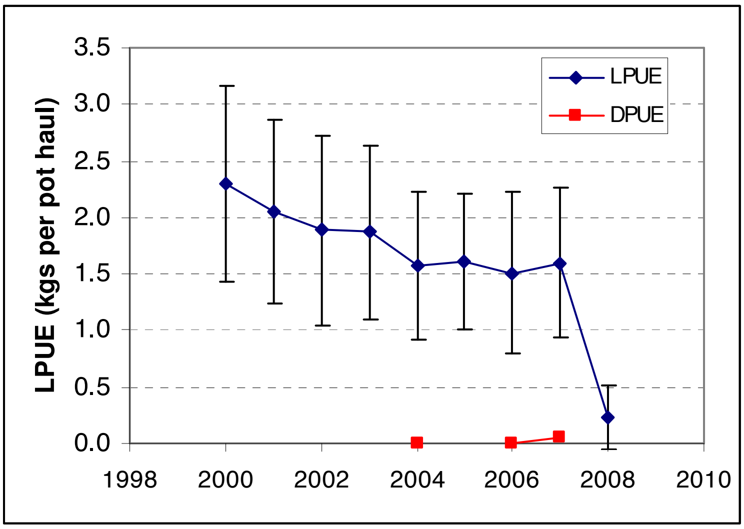

Figure 32. Annual average (±s.d.) crab LPUE and DPUE in the <13m south west crab reference fleet 2000-2008.

Table 28. Annual average (±s.d.) crab LPUE and DPUE in the <13m south west crab reference fleet 2000-2008. N=number of fishing events reported. Pots = sum of the effort represented by the data.

Year	Pots	LPUE			DPUE		
		N	Mean	S.d.	N	Mean	S.d.
2000	54740	782	2.29	0.87	0		
2001	56580	943	2.05	0.81	0		
2002	52120	857	1.88	0.84	0		
2003	57360	956	1.87	0.77	0		
2004	54590	881	1.57	0.65	140	0.004	0.002
2005	74220	1237	1.61	0.61	0		
2006	145808	1883	1.51	0.72	32	0.004	0.003
2007	265851	3890	1.60	0.67	96	0.051	0.027
2008	25780	48	0.23	0.28	0		

Table 29. Gross profit per unit of effort (GPUE) in the <13m and >18m crab fleets in the north west and south west in 2008 (LPUE data for south west is from 2007) based on value at first sale and LPUE (kgs per pot haul).

	North west			South west	
Month	First sale price	GPUE <13m fleet	GPUE >18m fleet	First sale price	GPUE <13m
January	€1.86		€1.52	€2.00	
February	€1.59		€1.46	€3.29	
March	€2.32		€1.84	€2.28	€0.87
April	€1.89	€0.65	€2.52	€1.67	€1.78
May	€1.35	€1.08	€1.60	€2.31	€3.71
June	€1.98	€2.20	€2.07	€2.18	€3.59
July	€1.95	€2.22	€1.75	€1.82	€2.81
August	€1.41	€1.18	€1.07	€2.00	€3.26
September	€1.51	€0.98	€1.22	€1.38	€2.46
October	€1.57		€1.33	€0.79	€1.29
November	€1.31		€1.37	€1.37	€1.37
December	€1.59		€1.70	€1.44	

9 Cockle

9.1 *Management recommendations*

The management regime for cockles in 2009 used a suite of measures which effectively limited the exploitation rate and protected juvenile cockles. This regime 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.

9.2 *Summary*

Annual biomass of cockles in Dundalk Bay and Waterford Estuary varies substantially due to recruitment variability, winter mortality in particular and previous removals by the fishery. Late summer biomass in Dundalk varied between 2000-4000 tonnes in 2007-2009. In the Waterford estuary biomass varied from 0-500 tonnes in the same period. The fishery, which opens in late summer or autumn, targets cockles over 22mm in shell width (11g body weight). These cockles are generally older than 2 years. A TAC is set by 'rule of thumb' at 33% of the late summer biomass. TAC in Dundalk was 950 and 719 tonnes in 2007 and 2009 respectively and 210 and 0 in Waterford in the same period. Both fisheries were closed in 2008 as no appropriate assessment of their impact had been completed. Spatial restrictions, daily catch limits and dredge size restrictions also apply. Catch rates declined between 30 and 50% during the 2007-2009 autumn fisheries.

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.

9.4 *Dundalk Bay*

9.4.1 Biomass 2007- 2009

Pre-fishery biomass was estimated directly by survey in each year 2007-2009 in Dundalk Bay (Table 30, Figure 35).

Biomass estimates from surveys in 2007, 2008 and 2009 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 settlement and mortality of established cohorts relative to the time in which the surveys are undertaken.

The 2007 biomass of 2277 tonnes was mostly comprised of commercial size cockles (>17mm shell width). Biomass was higher in 2008 due to a strong recruitment in the Spring of 2008. The majority of the biomass in 2008 was less than 17mm shell width. Biomass in 2009 was lower than in 2008 or 2007 (Table 30).

9.4.2 Total Allowable Catch 2007-2009

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 15% in 2009 (Table 30). 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 (22mm shell width) which is higher than the 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.

9.4.3 Catch rates

Catch rate per hour were higher in 2007 compared to 2009 as suggested by the higher biomass and higher concentration of biomass in 2007. Catch rates declined by approximately 50% during the season in 2007 but by less than 30% during the shorter 2009 season (Table 31, Table 32, Figure 33)

Table 30. Estimates of cockle biomass in Dundalk Bay in 2007-2009.

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

Table 31. Landings per vessel per day and LPUE in the 2007 Dundalk Bay cockle fishery for suction and non-suction dredges

	Suction dredge					Non-suction dredge				
	Landings per boat day			LPUE (kgs per hour)		Landings per boat day			LPUE (kgs per hour)	
Week	N	Mean	S.d.	Mean	S.d.	N	Mean	S.d.	Mean	S.d.
01/07/07	2	275.0	35.4	91.3	40.7	0				
21/07/07	51	837.7	224.0	530.5	385.9	17	482.4	265.9	129.1	50.9
28/07/07	57	796.2	246.7	449.1	304.3	31	556.5	224.6	167.9	127.4
04/08/07	81	724.5	247.0	375.8	281.3	55	582.0	254.8	175.6	84.4
11/08/07	66	674.5	265.3	358.7	269.5	45	518.8	272.7	175.1	105.9
18/08/07	83	685.4	261.6	311.8	219.9	45	639.9	232.6	197.6	83.5
25/08/07	54	412.4	162.3	161.7	99.9	41	324.6	135.1	122.9	58.3
01/09/07	60	569.4	223.9	192.9	86.2	60	620.3	202.0	169.2	76.4
08/09/07	66	462.6	197.6	202.3	115.6	39	337.0	130.0	129.5	70.1
15/09/07	64	536.0	173.9	212.8	95.5	58	457.7	161.8	151.0	83.1
22/09/07	7	530.6	80.8	156.3	28.2	2	461.5	85.6	110.3	33.0
29/09/07	68	520.1	237.3	203.2	99.2	33	376.9	191.5	141.3	86.8
06/10/07	32	473.8	198.9	169.0	63.5	11	344.5	98.1	111.7	49.2
13/10/07	34	393.2	111.6	148.9	46.7	18	374.3	81.1	97.1	25.6

Table 32. Landings per vessel day and per hour in the 2009 Dundalk Bay cockle fishery for suction and non-suction dredges

	Suction dredge					Non-suction dredge				
	Landings per boat day			LPUE (kgs per hour)		Landings per boat day			LPUE (kgs per hour)	
Week	N	Mean	S.d.	Mean	S.d.	N	Mean	S.d.	Mean	S.d.
30/09/09	92	264.4	127.7	88.9	34.7	66	213.2	105.8	61.4	26.2
07/10/09	55	261.7	130.4	82.5	40.4	38	253.3	80.4	62.2	27.0
14/10/09	78	241.6	86.7	67.7	23.1	62	229.3	87.9	65.0	28.6
21/10/09	11	250.6	82.0	74.3	24.3	10	268.2	76.7	63.9	13.5
28/10/09	5	185.2	118.4	63.5	18.0	3	196.7	35.1	52.3	8.1

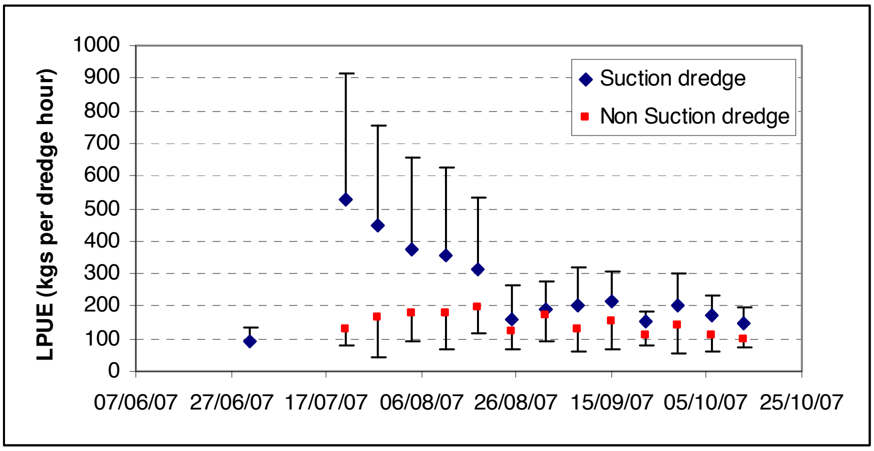

Figure 33. Weekly LPUE (±s.d.) in the 2007 Dundalk Bay cockle fishery in relation to dredge type

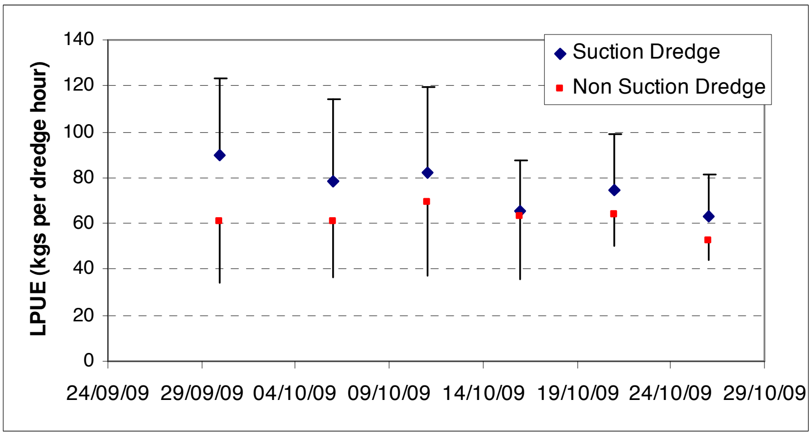

Figure 34. Weekly LPUE (±s.d.) in the 2009 Dundalk Bay cockle fishery in relation to dredge type.

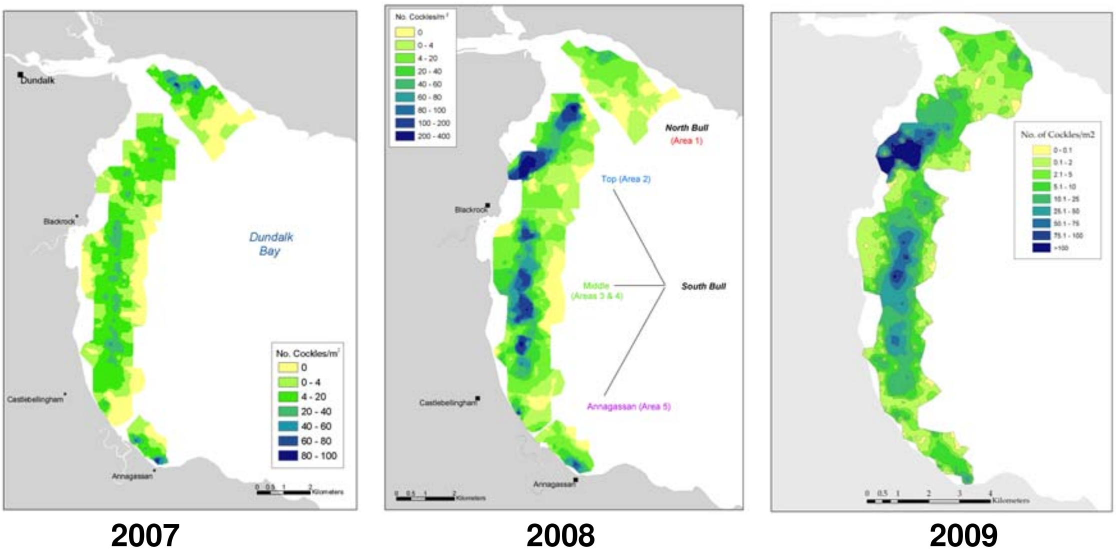

Figure 35. Distribution and density of cockles in Dundalk Bay 2007-2009.

9.5 *Monitoring for ecosystem effects*

Dundalk Bay is designated as a Special Protection Area (SPA 4026) for birds and a Special Area of Conservation (SAC 455) under the Birds and Habitats Directives respectively. According to the directives the fishery must not compromise the long term integrity and conservation value (area, range, structure and function of the ecosystem components for which the sites are designated) of the site. Monitoring for ecosystem effects coupled with GPS tracking of the vessels was established in 2009. There are 3 elements in the monitoring programme.

1. Quantifying the amount and location of dredging and its impact on undersized cockles and other non-retained by-catch
    a. Catch rate monitoring to determine to what degree cockle biomass is depleted during the fishery as reported above and, in addition to the biomass survey, to provide a second independent estimate of pre-fishery biomass and exploitation rate where this is feasible.
    b. Evaluating shell damage to cockles and other bivalves in the non-retained by-catch
2. A before after control impact (BACI) assessment of the impact of dredging on the intertidal benthic habitats
    a. Sediment grain size and total organic carbon
    b. Distribution and density of benthic fauna
3. A post fishery control impact assessment of habitat use by waterbirds

These data will be reported on in 2010.

9.6 *Waterford Estuary and Tramore*

9.6.1 Biomass 2007- 2009

Biomass surveys in 2007-2009 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 (Table 33, Figure 36). The Tramore bed held 78% of the total biomass in 2007 (Table 33). No commercial cockles were found in Woodstown or Passage East during the 2009 surveys.

9.6.2 Total Allowable Catch 2007-2009

The TAC for the Tramore cockle bed was set to zero in 2007 as no management plan was agreed. TACs, representing 33% of the biomass, were set for Passage East and Woodstown. TACs were also set to zero in 2008 as no appropriate assessment of the impact of the fishery on the conservation objectives of the Special Area of Conservation (SAC 00787) in which the fishery takes place had been undertaken. As the commercial biomass in 2009 was estimated to be zero no proposal to open the fishery was developed.

9.6.3 Catch rates

Catch rates in the 2007 Waterford estuary cockle fishery ranged between 200-400kgs per hour and declined by approximately 21% in the last 5 weeks of the fishery compared to the previous 5 weeks (Figure 37).

Table 33. Annual biomass estimates and TACs for cockle beds in the Waterford Estuary

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

Table 34. Landings per vessel day and LPUE in the 2007 Waterford estuary cockle fishery for non-suction dredges. Suction dredging was limited to the final 3 weeks for a total of 9 vessel days.

Week	Non-suction Dredge				
		Landings per boat day		LPUE (kgs per hour)	
	N	Mean	S.d.	Mean	S.d.
20/08/2007	2	490.0	438.4	182.0	66.0
27/08/2007	1	719.0		239.7	
03/09/2007	3	1733.3	680.7	400.0	100.0
10/09/2007	4	1000.0	0.0	212.5	25.0
17/09/2007	4	1036.3	79.3	199.2	23.1
24/09/2007	7	1237.9	264.6	350.7	122.5
01/10/2007	15	1005.0	232.6	425.3	125.9
08/10/2007	31	1011.6	235.9	396.7	134.9
15/10/2007	18	915.9	188.3	293.4	85.8
22/10/2007	1	1000.0		239.8	
29/10/2007	33	806.0	318.5	231.8	97.4
05/11/2007	26	820.9	315.5	274.5	105.3
12/11/2007	13	746.8	445.8	266.1	148.6

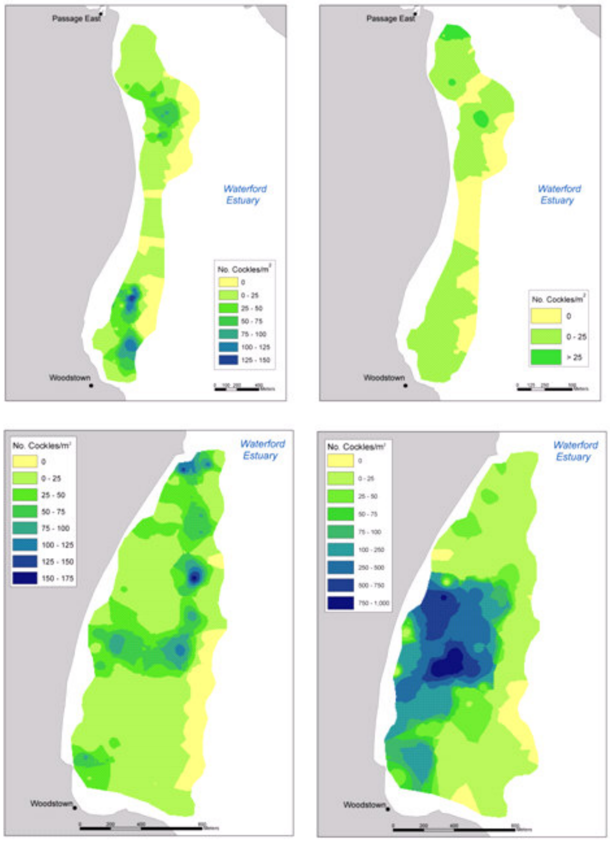

Figure 36. Distribution and abundance of cockles in Passage east and Woodstown in 2007 (left) and 2008 (right).

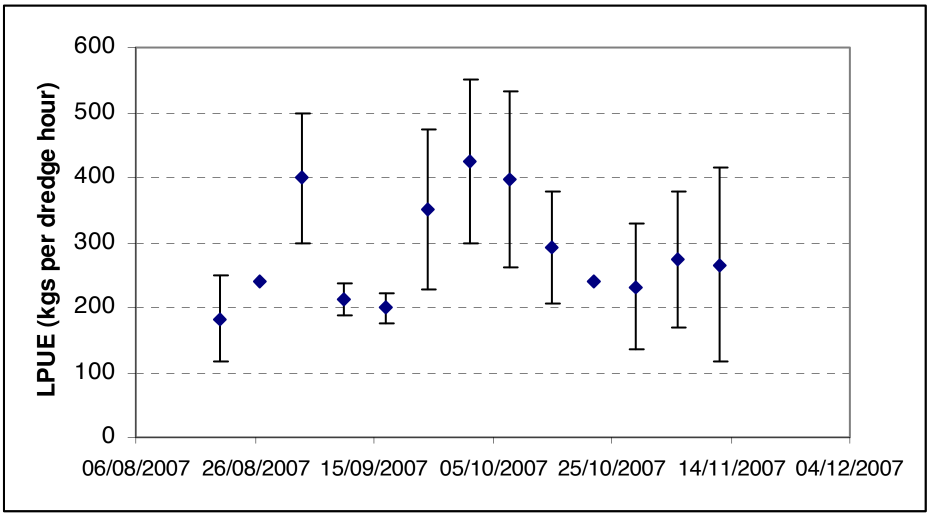

Figure 37. Weekly LPUE (±s.d.) in the 2007 Waterford estuary cockle fishery for non-suction dredges.

10 Razor clam

10.1 Management recommendations

Activity in the fishery is currently constrained by market conditions rather than management. Historical trends in the Irish Sea fishery and in previous west coast fisheries, the high efficiency of the gear, irregular recruitment and changes in benthic communities following fishing all suggest that there is significant potential for the fishery to over-exploit razor clam beds and that recovery might be slow. The fishery is currently depth limited but developments in hydraulic fishing methods may lead to expansion into deeper water.

The distribution of Razor clams should be mapped and depletion in local biomass by the fishery should be controlled. This would enhance recovery of the stock and the benthos from dredging effects and would reduce the risk of local extinction. Given the current market demand and level of activity managed rotation of the fishery may be feasible.

10.2 Summary

Catch rate data for the Malahide and Gormanstown Razor clam beds declined during the period 1998 to 2004. The Dundalk Bay fishery was stable from 2001-2004. Size composition of the landings was stable during the period 2000-2009.

10.3 The Fishery

Razor clams (*Ensis siliqua* L.) have been fished in the Irish Sea, from Dundalk bay south to Howth, since 1997 (Fahy and Carroll 2007). The fishery is generally located between the low spring tide mark seaward to approximately 15m depth in areas of fine sediments. The seaward extent is limited by the operation of the hydraulic dredge although the depth of fishing can be lesser or greater depending on dredge design.

Six areas in the Irish Sea have a microbiological classification within which fishing for Razor clams takes place (Table 35, Figure 38).

Since 2006 the fleet have relied mainly on the Dundalk Bay and Skerries classified areas during the months October to March. Although 30-40 vessels may be equipped to fish for Razor clams market conditions and demand in recent years have been poor and only a proportion of these vessels fish at any one time. The importance of areas other than Dundalk and Skerries is less because of distance to nearest ports or because these beds have been over-fished in the past. The distribution of razors in waters greater than 15m is unknown.

Table 35. Six classified production areas for Razor clams along the east coast of Ireland. Classification is in relation to e-coli counts in the tissues of the clam (Annex II, 854/2004)

Production Area	Boundaries	Current Classification
Malahide	Between 53° 25.4' N and 53° 29.4' N	B
Skerries	Area bounded by a line from Hampton Cove to a point at 06° W, 53°36.3' N to a point at 06° W, 53°34.5'N to Shenick Island	A* (Seasonal classification 01 April - 30 August reverts to class B at other times)
Gormanstown	Between 53° 38' N and 53° 40'N	B
Laytown	Between 53° 41' N and 53° 42' N	B
Dundalk Bay	Area bounded to the East by 6 ° W, to the South by 53° 49' N and to the North by 54° N.	B (Cockles) A (Razor Clams)
Carlingford Lough (Irish Waters)	Ballagan Point to Cranfield Point	A

10.4 Overlap with Natura sites

The fishery within the classified areas overlaps with Natura 2000 sites in Carlingford Lough (SPA 4078 and SAC 2306), Dundalk Bay (SPA 4026 and SAC 455), Gormanstown (SPA 4158), Skerries (SPA 4122, 4014) and Malahide (SPA 4069, 4025, SAC 204, 205). However, given the current pattern of fishing, which presumably reflects the availability of stocks within the Classified Areas, significant overlaps only occur with Dundalk Bay SPA 4026.

10.5 Catch Rate Indicators

10.5.1 Data

Sources

Landings per unit effort data were sourced from private diaries from August 2001 to January 2005. Quarterly length and weight measurements were recorded from landings from 2002-2009 and quarterly unsorted catch samples were collected from various razor clam beds along the east coast from 2001-2009 (with the exception of 2003). These unsorted catch samples provide information on non-retained by-catch and benthic community composition.

Precision and accuracy

The catch rate data obtained from index vessels is disaggregated to individual tow level. Catchability may vary according to gear settings, the effects of which have not yet been analysed and which could lead to bias in the time series. As abundance of razor clams is likely to vary spatially and at fine scales the trends in the catch rate data can only be representative of the particular fishing locations recorded in the data rather than for the razor bed as a whole. Available data comes from different areas in each year.

10.5.2 Landings per unit effort

A significant decline in LPUE, from 80-100kgs.hr^{-1} to 25-40kgs.hr^{-1} occurred in the Malahide area between 2001-2002 and 2003-2004 respectively (Figure 39). Catch rates in Dundalk were stable from 2001-2003. Catch rates declined in Gormanstown and Laytown between 2002 and 2003. The laying of a gas pipeline across the Gormanstown bed excluded vessels from fishing in this area during 2002.

10.5.3 Size composition

Size composition data, compiled from landings for Irish Sea razors on a quarterly basis since April 2002 (n=7789) showed that length ranged from 51.5mm to 211mm.

Data from unsorted quarterly catch samples collected from various vessels between 2000-2009 (n=10956), with the exception of 2003, showed that length ranged from 28 to 220mm.

The mean lengths of razor clams from both landings and unsorted catch were stable between 2000-2009, with the mean lengths recorded from landings, compared to the catch, being slightly higher overall (Figure 40).

Although catch rates have declined in Gormanstown and Malahide size composition for these areas were stable. Size composition data for this fishery does not seem to be sensitive to fishing effort or exploitation rate. This could be due to serial depletion of different areas of the beds by the fishery and or persistently poor recruitment. Regular recruitment in the face of high exploitation would be expected to lead to a reduction in mean size.

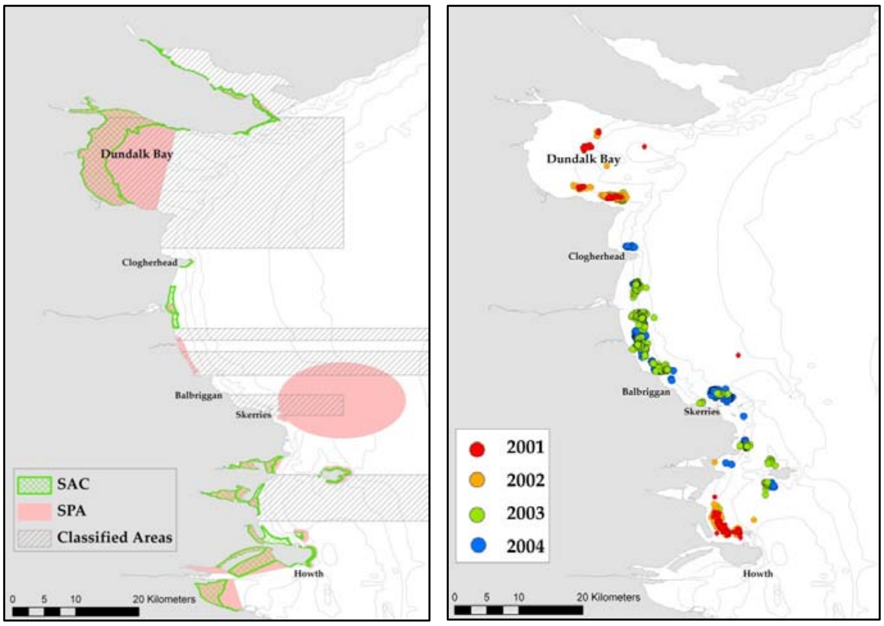

Figure 38. Areas classified for the fishing of razor clams along the east coast and special areas of conservation (SAC) and specially protected areas for birds (SPA) and locations for which reference fleet commercial catch rate data are available from August 2001 to December 2004.

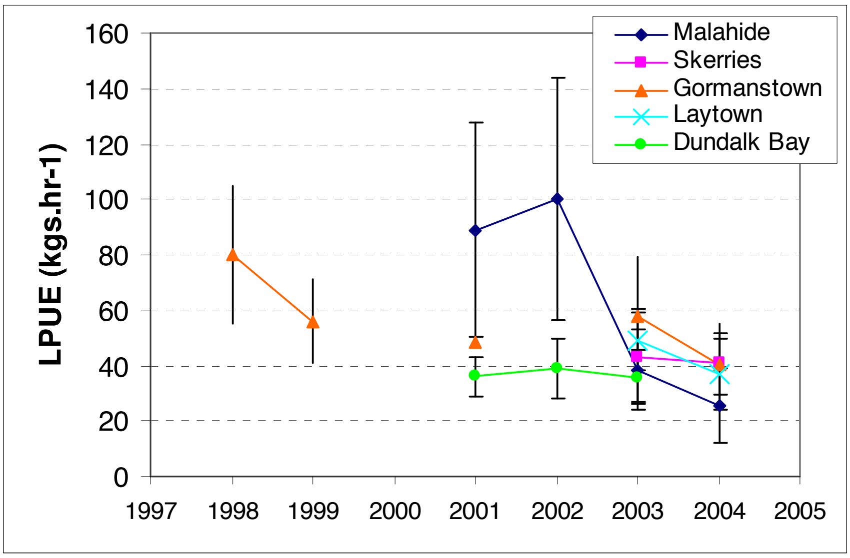

Figure 39. Annual mean LPUE (±s.d.) in the razor clam fishery from 1998 to 2004 for five classified production areas. Data for 2001-2004 are from private diaries. Data for 1998 and 1999 are reconstructed from Fahy (2001).

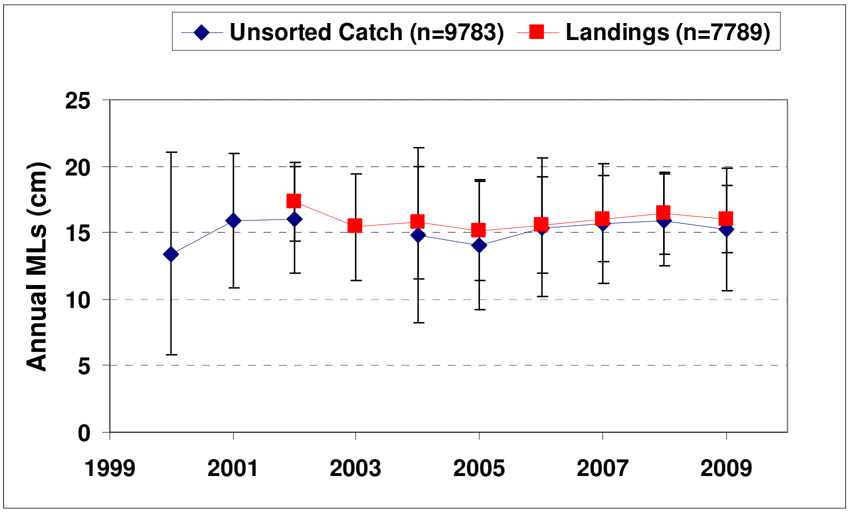

Figure 40. Annual mean lengths (MLs) of razor clams in the landings from 2002 to 2009. Vertical bars are 95% confidence limits.

11 Spider crab (*Maja brachydactyla*)

11.1 Management recommendations

The MLS protects the majority of the adult stock from fishing mortality. Although spawning potential is probably well protected, therefore, high exploitation rate on the proportion of the population above MLS leads to a significant, within season, fishing down of this exploitable stock. Limiting exploitation rate, using in season depletion in LPUE or in season changes in size composition, combined with modifications to the MLS (see below) could be used to provide for a more stable fishery.

As spider crab have a terminal moult any changes in the relationship between MLS and size distribution at terminal moult could significantly change the proportion of crabs that achieve a terminal body size larger than the MLS. Although there is no evidence that it is occurring strong size selective mortality, caused by the fishery, could lead to reductions in size at terminal moult. Although this would give further protection to the stock, at current MLS, the economic viability of the fishery would decline. Consideration should be given to adapting technical measures to reduce mortality on crabs, which have large terminal moult size, in order to reduce possible size selective effects on terminal moult size.

11.2 Summary

Catch rates in the 2009 Tralee and Brandon Bay spider crab fishery increased between March and May, and varied from 3.5-3.8kg.pot^{-1} between May and September. Discard rates averaged approximately 3.0kgs.pot^{-1} between May and September and varied from 50-80% of catch. Practically all crabs caught were adult but 60-70% were below the MLS. Assuming that there is high survival of discards the MLS significantly limits fishing mortality on the adult stock during the summer fishery. Fishing mortality on juveniles is effectively zero. As spider crabs have a terminal moult crabs that achieve terminal moult size, below the MLS, are never exposed to fishing mortality. Analysis of depletion in LPUE on cumulative landings (total = 220 tonnes), for periods when the population was assumed to be closed as indicated by stable rates of discarding, suggests a pre fishery biomass of 380 tonnes, above MLS, and an exploitation rate of 57% on crabs above MLS.

11.3 The Brandon and Tralee Bay fishery

The majority of the data reported here has been collected from the spider crab fishery in Brandon and Tralee Bays in 2009. This area is responsible for the majority of the national landings of spider crab.

11.3.1 Overlap with Natura sites

The spider crab fishery overlaps with Natura 2000 sites in both Tralee and Brandon Bays (Figure 41).

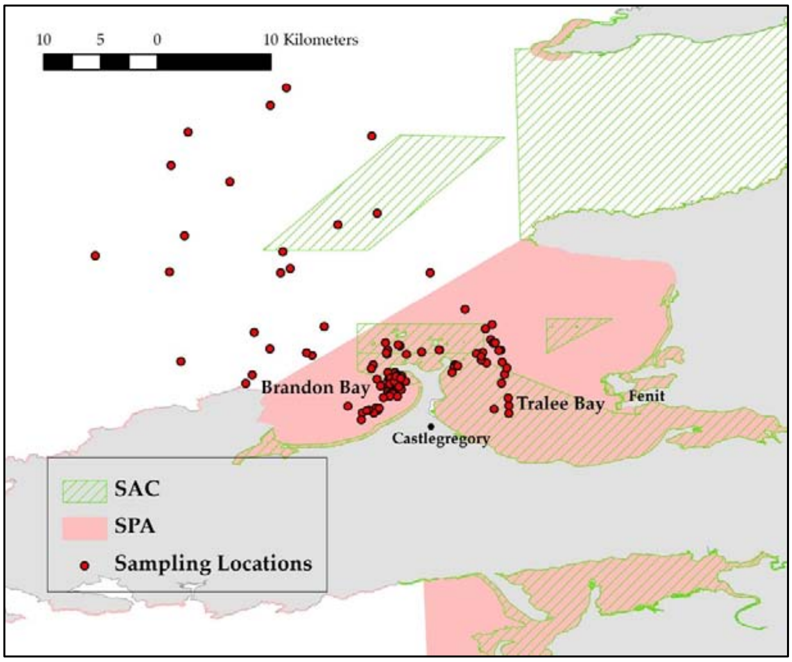

Figure 41. Sampling locations in the 2009 Brandon and Tralee Bays spider crab fishery. Natura 2000 sites are indicated.

11.4 Catch Rate Indicators

11.4.1 Data

Sources

Catch per unit effort data was obtained from a voluntary reference fleet programme from March until September 2009. Observer data was recorded during the 2009 fishing season from the beginning of April to the first week of June. Catch, discards and landings per unit effort data were recorded, along with biological measurements of the catch. A total of 2504 spider crab were sampled over a ten week period.

Precision and accuracy

The reference fleet in 2009 was a significant proportion of the total fleet and is regarded as an accurate representation of catch and effort for the Tralee and Brandon Bay fishery. The observer data on catch rate is less precise and potentially biased due to variable catch rates between vessels and limited coverage of fishing trips.

11.4.2 LPUE and DPUE

Monthly landings per unit effort (LPUE) recorded from the reference fleet programme (March-September 2009) peaked at approximately 92kgs per 100 pots in March. Monthly discard rates (DPUE) during the same time period peaked at approximately 319kgs per 100 pots in June, increasing from 90 in March. Mean catch per unit effort (CPUE) data also peaked in June at approximately 382kgs per 100 pots (Figure 42).

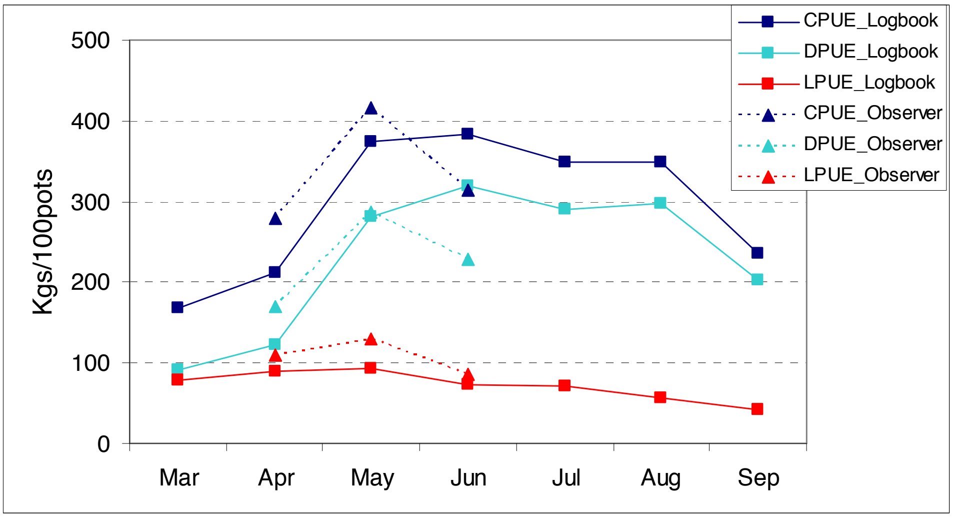

Figure 42. Catch and effort indicators for the spider crab reference fleet and observer programme in Brandon and Tralee Bays in 2009.

DPUE increased from March to May, was stable between May and August and declined in September. LPUE increased slightly from March to May and then declined.

The observer data showed a peak in all three catch indicators in May (LPUE at 129kgs per 100 pots; DPUE at 286kgs per 100 pots and CPUE at 415kgs per 100 pots). Peaks for CPUE and LPUE were slightly higher than the reference fleet data for April and May. However, in June the observer estimates, of both catch and discards per unit effort, were lower, although only one sampling trip was undertaken at the beginning of June.

Observer data showed that on average >65% of spider crab sampled each month were discarded, because they were undersized or damaged. The rate of male crab discarding increased from 62% in April to 69% in June, whereas female discards declined from 71% in April to 55% in June. The reference fleet data indicated that over 50% of the catch was discarded in March and this increased to over 80% in August and September. Approximately 62% of male and 65% of female adult crabs in the catch were below the MLS.

Regression of LPUE on cumulative catch (total = 220 tonnes) suggests a pre-fishery biomass, above the MLS, of 380 tonnes and a season exploitation rate of crabs above the MLS of 57% (Figure 43).

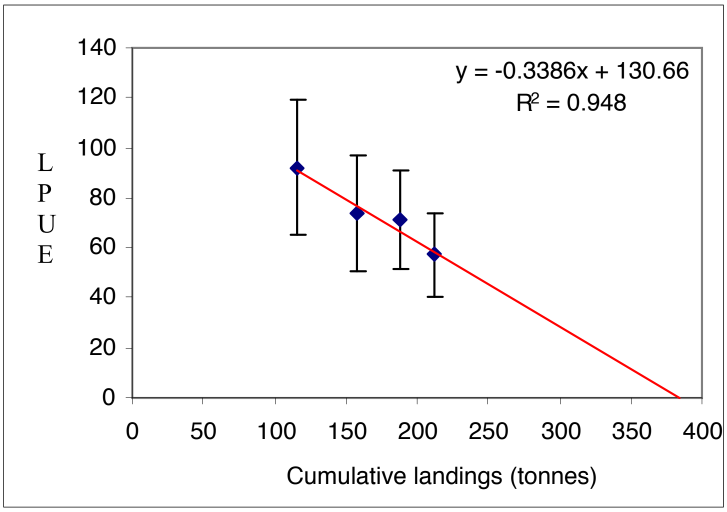

Figure 43. Regression of LPUE (kgs/100 pots) on cumulative landings of spider crab during 2009.

11.5 Size composition, maturity and fishing mortality

In total, 894 female spider crab were sampled during 2009 of which 98% were mature with only 2% of the females caught having 'flat' abdomens and therefore classed as immature. The percentage of crabs that were berried increased from 66% in April, 94% in May to 100% in June (Figure 44). The carapace length of egg bearing females ranged from 118 to 127mm.

Female length frequencies, from the 2009 observer data, ranged from 83 to 156mm with a mean length of 125±34.5mm (Figure 45). Males were larger than females, ranging from 89 and 178mm (mean length = 131±13.7mm). Males were dominant in the catches from April to the beginning of June.

Previous surveys were carried out in July/August 1985 by Fox (1985). Male and female carapace length ranged from 60-170 (mode 120-130) and 80-150mm (mode 120) respectively. In 2003 length range was similar to 1985 but there was significantly lower proportion of males over 130mm. In 2009 modal carapace lengths were 120-130mm and 130mm for males and females. The proportion of males over 130mm was higher than in 2003 but lower that in 1985. By comparison modal sizes in a newly developing fishery in Galway and Mayo in 2002 were 150-160mm and 130-140mm for males and females respectively (Figure 46).

The size frequency data from 1985, 2003 and 2009 suggests that fishing mortality was higher in 2003 than in 2009 and lowest in 1985. Given the limited life span of spider crabs following terminal moult the shape of these distributions probably reflect in season mortality or the combined effect of recent fishing seasons. Data from newly developing fisheries in Galway and Mayo in 2002, when fishing effort was low, show a much higher proportion of large males in particular.

The capacity of the fishery to fish down the adult male and female population above the MLS is evident in the length frequency distributions. Although the MLS protects the majority of the adult stock and its spawning potential uncontrolled fishing effort will result in rapid depletion of the proportion of the adult stock above MLS and a high reliance by subsequent fisheries on growth of juveniles above the MLS.

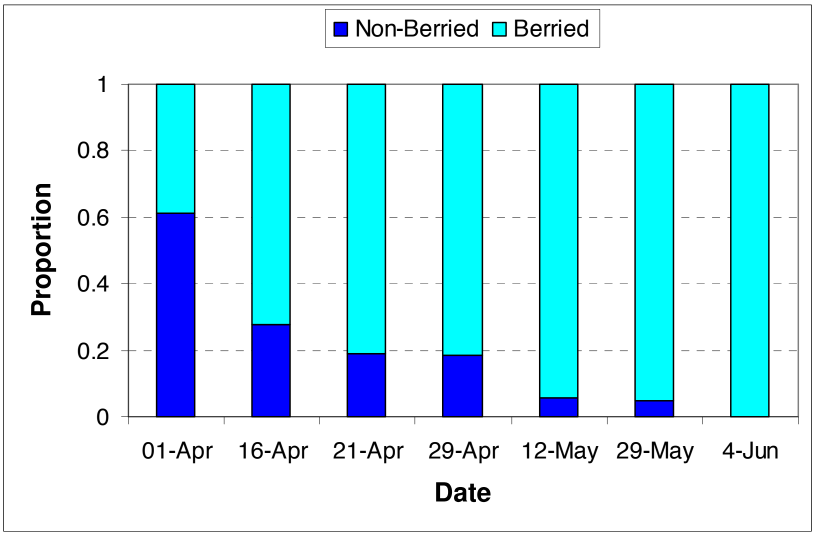

Figure 44. Proportion of berried to non-berried female spider crab in the catch between April and June in the 2009 Tralee and Brandon Bay fishery.

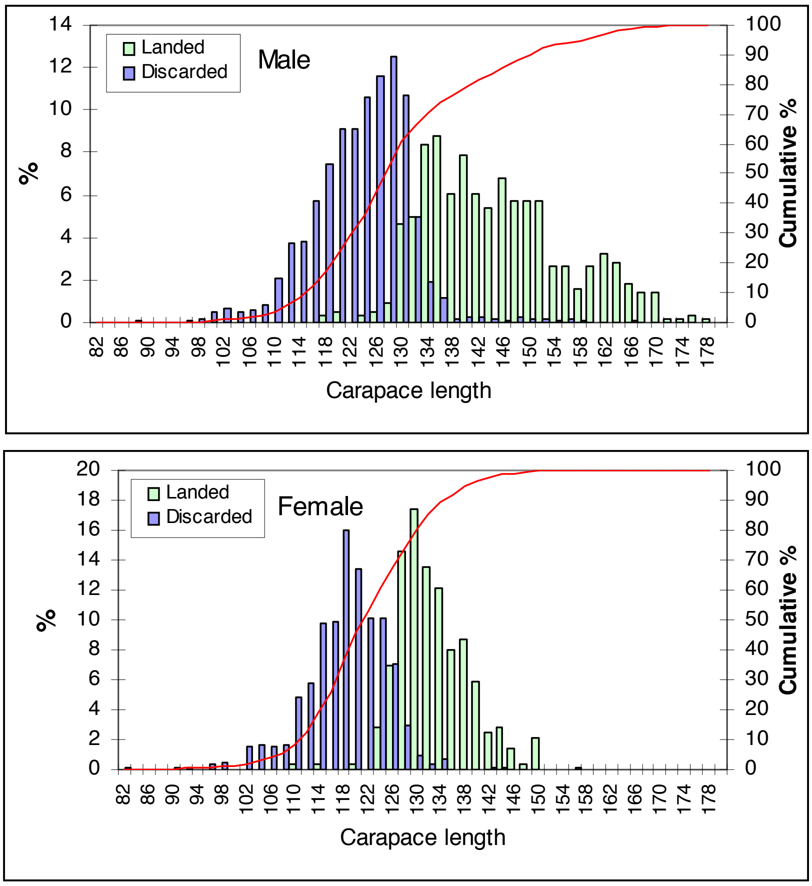

Figure 45. Length composition of discarded and landed male and female spider crab and cumulative length distributions of the catch of spider crab in the 2009 Tralee and Brandon Bay fishery.

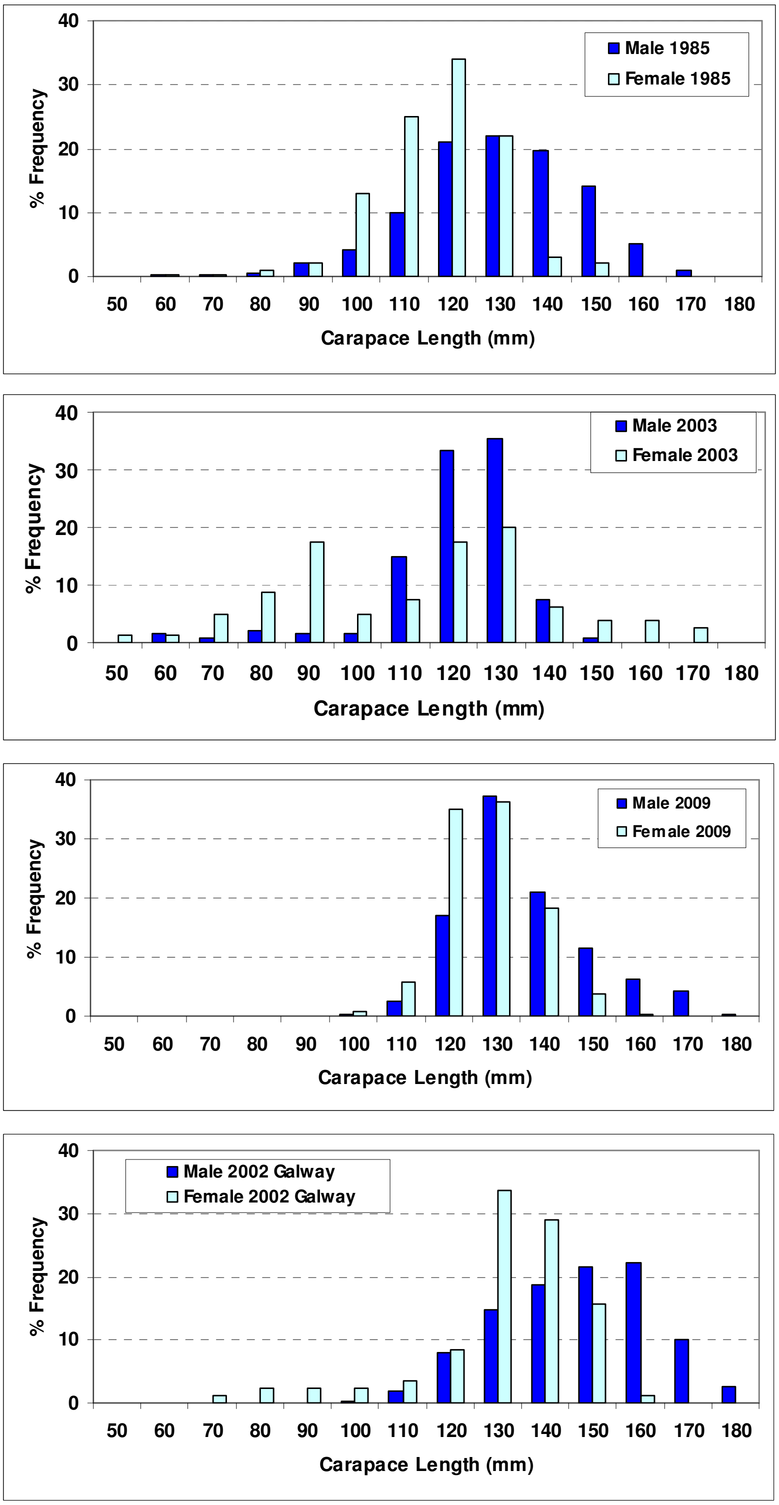

Figure 46. Length frequencies for male and female spider crab recorded from Brandon and Tralee Bays in July/ August 1985, August 2003 and April-June 2009. Data for the 2002 fishery in Galway is shown for comparison.

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13 Glossary (of technical terms as used in this report)

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

Appropriate Assessment An estimation of the degree to which a fishery may impact the environment in which it operates and more specifically how it may affect habitats and species for which the area is designated under the EU Habitats Directive.

Benthic Anything living on, or in, the sea floor.

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

Biological reference points Various reference points can been 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

Bio-toxin Chemicals, of biological origin, accumulated by organisms which have toxic effects when ingested.

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

By-catch Refers to those species captured but not specifically targeted by fishermen during a fishing operation. Some by-catch may be retained if it is commercial. Non-commercial by catch, including undersized fish, is discarded. Discarded fish may be alive or dead.

Connectivity A term describing how populations or stocks of fish of a given species are geographically connected through migration or dispersal. A number of interconnected populations is a meta-population

CPUE /Catch Per Unit of Effort The catch of fish, in numbers or in weight, taken by a defined unit of fishing effort. This quantity can be broken into components of the catch including the LPUE (landings per unit effort), which is the amount of commercial fish of a given species landed for a unit of effort, and DPUE which describes the equivalent for discarded fish.

Discard Discards are defined as that part of the catch returned to the sea as a result of economic, legal or other considerations.

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).

EPR Egg production per recruit. This is a measure of how many eggs a mature fish might produce during its lifetime under a given fishing pattern which determines at what size (age) it is captured and the probability of capture.

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. When two or more kinds of gear are used, they must be adjusted to some standard type

Fishing Mortality Deaths in a fish stock caused by fishing.

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)

Management Plan is a agreed plan to mange a stock. With defined objectives, implementation measures, review processes and 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.

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.

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.

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

SACs Special Areas of Conservation, sites designated under the European Community Habitats Directive, to protect important natural habitats and species.

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

SPAs Special Protection Areas, sites designated under the European Community Birds Directive, to protect important populations of birds.

Standardise (indicators) An indicator eg catch per unit of effort can be reported in its nominal (observed) form or a standardised form. The purpose of standardisation, using the example of catch per unit effort, is to remove variability in the indicator that is not due to changes in fish abundance, which the indicator purports to measure

Terminal Moult Some species such as spider crab reach a terminal size (they stop growing). The moult at which this final size is reached is the terminal moult

V-Notch(ing) The V shaped mark cut into a lobsters tail. These lobsters are protected from fishing.

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

Sample A proportion or a segment of a fish stock which is removed for study, and is assumed to be representative of the whole. The greater the effort, in terms of both numbers and magnitude of the samples, the greater the confidence that the information obtained is a true reflection of the status of a stock (level of abundance in terms of numbers or weight, age composition, etc.)

Shellfish Fisheries Those fisheries were the target species are either crustaceans (e.g. *Nephrops*, lobsters, crabs and crayfish) or molluscs (Cephalopods, scallops, oysters etc.).

Stock A "stock" is a population of a species living in a defined geographical area with similar biological parameters (e.g. growth, size at maturity, fecundity etc.) and a shared mortality rate. A thorough understanding of the fisheries biology of any species is needed to define these biological parameters.

Territorial Sea The sea area inside 12nm from the Irish national baselines.

TCM / Technical Conservation Measures Measures such as minimum landing sizes or gear specifications aimed reducing the landings of certain sizes or types of fish

TAC Total Allowable Catch. Usually the quantity of fish that can be removed from a stock in any given year.

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