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THE STATUS OF THE INSHORE COMPONENT OF THE NORTHERN BROWN CRAB *CANCER PAGURUS* FISHERY, ASSESSED FROM A TIME SERIES OF LPUE CONSTRUCTED FROM HISTORICAL SOURCES.

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Vessels from the Malin Head inshore fleet

SUMMARY

A 27 year LPUE series was compiled from daily landings and creel numbers fished, as reported by a processor and by personnel participating in the activities of a small inshore fleet at Malin Head, Co. Donegal. The fleet targeted brown crab in the late summer and autumn months and the series was compared with two other series of LPUE constructed from data obtained from two fleet sources fishing the same stock. The most significant event to have taken place since records commenced in the late 1970s was the introduction in the 1990s of a small vivier offshore crabbing fleet. Competition between the inshore and offshore components intensified and the inshore fleet responded by further capitalising and increasing its seaward range. Since the mid-1980s the number of boats in the Malin Head inshore fleet pursuing the autumn fishery halved while the total amount of gear increased by 29%. The number of pots set by a vessel in a day averaged 600 in 2004 but in 2000 the practice of fishing two sets of gear simultaneously became established. The vivier boats also moved inshore and the ranges of the two fleets now overlap. In the past 15 years there was a loss of between 37 and 57% LPUE, according to the data assembled in this work. Schaefer analyses carried out on the inshore Malin Head fleet's results and extended to cover the estimated landings of the Donegal inshore fleet, indicate that maximum sustainable yield was almost reached and that the $F_{0.1}$ point was exceeded by both fleets. Any additional increase in F is likely to further accelerate decline in LPUE. The stock is regarded as being close to over-fished in a regime without effective effort controls. The problems associated with managing a fishery of this kind are briefly discussed.

CONTENTS

INTRODUCTION

Brown crab, *Cancer pagurus*, is one of the most important constituent species of Irish inshore fisheries. Provisional figures for 2004 record landings of 13,690 t had a first sale value of €14.5 m (Source: DCMNR).

From 1990 landings of brown crab expanded by an average of 650 t per year (Figure 1), a three-fold increase in ten years. Price per tonne increased from 1996 to 2002 but fell sharply in 2003 and 2004 amid reports from within the industry of landings of low quality product and of market saturation.

The structure of Irish brown crab stocks is not fully elucidated. A major divide is proposed between crab in ICES statistical divisions VIa and VIIb, which make up the largest fishery and which, in 2003, contributed 54% and crab from south east Ireland (divisions VIIa, g) which accounted for 7% of the landings in 2003. More is known of these two stock divisions than of any other. Crabs in both have distinctive migration patterns, with females in divisions VIa/VIIb migrating out to the shelf edge. Tagged crab in the northern stock have been recovered from as far south as Co. Galway. In the south east, females migrate south into division VIIg and possibly into division VIIf, their migration patterns probably guided by the circulation patterns around the Nymphe Bank in the Celtic Sea. Tagging studies will further elucidate stock structures. The most distinctive differences between the northern and south eastern stocks is the LPUE which in the south east in 2002 was approximately half the value recorded in the Donegal offshore fishery (Fahy *et al.*, 2004).

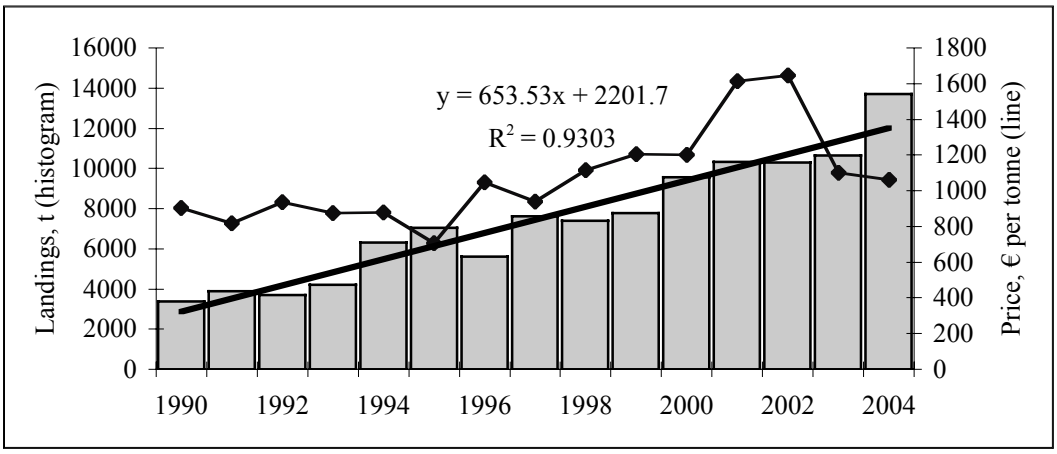

Figure 1. Landings to Ireland and first sale price of brown crab, 1990 – 2004.

The northern brown crab stock is the best documented brown crab fishery in Ireland. Observations have been made on its biology by Fox (1986[a-d]) and Cosgrove (1998) and a major investigation of migratory movements was undertaken by Robinson *et al*. (2002). Tully *et al.* (1998) devised a computerised system for collecting catch effort data from the offshore super crabber vivier fleet since 1991 and that exercise has continued until the present time; the data series has been updated in a number of international fora. Some data have been collected on the inshore fleet component by Robinson *et al*. (2002) although its coverage is more sporadic and less comprehensive.

The distribution of landings in 2003 (Figure 2) emphasises the importance of the northern crab stock.

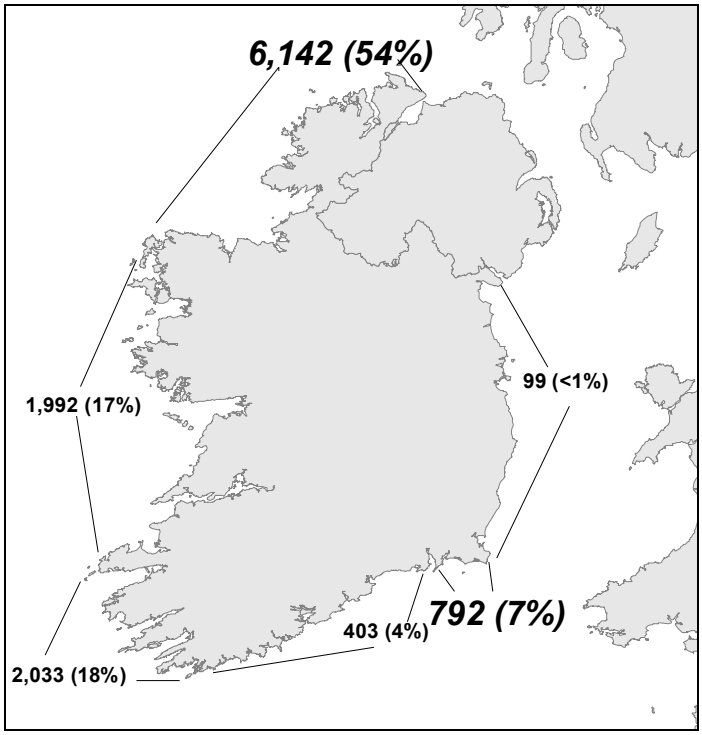

Figure 2. Landings, tonnes (percentage national landings) of brown crab to Ireland in 2003. The heavy font identifies the northern and south east crab groups

Crab fisheries are difficult to assess because crab cannot be aged and little is known about stock: recruitment relationships. One method of managing a stock is to ensure its LPUE levels remain stable.

LPUE may be measured in a number of different ways of which the most precise would be the landings and discards quantified from a single pot, set at a marked location and fished for a known soak time. More imprecise indicators are the landings per boat per day without any indication of the size of the vessel or the amount of gear used and with only an approximate indication of location but estimated on the assumption that the fleet contains similar vessels that operate in a standardised way over the short to medium term.

Generally, vessels fishing in Irish coastal waters do not complete logbooks. These boats are described as under 12 m in length although the Irish inshore fleet includes boats that exceed this dimension (Steins, 2001). An alternative definition might be the term “day boat” which describes the activity pattern of such vessels, setting out in the morning and returning to port before nightfall. Landings from boats of this kind are made daily and this statistic is recorded by fish buyers and processors in their “books inwards” purchasing accounts. Daily consignments are a crude measurement of the performance of the vessels in question because they do not take into consideration the length of time actually fishing, as opposed to steaming, nor the amount of gear used on a particular date. Sometimes however, daily consignment weight is the only available indictor of fishery performance and the statistic has been used to provide a time series for Irish inshore shrimp (Fahy *et al.*, in prep) and whelk (Fahy *et al.*, 2005) and brown crab fisheries (Fahy *et al.*, 2004). Brown crab may be accumulated in keep boxes prior to sale and this obscures recognition of a daily consignment (Fahy *et al.*, 2002).

The availability of a time series of daily landings dating from 1978 to 2004, provided by a single processor who was supplied by a small inshore fleet exploiting the northern crab stock, prompted this investigation. One of its purposes was to evaluate the utility of daily consignments as a method of monitoring performance in the context of the detailed information gathered by more sophisticated methods from the co-existing offshore vivier super crabber fleet and the LPUE data collected over a shorter period from the inshore vessels of essentially the same fleet and stock, although not necessarily the same fishery. The data were also used to assess the status of the brown crab stock available to the inshore fleet, using a Schaefer analysis (King, 1995).

MATERIALS AND METHODS

A buyer of brown crab provided details (dates and weights) of individual consignments from which the weight of total annual landings (TL) and number of consignments (Nc) of the fleet in question were obtained. Annualised daily consignment weights (Dc) were obtained from TL/Nc. Personnel working in the Malin Head fishery supplied details of gear in use, in particular the average number of pots set annually (Np). The assumption was made that all vessels belonging to this fleet fished on each fishing day and that the same average number of pots contributed to the average weight of a consignment of crab landed in a particular year. The average landing of crab per pot (LPUE/pot/day) was therefore Dc/Np.

The measurements of LPUE obtained in this way were either used directly or the calculated log/normal plot of LPUE against time was used. Values for years in which data were not available were either interpolated or they were omitted from the calculations.

The total effort in each fishing year was obtained from the formula: [TL/(LPUE/pot/day)]*Np.

The exercise was repeated using the landings to Co. Donegal reported by DCMNR from which the estimated landings of the vivier super-crabber offshore fleet were deducted.

Schaefer analyses of the inshore fishery were performed using LPUE data from this fleet and the landings from this fleet and landings to Co. Donegal after the estimated landings to the offshore vivier sector had been deducted.

Statistical packages used in the work were Microsoft Excel 9.0 and SPSS 11.0.

RESULTS

The Malin inshore crab fishery and fleet

The fleet consisted of vessels based in a number of ports along the north east Donegal coast: at Greencastle, Bunagee (Culdaff), Glengaad and Malin Head. Landings to this area increased between 1995 and 2003 although they declined slightly as a percentage of the total landings into Co. Donegal (Table 1). Some brown crab were landed by vessels other than those belonging to the inshore Malin Head fleet and the landings in Table 1 were made during the full calendar year, whereas this investigation concerns daily landings in the second half (July – December) of the year only.

Table 1. Landings of brown crab to ports in Co. Donegal, 1995-2004. (Source DCMNR)

	1995	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
Greencastle	120	291	314	151	145	166	660	396	356	260
Glengad	121	19	98	110	174	202	301	344	50	437
Malin Head	930	737	1028	808	792	760	1037	1056	1256	1424
Urris	111	147	144	153	139	159	115	122	140	165
Buncrana	0	3	0	0	0	0	0	0	0	0
Fanad	174	150	153	120	243	162	177	233	328	132
Rathmullan	0	15	41	40	46	91	291	74	168	156
Downings	897	892	807	894	1042	873	2200	2069	2283	2545
Killybegs	88	131	79	8	52		34	278	379	420
Burtonport	393	206	581	574	722	847	502	450	318	211
Bunbeg	55	68	36	0	127	22	27	53	7	8
Dunfanaghy	41	41	46	57	53	30	29	66	67	72
Magherarorarty	51	40	68	53	52	19	19	33	0	197
Teelin	16	9	23	27	27	28	0	0	0	45
Malinmore/Malinbeg	1	3	2	0	0	0	1	0	0	10
Rosbeg/Portnoo	29	11	11	4	0	0	0	0	0	2
Total	3027	2764	3431	2999	3614	3359	5393	5174	5352	6084
Malin Head, Glengaad, Greencastle as % total	39	38	42	36	31	34	37	35	31	35
Estimated total to Donegal inshore crab boats (t)	1312	1333	1789	1162	2070	1596	3149	2652	3056	3788

(Landings attributed to inshore crab fleets in Co Donegal in other years were: 2,636 tonnes in 1991, 2,390 tonnes in 1992, 1,735 tonnes in 1993 and 2,219 tonnes in 1994.)

Crab were exploited during most months of the year by vessels landing into the Malin Head Fishermen's Co-operative Society Ltd., but there were some seasonal differences in the way the fishery was organised. Soft-eyed creels were put out in spring when mainly female crab were harvested, nicked (the adductor muscle of the chileped was cut) and stored in ponds to be sold on. In the late summer when crab migrated inshore and were in best condition, the same gear was used to harvest hen crab that were transferred for whole crab processing to the factory which supplied the data used here. Each consignment recorded represents one day's fishing by one vessel but further details of the amount of gear used to make the landings were not available, nor could individual boats be linked to specific consignments.

In the 27 years covered by the data, the fleet underwent considerable change. Commencing in the 1970s, the number of pots used by a vessel averaged 200. Technical developments in navigational aids and hydraulic gear recovery methods allowed that number to increase. In the 1980s the number of pots per boat had risen to 300 creels and in 1985 the total effort in the fishery was estimated to be some 35 boats using *c*10,000 pots.

The introduction of vivier crabbers in the 1990s prompted a competitive increase in gear that was accompanied by various changes to the inshore fleet.

A tow (gang or train) of creels numbered approximately 50 in this area and the addition of gear was described as one or two tows to a boat in a year, when such a development occurred. In our reconstruction of an effort series, we assumed that half a train (25 pots) was added by each vessel from 1989 to 2000. More detailed information was available for the last five years (2000-2004) and this allowed us to estimate that an average 600 pots per vessel were in use at the end of the 1990s. The data that are summarised in Figure 3 suggest that effort stabilised in the last four years, but this would be incorrect.

Seventeen vessels were identified as participating in this fleet in 2004. In 2003 one vessel had fished 850 pots with a one day soak time but this boat, the following year, adopted two sets of 700 pots and this pattern is becoming the rule among boats of 12 m. In 2000, five of the larger inshore vessels began to fish two sets of 700 pots on alternate soaks, doubling the amount of gear per vessel and further increasing the effort by extending the soak time. Tully *et al.* (1998) demonstrated that a longer soak time of up to three days is rewarded by an increase in catch. Adverse weather conditions frequently prolong soak times in inshore fisheries but two sets of gear ensure that, even in favourable weather conditions, effective fishing time will be longer.

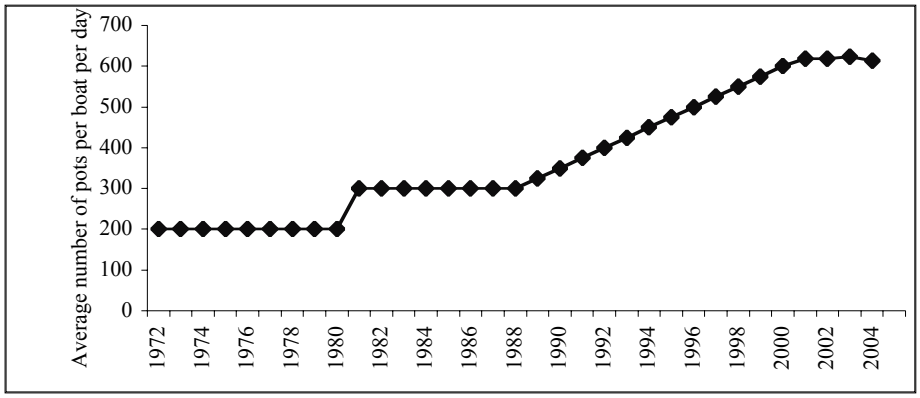

Figure 3. Reconstruction of the average number of pots in use each year in the Malin Head inshore fleet, 1978 – 2004 inclusive.

Crew size ranged from 3 to 5 people on the bigger boats. Some inshore fishermen operating on this coastline stated that when the larger vivier boats were first introduced, they supposed that the boats would remain far offshore; in recent years the super-crabbers have moved within 6 nm. Some of the larger inshore boats currently fish out to 20 nm from shore so that there has been overlap in the ranges of the two fleets. Table 2 summarises the amount of gear in use in this fishery:

Table 2. Gear use in the fishery

Year	Boats	Pots	% change
1985	35	10,000	
1999	20	12,000	20
2004	17	12,900	7.5

Between 1985 and 2004, the number of boats in this fishery declined by 51% while the amount of gear in use increased by 29%.

The landings

"Buying-in" data for the period 1978-2004 consisted of the weights of crab consignments purchased within the Malin Head fishery area on given dates. In all 18,482 consignments covering 17,991 tonnes of brown crab were documented. Between 1991 and 2004 the landed animals which were subsequently rejected by the factory were quantified and these data were added to the amounts processed in order to obtain a consignment size.

The data were first of all screened to remove any consignments that might have been bulked. All consignments were grouped into six periods each covering half a decade.

The weight frequencies of the consignments bought-in by the company were unimodal and positively skewed in the majority of the six periods of 5 years into which they were grouped, an exception being the period 1980 – 1984 in which there was a suggestion of a second mode. On the basis that higher modal groupings are more likely to contain bulked consignments, the decision was taken to select a threshold above which bulked landings were a distinct possibility. This was 3,000 kg (Figure 4) which, in all cases, accommodated the first mode of the weight frequency distribution. In the early 1980s when the stock was probably more abundant, daily landings of 4 tonnes were occasionally made (O'Donnell *pers comm*) and that might have been an alternative cut off point.

In each of the half decadal periods, the incidence of consignments <3,000 kg varied. None reached this threshold in 1978-1979. Thereafter the percentages below 3,000 kg were 83, 94, 96, 99 and 100% (rounded to the nearest whole number) in each of the five remaining five year intervals. Details of the two weight frequency series are set out in Table 3.

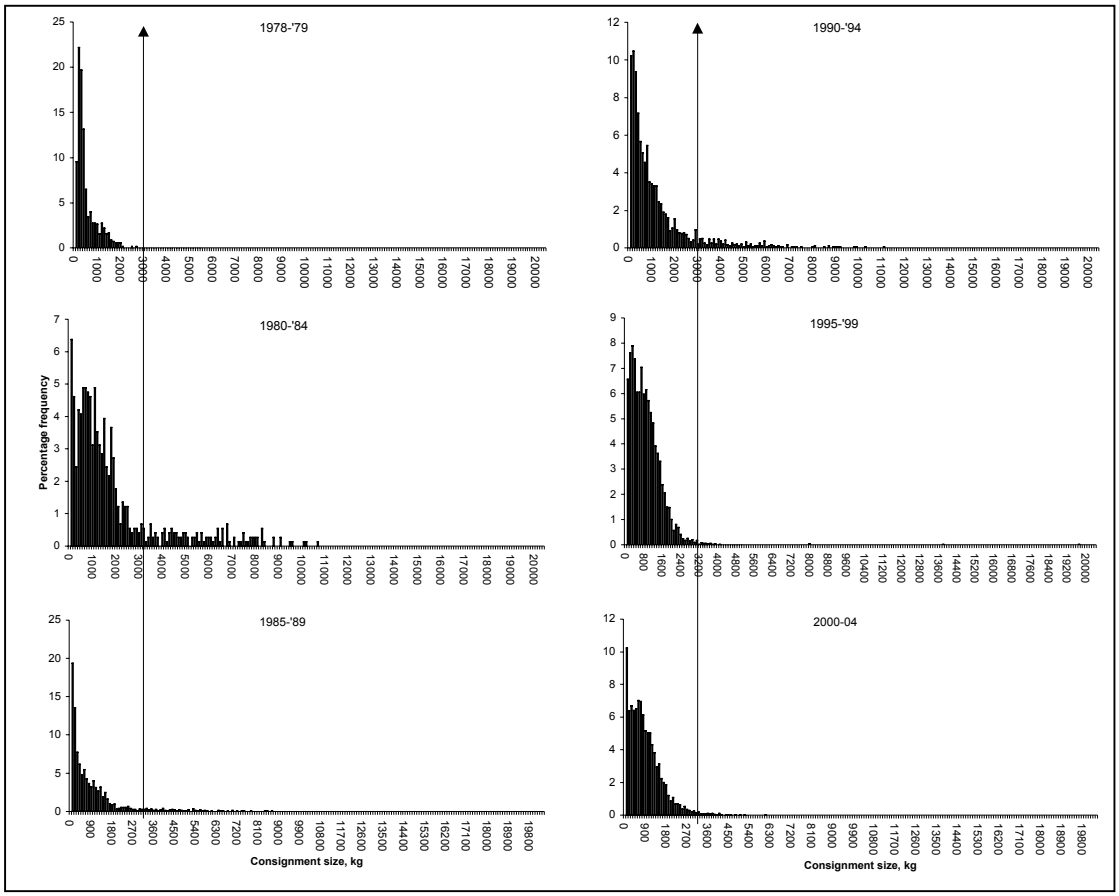

Figure 4. Percentage weight frequency distributions of consignments of brown crab from the northern crab stock landed by the inshore Malin fleet, in five yearly intervals.

Table 3. Weight of all consignments and of consignments less than 3,000 kg in each of six periods from 1978 - 2004 inclusive

Period	All consignments		
	Mean	Standard deviation	Count
1978 - 1979	462	437	722
1980 - 1984	1,812	2,004	737
1985 - 1989	837	1,146	2,170
1990 - 1994	1,225	13,255	5,016
1995 - 1999	858	2,067	5,105
2000 - 2004	841	681	4,732
	Consignments < 3,000 kg		
	Mean	Standard deviation	Count
1978 - 1979	462	437	722
1980 - 1984	1,031	701	613
1985 - 1989	608	605	2,046
1990 - 1994	779	618	4,801
1995 - 1999	808	569	5,071
2000 - 2004	807	609	4,676

In Figure 5, consignment weights are averaged on an annual basis from 1991 until 2004. Consignment size tended upwards over the 14 years, increasing from 748 kg in 1991 to 853 kg in 2004. All annual weight frequency distributions in the period 1991 – 2004 inclusive were compared by one way ANOVA and significant differences ($P<0.05$) are set out in Figure 6. The most distinctive years were 1997, 1998 and 1995, possibly indicating the years of greatest annual change in the fishery.

Mean consignment weight per month (+/- 1 s.d.) for the duration of records is shown in Figure 7. The fishing season usually ran from August to December inclusive and fishing in July commenced only in the mid-1990s. From 1991 (there were no records for the previous year) until 1999 the fishery provided similar yields, average consignment size being stable throughout. Consignment size rose from July to reach a peak in October after which it declined to December. The two years 2000 and 2001 displayed a fall in yield to among the lowest or the actual lowest value(s) in the series from 1991.

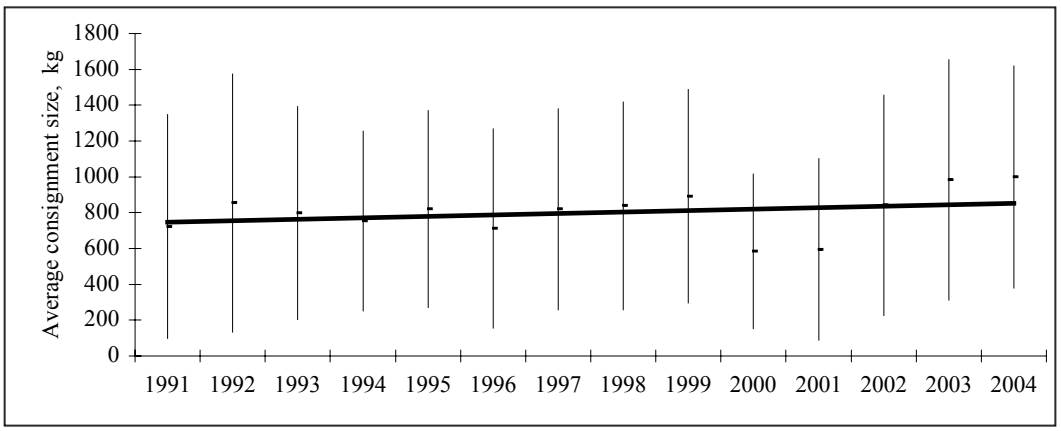

Figure 5. Annually averaged consignment weights (+/- 1 s.d.) of brown crab landed daily by the Malin inshore fleet, 1991 – 2004.

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1991						x								
1992							x	x	x			x		
1993				x	x		x							
1994			x		x		x							
1995			x	x			x	x				x		
1996	X													
1997		x	x	x	x			x				x		
1998		x			x		x		x			x		
1999		x						x						
2000											x			
2001										x				
2002		x			x		x	x						
2003														x
2004													x	
Totals	1	4	3	3	5	1	6	5	2	1	1	4	1	1

Figure 6. One way ANOVA of daily consignment weights compared annually.

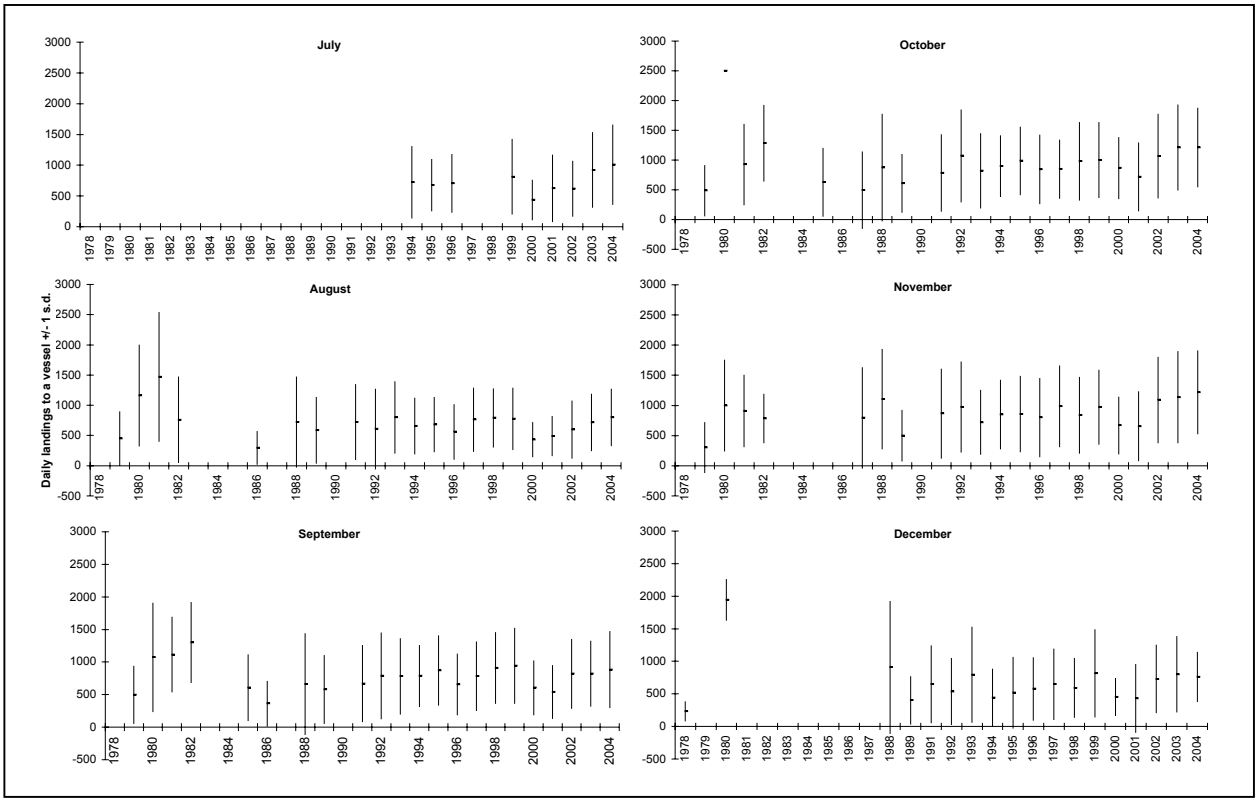

Figure 7. Mean +/- 1 s.d. of consignment weight (kg) of brown crab landed from the Malin Head inshore fishery in each month from 1978 to 2004 inclusive.

LPUE

Pot numbers (Figure 3) and consignment sizes were combined to produce an LPUE series in Figure 8. This, in turn, was compared with the existing LPUE series of Tully *et al*. (1998) and Robinson *et al.* (2002) in Figure 9 and, finally, the trends of the three series were compared as fitted log normal regressions in Figure 10. A fourth data series, compiled from the complete recent data set (1980 - 2004) is not included in the above: $y = -0.04x+80.289$. N=24, $R^2=0.5275$ and $P<0.0001$.

Differences might be expected in LPUE data from different sectors of a fishery, the three time series of LPUE from 1990 – 2004 provided similar trends in LPUE although the offshore fleet and inshore Malin curves were more similar to each other (LPUE is expressed as annualised kg per pot lift) (Table 4).

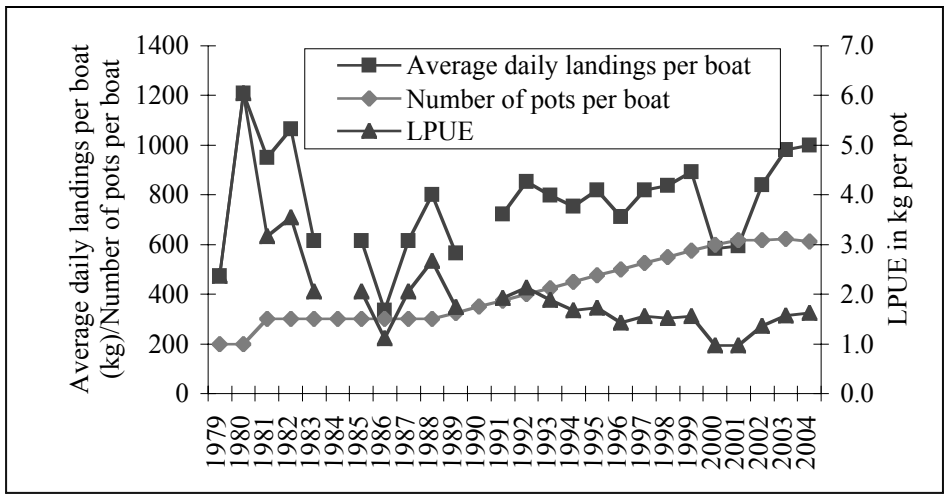

Figure 8. Average annual consignment weight and pot numbers and the LPUE series obtained from them.

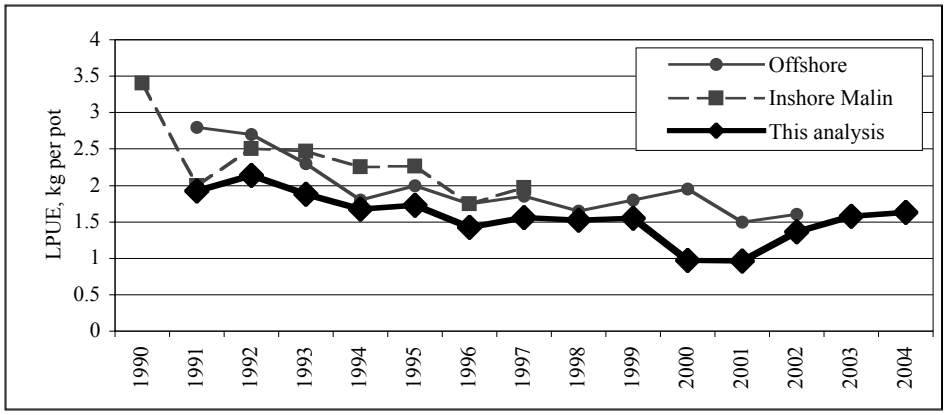

Figure 9. Three LPUE series for the northern crab stock compared: Tully (offshore), Robinson (inshore) and this series (inshore Malin fleet).

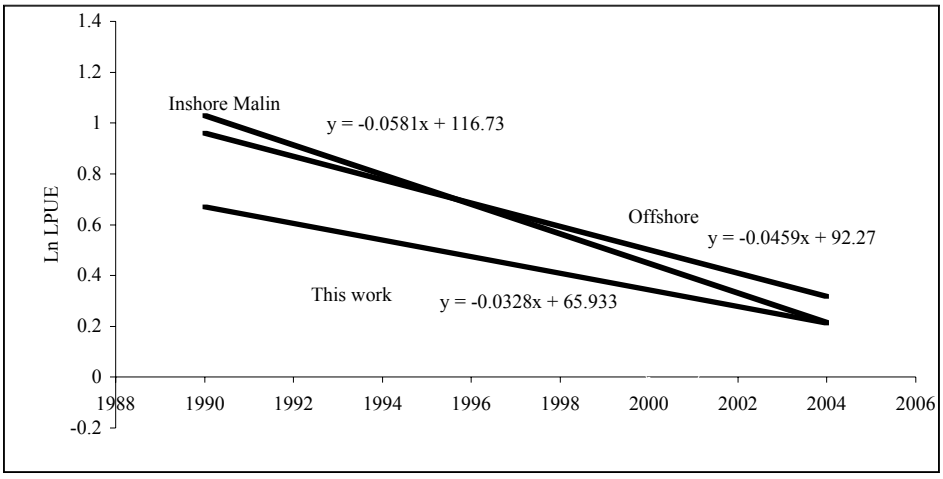

Figure 10. Log/normal plots of LPUE for the three data series in Figure 9, extended to cover the period 1990 – 2004. For the offshore fleet, R^2=0.7044, N=12 and P=0.0006 for the inshore Malin data R^2=0.5011, N=8, P=0.049 and for this analysis, R^2=0.3643, N=14 and P=0.02.

Table 4. LPUE Data from three time series (1990 - 2004) and this study (1980-2004).

	1990-2004 Inshore Malin	1990-2004 Offshore	1990-2004 This Study	1980-2004 This Study
LPUE in 1980	3.0	2.5	1.9	2.0
LPUE in 2000	1.3	1.3	1.2	1.1
% Loss	57	48	37	45

Appropriately, the latest data in our investigation were based on a more detailed account of gear in use in this fishery in the most recent years when convergence was greatest.

Schaefer analyses were undertaken, on the basis that similar LPUE values applied throughout the inshore sector of the northern crab stock, using the LPUE data obtained here in raw data form and derived from the log normal regression of the LPUE series from the Malin inshore fleet. The total autumn landings attributed to the inshore Malin fleet were used to obtain the yield: effort calculations for the Malin inshore fleet. In the case of inshore landings to Co. Donegal, these were as reported by DCMNR (Table 1) after deduction of landings estimated for the offshore vivier fleet. Both the raw LPUE data and those derived from the fitted log normal curve provided closely similar outcomes for maximum sustainable yield (MSY) and f_{msy} though not for $F_{0.1}$. The results of the analyses (Figure 11) are summarised Table 5.

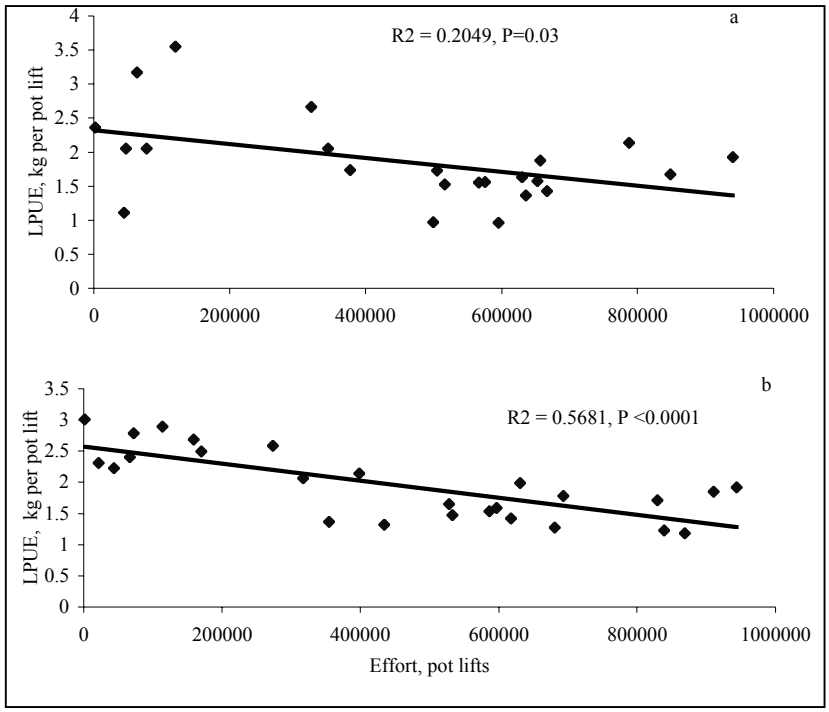

Figure 11. Correlation between LPUE and total effort in the Malin Head inshore fleet, a, raw data and b, values from the log normal correlation of the data. The value for 1980 was omitted from both data sets.

Table 5. Correlation between LPUE and total effort in the Malin Head inshore fleet,

	MSY (kg)	f_{msy} (pot lifts)	$F_{0.1}$(pot lifts)
1. All Donegal inshore fleet - log normal	3,878,893	4,083,980	2,500,000
2. Malin Head inshore fleet - log normal	1,203,286	933,039	425,000
3. Malin Head inshore fleet - raw data	1,105,826	785,521	730,000
Ratio of Donegal/Malin Head 1:2	3	4	6
Ratio of Donegal/Malin Head 1:3	4	5	3

The Malin Head fleet represented a substantial component of the inshore effort in Co. Donegal, accounting for 29-31% of the MSY in the inshore crab fishery in the county (depending on which data series was used in the calculation). Its capacity was large and pot lifts by the Malin inshore fleet represented 19-23% of those required to achieve MSY within the inshore crab fishery. The amount of effort required to reduce the rate of increase in annual yield to 10% of its initial value is 17-29% of that required for the Co. Donegal inshore fishery for crab as a whole.

The Schaefer curves suggest that the yield to effort relationship was similar in the inshore fishery in Co. Donegal and in the Malin inshore fleet. In both, current levels of fishing were close to MSY and in the case of Malin, f_{msy} might be exceeded at less than calculated MSY. In both cases $F_{0.1}$ levels were surpassed. The stock is regarded as being close to overfished, in a regime without effective effort controls.

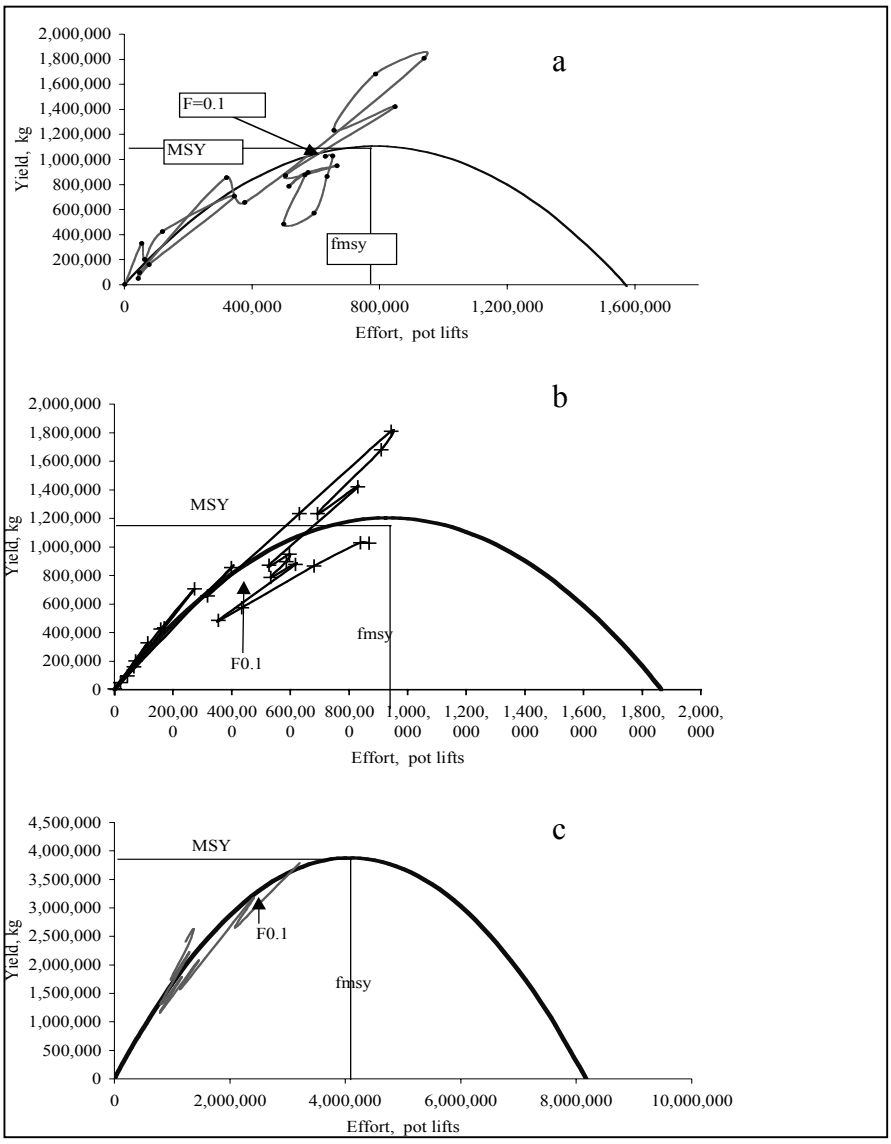

Figure 12. Schaefer models of the relationship between yield and effort (established on the relationship between LPUE and effort (pot lifts)) in (a) the Malin Head inshore fleet, raw data and (b) the Malin Head inshore fleet, ln normal series and (c) the Co. Donegal inshore fishery, ln normal series.

DISCUSSION

Before discussing the outcome of the LPUE time series, a reminder that they may not be strictly comparable is appropriate. The latest data for the Malin Head inshore boats came from a fleet that operated mainly within 12 nm from shore, but during only the second half of the year. The exact provenance of the Malin inshore series (Robinson *et al.*, 2002) is not known. It might well be the same vessels operating throughout the year or selected vessels which completed log books and which for that reason, might present a biased sample of total fleet activity. The offshore sector consisted of more mobile vessels capable of targeting higher densities of crab and setting gear directly upon them. These vessels operated increasingly in both inshore and offshore waters.

The data presented here indicate dramatic depletion in a stock whose abundance may have halved over 15 years. That much was clear from the two earlier datasets although the latest inshore one suggested the decline, while dramatic, might not have been so serious. However, brown crab congregate in shallow waters during the summer months and their abundance at that time might not give a true account of stock abundance over its wider range. Calculations based on the longer data series (from 1980) used in the present work had a very similar outcome to the Malin Head and offshore time series.

The Malin Head inshore crab fishery, probably in general agreement with the trends in the more extensive Co. Donegal one, had a declining LPUE for almost as long as the records exist. In the 1990s the decline accelerated with the introduction of the offshore vivier crab boats and it represented either a dilution effect (the sharing of a resource of finite size among a greater number of creels) or a real decline in the abundance of the animals.

The offshore LPUE series compiled by Tully is the most authoritative of the three and it shows three phases: between 1991 and 1994 the LPUE declined as older animals belonging to a hitherto more lightly fished stock were removed; thereafter LPUE stabilised until 2000 when it again fell. The latest ICES SGCRAB report (Anon, 2004) has not reported data for 2003 or 2004, therefore it is not possible to continue the series further. The offshore fleet is mobile, moving gear to the highest densities of crab hence the prevailing high LPUE data for this fleet may not represent the true abundance of the animals; the area in which fishing takes place is known to have expanded considerably since the vivier crabber sector came into existence in the early 1990s.

From an economic perspective the decline in LPUE has driven the restructuring of the fishing fleet and, consequently, capitalisation of the fishery. This is reflected in the high levels of investment made by remaining fishermen in boats and gear at a time when real return on investment is, at best, stable or declining.

However uncertain the significance of the assessments, a precautionary approach is required where future developments are concerned. The necessity for such an approach is emphasised by the lack of any mechanism for withdrawing effort from an over-fished stock. The “western waters” regulation (1954/2003/EC) foresaw that the Commission would revise and update effort ceilings for edible crab and spider crab by which fishing effort would be allocated on the basis of kilowatt/days. The kilowatt/days limits applying to the area in question were published in 1415/2004/EC.

However, within the sea area occupied by the northern crab stock, this applies only to vessels equal to or greater than 15 m. For pot fishers, there is flexibility within these limits to better utilise time at sea by setting several sets of gear simultaneously and thus increasing effort by prolonging soak time. Evidence of certain inshore vessels within the Malin fleet using two sets of gear since 2000 is provided. This option is also open to inshore fleets that are, in addition, not constrained by any kilowatt/days ceiling at present.

The proximity of current landings and effort to MSY and f_{msy} must cause concern in the Donegal fishery. Were declining LPUE to accelerate further, an escalation in effort is the likely response causing further and long term damage to the resource.

Though indicating marginal increases in average gross returns per consignment, the economic data have to be considered against the backdrop of substantial investment by vessel owners in boats, technology and gear. Factoring in the increased cost of fuel and other operating costs, data derived from CSO over the period, suggested that real returns on investment declined. Those participating in the fishery were faced with a cost-price squeeze wherein both capital and operating costs rose substantially in recent years but returns on fishing effort were essentially negative. This process drove owners out of the crab fishery as capital costs escalated. However, rather than leading to much needed reduction in overall fishing effort, remaining fishermen invested in greater quantities of gear in an effort to maintain their catches and income. Without fundamental changes in the open access nature of this fishery, one can expect these trends to continue into the future with detrimental consequences for both the fishery and those communities that it supports.

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