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**The transport chain of velvet crabs from Orkney, the Western Isles
and Northumberland to Spain**

A Preliminary Review

Dr. A. R. Hearn

For Sea Fish Industry Authority

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Contents

1.	Introduction	5
1.1	Species Description	5
1.1.1	General description	5
1.1.2	Recent and current research	7
1.1.3	Biology relating to the fishery	8
1.2	Legislation	9
1.3	Aims and Objectives of study	9
2.	Background of fishery	11
2.1	Europe	11
2.2	UK	12
2.2.1	Orkney	12
2.2.2	Western Isles	14
2.2.3	Northumberland Coast	15
3.	Methodology	16
4.	Results	19
4.1	Treatment at Source	19
4.1.1	Orkney	19
4.1.2	Western Isles	20
4.1.3	Northumberland	20
4.2	Amounts Moved	21
4.3	Transport and the Transport Chain	22
4.3.1	Vivier Transport	22
4.3.2	The Transport Chain	23
4.4	Costs, Mortality and Gross Profit	28

5. Discussion	38
References	41
Appendices	43
Appendix A: Contact Names and Telephone Numbers	43
Appendix B: Regarding Vivier Lorries and Ferried	45
Appendix C: Call-cards for Contacts	48

List of figures

1.1 <i>Necora puber</i> , the velvet swimming crab	6
2.1 Catch and income of velvet crabs in Orkney (Data from OIC, 1998)	12
2.2 A double-eyed creel	13
2.3 Catch and value of velvet crabs, Western Isles 1997-2001 (Data from Stornoway Fisheries Office)	14
4.1 Amounts of velvet crabs marketed by different merchants annually. Blue diagonal shading refers to Orkney, red horizontal: Northumberland; green vertical: Western Isles.	21
4.2 Generalised pattern of flow of velvet crab produce from fisherman to consumer.	24
4.3 Approximate tonnage of velvet crabs imported and exported by company in a year. Red horizontal: UK exporters; Blue diagonal: Spanish importers.	25
4.4 Point of origin of velvet crabs sold in Mercamadrid in December 2001, from <u>www.mercamadrid.es</u> , those sections in red patterns refer to areas within Spain.	27
4.5 Approximate weekly sales of velvet crabs (kg) at wholesalers. Red horizontal stripes: Barcelona; Blue diagonal stripes: Madrid.	28
4.6 Transport routes and time taken from UK locations to Spain	30
4.7 Mean monthly mortality at packing (1999-2000) from Hearn (2001)	32
4.8 Percentage discards for various reasons in 1999 and 2000 (from Hearn, 2001).	33
4.9 Mean monthly prices at first and last sale for velvet crabs in Orkney and Spain, 2000 (from Hearn, 2001).	34
4.10 Monthly weight of velvet crabs sold at Mercamadrid in 2001 and mean monthly prices in euros (1€ = approx. £0.65) from <u>www.mercamadrid.es</u>	36

List of tables

1.1. Biological parameters of different stocks of velvet crab (González-Gurriarán, 1985a, 1985b; Norman, 1989; Choy, 1986; Hearn, 2001) Sizes refer to carapace width.	8
2.1 Catches of swimming crabs in metric tonnes (source: FAO Yearbook, vol.80,1995).	11
4.1 Ratio of shellfish: water required for different species of shellfish during vivier transport, according to Lurreitxaso and Tarbert Shellfish.	22
4.2 Amount of velvet crabs (kg) sold in Mercamadrid since 1997, from www.mercamadrid.es	27
4.3 Activity and range of time period (hours) according to interviewees	31
4.4 Range of prices per kilo product and main costs incurred at each stage of velvet crab transport chain	37

1. Introduction

1.1 Species Description

1.1.1 General description

The velvet swimming crab, *Necora puber* (L.) is a true crab of the family Portunidae (swimming crabs). Portunids are rapidly moving marine crabs, which are able to swim, due to the propulsion caused by action of the last two podomeres, which are flattened into paddles. Of the seven portunid species occurring in the British Isles, it is the largest (Ingle, 1983). It has previously gone by a variety of names, including *Portunus puber* (L.) (Leach, 1814), *Macropipus puber* (L.) (Christiansen, 1969) and *Liocarcinus puber* (L.) (Ingle, 1980).

Its common name, the velvet swimming crab, is subject to local variations, known as the devil crab, lady crab or velvet fiddler crab, amongst others.

The velvet swimming crab is predominantly black or brown, with short, light brown hairs covering the exoskeleton, giving it a characteristic "velvety" feel. The adult has a carapace length of up to 65mm and carapace width of about 90mm although larger crabs have been recorded (MacMullen, 1983).

The dorsal surface of the carapace is flattened and the frontal margin has up to ten narrow unequal teeth of which the middle pair is the largest (Hayward and Ryland, 1990). The dactylopodite is provided with median and marginal ridges. The most distinguishing features of the crab are its eyes, which are bright red (Figure 1). There are also red, black and blue markings at the joints or on the legs and pincers (Hayward and Ryland, 1990).

Sex is distinguished by the shape of the abdomen. Males have a triangular abdomen, with the third, fourth and fifth segments fused. The female abdomen is large and rounded, with seven segments. Males have two pairs of pleopods, which are developed for copulation, whereas females have four pairs of pleopods lined with fine hairs, specialised for carrying eggs.

N. puber is widely distributed around NW European waters, from the Norwegian coast at 61°N (Christiansen, 1969) down to what was the Spanish Sahara, 24°N (Capart, 1951). In the Mediterranean, it is limited to Spanish, French and Adriatic coasts (Clark, 1986).

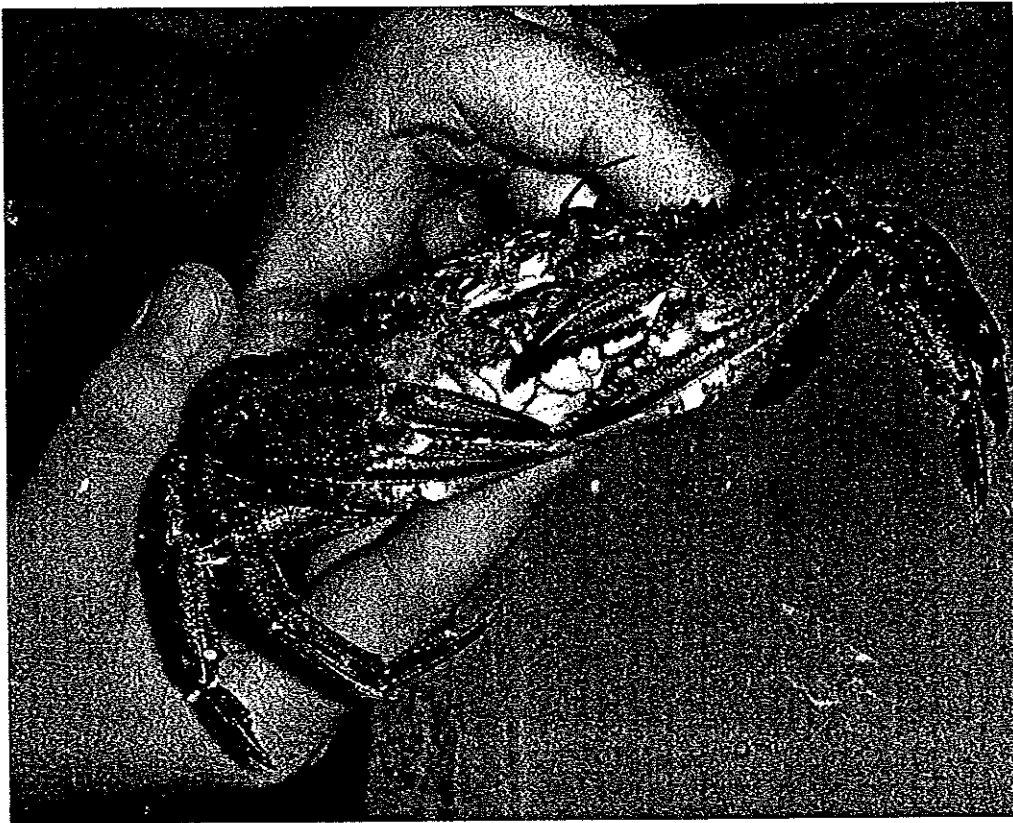


Figure 1.1 *Necora puber*, the velvet swimming crab

N. puber, unlike the other portunid species occurring in British waters, which prefer sand or gravel, is found on rocky substrates from the lower shore down to 70m (Hayward and Ryland, 1990). It also occurs in large numbers under mussel rafts in the rias of Galicia, NW Spain (Gonzalez-Gurriarán, 1981). This is due to the increased food supply and changes in the sediment arising from shell deposits (Romero *et al*, 1982).

Individuals may also be found at greater depths, but those occurring deeper than 80m are typically bright orange in colour, with fair-coloured setae. It has been proposed that these "red velvets" may belong to a separate stock (MacMullen, 1983).

1.1.2 Recent and current research

As the velvet crab has gained in commercial importance, so scientific studies have focused on those aspects of its biology directly related to its viability as a commercial product.

Early work on *Necora puber* focused on larval development (e.g. Lebour, 1928; Rice and Ingle, 1975), feeding habits (Czepa, 1907; Kitching and Ebling, 1967), moulting (Drach, 1933), chemoreception (Laverack, 1963), cheliped abnormalities (Calman, 1913; Audigé, 1927 and Aberloos, 1932) and parasites (Bourdon, 1965).

The first systematic study of a population of velvet crabs was not carried out until 1981. González-Gurriarán (1981, 1985a, 1985b) carried out a thorough analysis of the population of velvet crabs in the rias of Galicia, in northern Spain, once it became apparent that the stock was showing signs of overexploitation.

The UK population of velvet crabs has since been the subject of PhD theses by Glass (1985), Choy (1986), Norman, (1989), Bakir (1990) and Hearn (2001). These studies have focused on distribution, reproduction, and growth and mortality. In some cases, behaviour, meat quality and larval and juvenile phases have also been addressed. Hearn (2001) carried out preliminary stock assessment and commenced a long-term dataset currently being continued at Heriot-Watt University for the Orkney stock. In addition to this, the Shetland (Tallack, North Atlantic Fisheries College) and Mainland Scotland (Combes, Marine Laboratory Aberdeen) stocks are the subjects of current PhD theses, soon to be completed.

On a commercial level, Whyman et al (1985) carried out a study of the mortality rates of the velvet crab during transport and storage. MacMullen (1983) reviewed the velvet crab fishery in the UK, with reference to the capture and transport of the product. Hearn (2001) and González Escalante and González-Gurriarán (1984) have

examined use of different baits and soak times for the capture of velvet crabs. There is currently a team at Hull University researching methods for improved packing and transport of velvet crabs. Once company in Spain is also researching the possibility of storing and feeding velvet crabs on arrival in Spain.

1.1.3 Biology relating to the fishery

When carrying out stock assessment for the purposes of aiding the sustainable management of a stock, certain aspects of the biology of the stock are required. These include the determination of the reproductive cycle (e.g. periodicity, fecundity, size at maturity) the growth of the stock (the moult process, moult frequency and moult increments) and an indication of abundance and distribution.

Table 1.1 summarises some of the main characteristics of stocks of velvet crab in some different areas.

Table 1.1. Biological parameters of different stocks of velvet crab (González-Gurriarán, 1985a, 1985b; Norman, 1989; Choy, 1986; Hearn, 2001) Sizes refer to carapace width.

Parameter	Galicia	Plymouth	South Wales	Orkney
Highest fecundity	448786	366000	262000	278000
Maturity fem. mm	49.8-52.3	40.5-48	37.5-38	38-43
Maturity mal. mm	53.3-54.7	46.5-48.5	42-54	51
No. rep per year	2	2	2	1
Age at sex. mat	1yr	1.5yrs	1.5yrs	3yrs
Max size fem	96mm	97.8mm	83mm	98.4mm
Max size male	109mm	107.25mm	107mm	98.4mm
Total mortality	1.53-1.79		1.71-2.01	0.96-1.2
Natural Mortality	0.3-0.5		1.2-1.4	0.2-0.3
Longevity (years)	4			8

As can be seen from the table, the velvet crab shows considerable plasticity in terms of its vital parameters, depending on its geographical location. The stock in Spain is fast growing and short lived compared with the Orkney stock. This has implications

for the management of the fishery, especially in terms of setting minimum landing sizes (which are generally aimed at allowing each individual at least once chance of successful reproduction) and establishing closed seasons (which normally coincide with the times of peak reproductive or moulting activity).

1.2 Legislation

UK inshore creel vessels are required to hold Miscellaneous Shellfish Licences, but other than this, there are no restrictions on gear design, effort and allowable catch. The Sea Fisheries (Shellfish) Act 1967 is the main regulating tool regarding UK shellfish species. However, the only legal limitation on the velvet crab fishery is The Undersized Velvet Crabs Order 1989 (SI 1989 No.919), which implements a 65mm carapace width minimum landing size. Catches for scientific research are exempt from this order.

Whereas for other species such as edible crabs, a whole range of other limitations are also in place (e.g. the prohibition of landing soft shelled or ovigerous female edible crabs), similar provisions for velvet crabs do not exist. However, in most areas, it is common practice to return soft and ovigerous crabs to the sea, as the merchants will not accept these. This is an example of a market-driven rather than a legally binding measure.

1.3 Aims and Objectives of Study

This study aims to examine the transport chain between 2-3 main fishing areas in the UK (Orkney, the Western Isles and East Coast-Northumberland) and the main market for velvet crabs, which is in Spain.

The objective of this project is to provide those involved in the velvet crab sector with detailed information about the distribution of the produce, from the moment it is landed to the point of sale to the general public, in supermarkets and fishmongers in Spain. This information will then be used in future research into the possibility of expanding the market (both nationally and internationally) and optimising transport

efficiency in terms of both mortality and economic profits. Information gathered from operators includes the following:

1. Amount of produce moved (and the seasonal variation)
2. Starting point and destination
3. Treatment (if any) of produce at each stage
4. Treatment in relation to other species
5. Mortality of produce (and seasonal variation)
6. Time from start to finish and at each stage
7. Total cost of procedure and cost at each stage (itemised)
8. Income from sale of produce and from each stage
9. Expectations of importers
10. How Scottish product is perceived in relation to that of other countries
11. Opinions on possible management tools such as bans, increased MLS
(minimum landing size)

2. Background of the fishery and market

2.1 Europe

The main countries involved in portunid fisheries are Spain and France, along with the UK. In addition to *Necora puber*, the other commercially exploited species are *Liocarcinus depurator* and *Carcinus maenas*, both of which also have their main market in Spain. Table 2.1 shows the landings of swimming crabs (including *Necora puber*) for European countries over the past few years:

Table 2.1 Catches of swimming crabs in metric tonnes (source: FAO Yearbook, vol.80, 1995).

Year	1982	1984	1986	1988	1989	1990	1992	1995
France	994	983	918	637	637	637	326	241
Portugal	14	25	48	49	38	147	36	32
Spain	151	210	278	229	229	258	206	400
UK		330	695	1584	448	1690	2442	3835
Total	1159	1548	1939	2499	1352	2732	3010	4508

The UK fishery has only recently developed, largely as a result of the depletion of Spanish stocks. This apparent collapse was due to a combination of lax enforcement of regulations and continuous heavy exploitation of the stocks.

The figures show how the fishery in France has decreased steadily and rapidly over the last twenty years and can no longer be considered as an important part of that sector in France. In Portugal, the velvet crab fishery is anecdotal. The Spanish figures show a gradual increase in catch, but levels are still lower than in the 1970s, when catches were consistently over 500 tonnes (MacMullen, 1983). The Spanish fishery is a multispecies fishery including the octopus (*Octopus vulgaris*), which has recently gained in importance as the velvet fishery declined. The regulations in recent years have, therefore, been geared more towards the octopus than the velvet crab, and have thus sometimes been disadvantageous to velvet crabs (pers. comm. Freire, University of La Coruña).

The main market for velvet crabs is Spain, with some product also consumed in France and Portugal. Most of the demand is for live product, but there is also demand for cooked and frozen product, especially near Christmas (pers. comm. Daniel Martin, Mercabarna).

2.2 UK

2.2.1 Orkney

The development of the velvet swimming crab fishery in Orkney occurred recently. Velvet crabs were discarded as by-catch in the recent past and considered pests for stripping bait intended for lobsters. However, a foreign market for velvet crabs has developed due to overexploitation of Spanish stocks in the 1980s (Gonzalez-Gurriaran, 1981), which has led to an industry which now boasts a yearly income of over £1m (OIC Report, 1998). It has allowed fishermen to diversify from the seasonal Brown Crab (*Cancer pagurus*) and Lobster (*Homarus gammarus*) fisheries into a year round fishery which incorporates the velvet crab. Figure 2.1 shows the yearly catch and total income from velvet crabs since the fishery began in the mid-1980s.

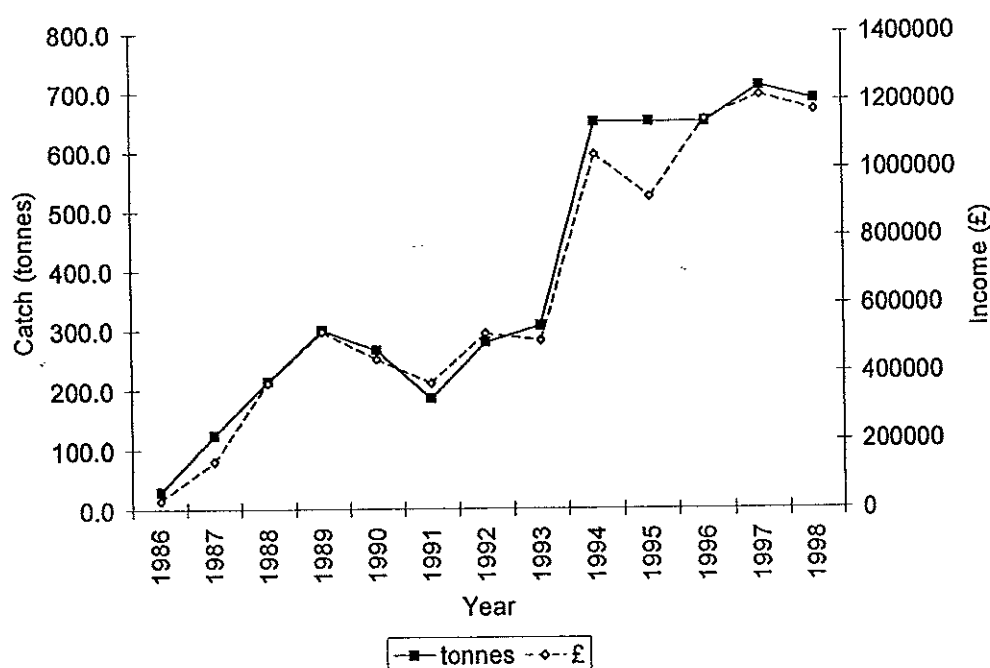


Figure 2.1 Catch and income of velvet crabs in Orkney (Data from OIC, 1998)

There are seasonal fluctuations to the catch. Different areas are targeted throughout the season. The west coast fishery is generally early in the season, from March to July, whereas the northern isles fishery is most intense later on in the year and over Christmas.

The method of fishing in Orkney is by the creel. Between 10-40 creels are laid on each backrope and laid in the fishing grounds. The bait, usually consisting of frozen horse mackerel or scad, is stripped by a combination of velvet crabs, edible crabs and lobsters, within two days (MacMullen, 1983).

The traditional Orkney creel was a wooden structure with a weighted base (18" by 20") and a single, hard eye. Mesh was usually made from sisal. In the 1960s, the double-eyed creel, which came from Shetland was adopted. This was slightly larger (19" by 27") and had a hinged door, which facilitated catch retrieval. The current creel (figure 2.2) is based on this design, but is now made of more durable materials – a plastic coated steel base and nylon mesh (stretched diameter ~4cm).

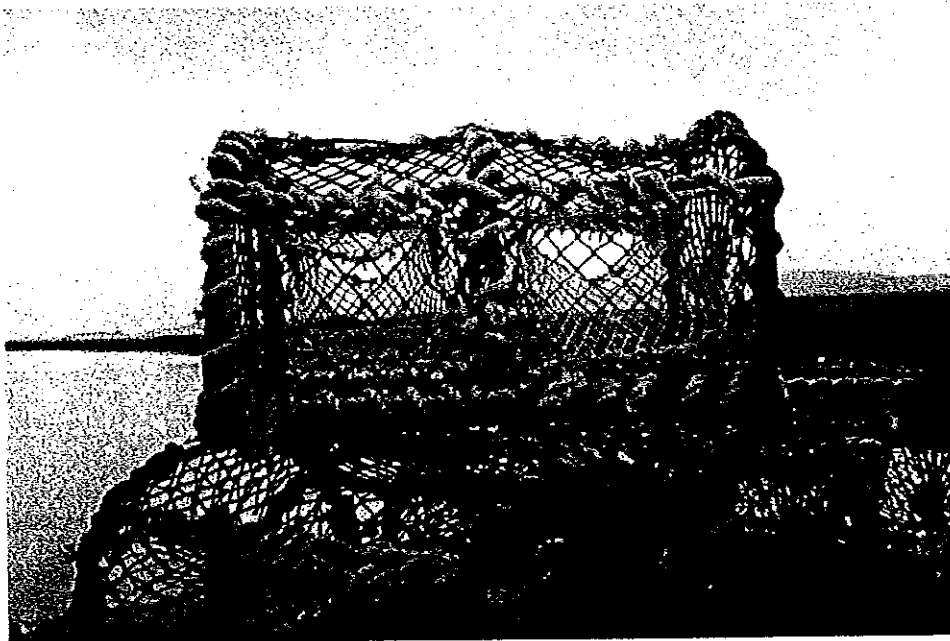


Figure 2.2 A double-eyed creel

Parlour creels, with an internal eye leading to a closed compartment are also frequently used and, to a lesser extent, more unwieldy triple-eyed creels are deployed.

The design of the eye varies depending on the target species, but the principle involves a tapering entrance, which facilitates entry but prevents exit. The mesh used in the construction of the eye tends to be smaller (2cm), whilst the diameter of the eye itself varies between 3-5 inches. Bucket creels (where the eye is a bottomless bucket in the top of the creel) based on the inkwell design are also sometimes used, but mainly for targeting lobsters and partans (brown crabs).

2.2.2 Western Isles

The velvet crab fishery here started in the early 1980s, in the Sound of Harris. According to MacInnes (pers. comm.), the fishery developed as a response to a demand from Spain, where the local stocks were depleted, and in conjunction with the development of the live trade in brown crabs. Fishermen were forced to diversify due to falling lobster catches. As in Orkney, buyers do not accept ovigerous or recently moulted crabs, and the stock appears to be in a healthy state.

Figure 2.3 shows the catch and income at first sale for velvet crabs in the Western Isles since 1997.

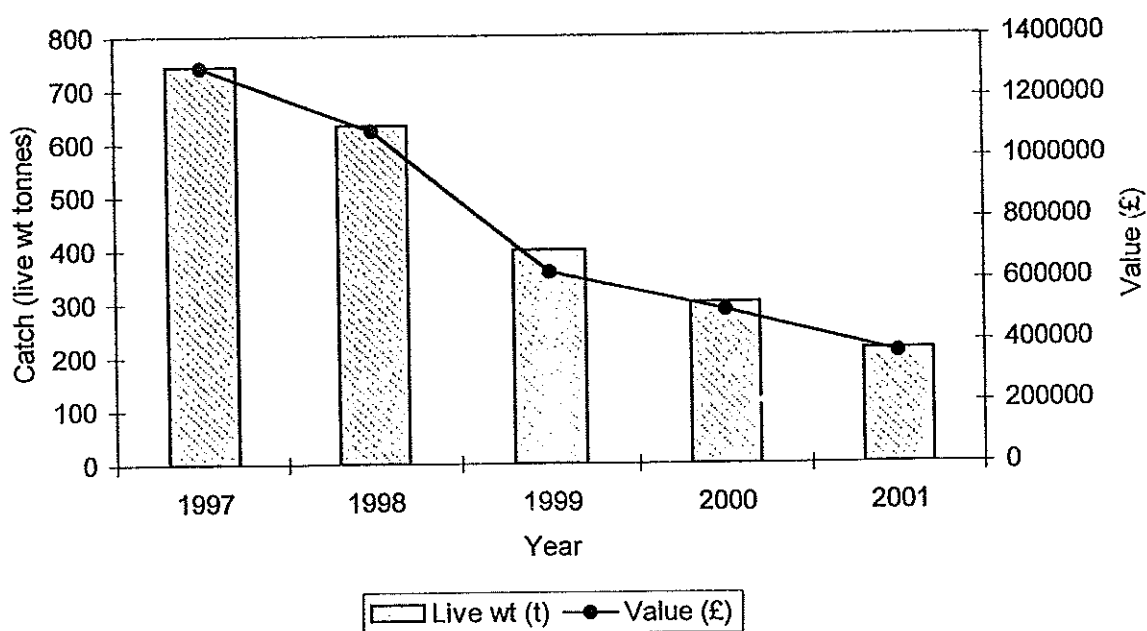


Figure 2.3 Catch and value of velvet crabs, Western Isles 1997-2001 (Data from Stornoway Fisheries Office)

The graph shows a steady decline in catch since 1997. This is due to a number of reasons. Prior to 1998, figures were entered per creek on a monthly basis, but were approximations. After 1998, fishermen on vessels smaller than 10m were encouraged to hand in their own landings. Many did not do this, although the situation is improving. Many fishermen land directly to viviers exporting the product, so local estimates of catches and landings are difficult to obtain. Secondly, a number of vessels have stopped fishing for velvet crabs and are now targeting prawns, which give better prices (£6-9 per kilo) in comparison with the velvet crab (£1.50-2.50 per kilo). Currently, around 100 vessels target velvet crabs at some point during the year in the Western Isles, making the velvet crab still the third most important commercial species of shellfish in the area, after prawns and lobsters. The description of the creel method of fishing for Orkney is generally also true for the Western Isles.

2.2.3 Northumberland Coast

The velvet crab fishery on the east coast around Whitby, Staithes and the Scottish border appears to be geared more towards the cooked product rather than export of live animals. This eliminates the problem of mortality during transport, but has the disadvantage of there being a lower demand for processed velvets throughout most of the year, with the possible exception of Christmas (Daniel Martin, pers. comm..)

There is currently interest in commencing live export from some areas, but the current live market is small and seen as additional income to the more important brown crab and lobster fishery in the area. The fishery began as recently as 1996, before which velvet crabs were seen as pests and sometimes used as bait. There are currently around 300 shellfish vessels, employing some 700 men (North Eastern Sea Fisheries Committee, pers. comm.), which land velvet crabs at some point of the year. Total reported catches for 1999 were 18 tonnes. This figure corresponds to the catches declared through the permit scheme operating in the area, which obliges fishermen to report all catches taken within the 6 mile limit. The main landing ports for shellfish are Whitby and Bridlington.

The description of the creel method of fishing for Orkney is generally also true for Northumberland.

3. Methodology

An initial visit was carried out to Orkney, Northumberland and the Western Isles. At each location, the main operators were interviewed. The successive stages were be followed, where possible with visits to business headquarters (e.g. Lurreitxaso SA, in Oviedo, Spain), otherwise via telephone interviews. The major wholesalers in Spain (Madrid and Barcelona) were visited in order to observe the unloading and sale procedures, and to speak to the buyers. Appendix A shows the names and details of those businesses interviewed.

The following lists summarise the main questions asked to operators at each stage. It must be taken into account that in some cases the questionnaires were modified to cater for businesses involved in more than one aspect of the transport chain (e.g. Lurreitxaso SA transport velvet crabs directly from local merchants as well as distributing the produce in Spain). In all cases, interviewees were reassured that they need not answer any question which they felt may be confidential to their company.

A. To merchants at source

1. How many fishermen do you deal with?
2. How much product do you transport/seasonality?
3. With what frequency are velvets landed?
4. How long from landing to transport?
5. What treatment when being stored?
6. What mortality from landing-packing?
7. How are they packed?
8. How are they transported?
9. Compare with other species?
10. Ever considered alternative options?
11. Factors determining prices given to fishermen?

12. Range of prices to fishermen?
13. Factors determining price to transporters?
14. Range of prices to transporters?
15. Main costs?
16. What transporters etc do you deal with?
17. Fate of product once leaves hands?
18. Effects of MLS, bans etc?

B. To transporters

19. How many UK merchants do you deal with?
20. Which areas?
21. Do you deal with foreign merchants (Spain, France)?
22. How much produce/seasonality?
23. Volume-weight per trip?
24. Other species involved?
25. What routes do you take?
26. How long does a trip take?
27. What is the mortality?
28. Any treatment?
29. Factors determining price?
30. How much do you pay for velvets?
31. How much do you sell them on for?
32. What are your main costs? (Quantify)
33. Any idea of fate?

C. To Spanish merchants

1. How much produce from each area and UK as whole?
2. How does this compare with other areas (why)?
3. Mortality on arrival?
4. Treatment on arrival?
5. Time from arrival to next stage?
6. What is next stage?
7. Main costs of stage?
8. Prices given to next stage?
9. Expectations of quality?
10. How is Scottish product perceived?
11. Effects of changing MLS etc?

D. To Merca-sources and fishmongers

1. How much produce do you move?
2. Seasonality?
3. Where is product from?
4. Are people aware when they buy?
5. Is there difference in price-perceived quality?
6. How much do they cost?
7. Treatment?
8. How many customers?

4 Results

4.1 Treatment at source

4.1.1 Orkney

There are currently eight merchants or agents for large shellfish companies operating in the Orkney islands. Virtually all the catch goes through one or other of these operators, with very little being exported directly to Spanish companies from the fishermen at the pier.

Velvet crabs are far less robust than common brown crabs or green crabs. Handling of velvet crabs on capture varies between fishermen, but the catch is generally kept away from exposure to light and wind, which act as drying agents, lowering the quality of the catch. After each fishing trip, the velvet crabs are placed in wooden crates (30 kilo capacity) and floated off mooring points close to the harbour until they are landed (usually once a week, sometimes twice). Sometimes, mesh bags are used for storage, but it has been observed that this increases the mortality of the catch and limb loss prior to landing (pers. obs).

The merchant a fisherman might deal with usually depends on the harbour his boat operates from, but may also be affected by competition, demand, day of landing and other reasons. Some merchants work with up to 20 boats, others with smaller numbers (5 or 6), and yet others may only work with one or two boats. The merchants do not deal exclusively with velvet crabs – lobster, edible crab and green crab are also caught, and some also deal in molluscs, such as cockles, winkles and scallops.

Some merchants have ponds, in which case, once the catch is landed, the crates are transferred to these ponds until packing takes place. The crates are floated in these ponds, which are constantly supplied with air, and kept at low temperatures. Other species such as lobster and edible crab are kept loose in ponds over long periods, but the velvet crab is kept for a maximum of two days and if possible, not at all.

Packing takes place on long metal tables, onto which the crates are emptied. Packers grade the crabs into large (>75mm) and small (65-75mm), and remove any dead, undersized or ovigerous individuals. In theory, the fisherman has removed any undersized or ovigerous individuals whilst still at sea, so in actual fact, the catch is screened twice before being packed. The crabs are packed tightly into wooden crates with a net weight of 9kg. In some cases, they are packed into plastic crates. Those who use plastic crates claim that this preserves the quality of the catch better than wood because wood leaves a residue in the water and plastic gives a better air-water distribution. They are then loaded directly onto vivier trucks, or returned to the aerated ponds for a few hours until loading occurs. Towards the back end of the season, many are boiled or frozen locally.

4.1.2 Western Isles

The Western Isles differ from Orkney in that many of the fishermen deal directly with Spanish or UK companies based outside the area, who bring in vivier trucks and load catch directly from the boats at the piers. There are one or two local merchants with ponds, dealing with around 12 and 5 boats respectively.

Catch is landed weekly and, as vivier trucks are dealt with directly, packed and loaded onto the trucks immediately. In the case of the local merchants, the catch may spend up to two days in ponds prior to packing. The crabs are packed into 9kg crates for transport.

4.1.3 Northumberland

In this area, as catches are low and tend to supplement the more important brown crab and lobster, velvet crabs are sometimes landed daily in buckets to the local processor, who can then cook and freeze them immediately, after which they are packed in trays and sent by refrigerated lorry to the distributors.

For the live trade, catch is landed weekly in buckets, and kept in plastic crates (net weight 9kg) in ponds with cold (6°C), aerated water for a maximum of 24 hours.

Some Spanish companies operate in the area, as with the Western Isles. Some local merchants then drive the packed catch dry across to the West Coast where it is packed into vivier trucks headed for Poole (this journey may take 4-5 hours).

4.2 Amounts moved

Although official landings statistics say that recent annual catches of velvet crabs were around 700 tonnes for Orkney, 250 tonnes for the Western Isles and 18 tonnes for Northumberland, these figures are not distributed equally among all operators. Figure 4.1 shows the approximate amounts of velvet crabs marketed from each merchant interviewed in this study:

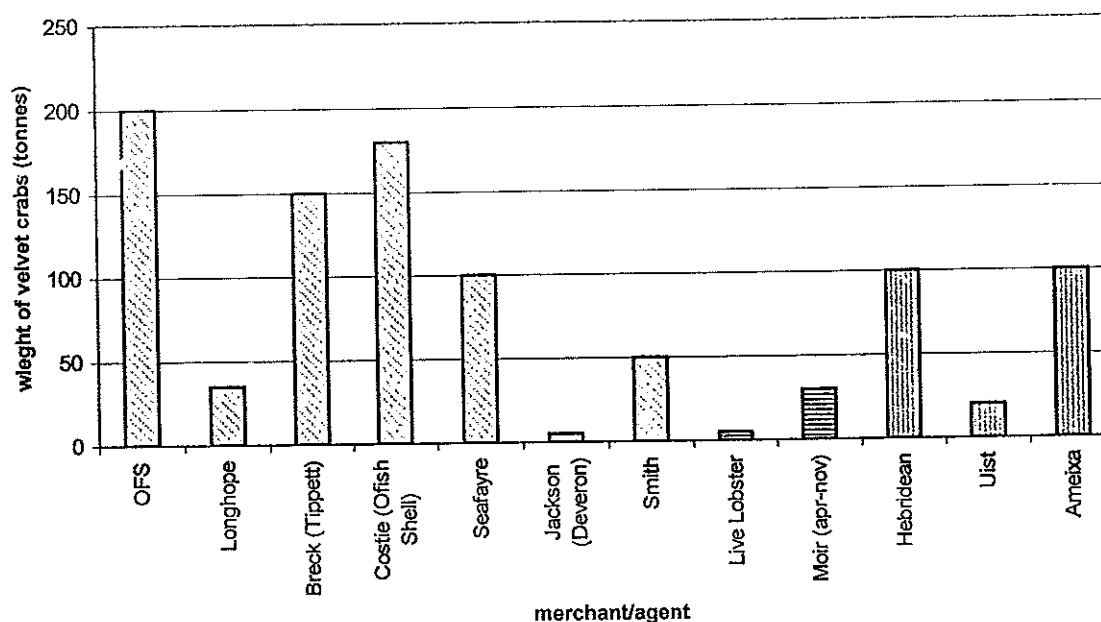


Figure 4.1 Amounts of velvet crabs marketed by different merchants annually. Blue diagonal shading refers to Orkney, red horizontal: Northumberland; green vertical: Western Isles.

This graph shows the variability in the sizes of enterprises, and also indicates how a large amount of produce may be transported without being registered locally, as the Spanish vivier trucks do not tend to declare their cargo to local fisheries authorities. Thus, the approximate 100 tonnes of velvet crabs exported annually by Ameixa de Carril are equivalent to the amount moved by the local operator, Hebridean Marine.

4.3 Transport and the transport chain

4.3.1 Vivier transport

The velvet crabs are packed into 9kg crates, which are stacked in Vivier lorries where aerated seawater at 9-10°C is constantly pumped through the crates. Velvets are easily stressed by aerial exposure, hypoxia and high temperatures. Although the vivier system allows a degree of aeration, as the crabs are so tightly packed into the crates, which are in turn tightly packed, it is often the case that the inner core of crates stagnate and hypoxia results. Death often has a "snowball effect" on the surrounding individuals (Whyman et al, 1985). This means that the death of one individual causes the death of those adjacent to it, and so on. Stress due to aerial exposure is also size dependent, the larger individuals being the first to succumb, with the subsequent greater loss to the merchant.

The success of vivier transport is dependent on four factors: the quality of the velvets themselves, the quality of the holding water (in terms of aeration and temperature), the quality of the equipment and correct handling (Sea Fish Industry Authority, 1990).

Vivier lorries vary in their size and capacity, but a typical load may include a variety of shellfish, such as velvet crabs, lobsters, edible crabs and prawns, with a total shellfish weight of 5-6 tonnes, out of which 1-2 tonnes may consist of velvet crabs. Each species requires a certain amount of water. According to Tarbert Shellfish and Lurreitxaso, the following relationship exists:

Table 4.1 Ratio of shellfish: water required for different species of shellfish during vivier transport, according to Lurreitxaso and Tarbert Shellfish.

Species (1 tonne)	Tonnes water required
Velvet crab	2-3
Edible crab	1
Prawn	5

In most cases, vivier lorries pick up the velvet crabs at the place where they are packed – either at the merchant's installations or on the pier if dealing directly with fishermen. However, in some instances, due to ferry costs, or adverse weather conditions, the produce is transported dry over short distances in vans before being loaded onto the viviers. This is sometimes the case with companies in Orkney such as OFS and the Western Isles, such as Hebridean Marine. One company in Northumberland drives their produce dry by van to Penrith, from where it is loaded onto the viviers and sent south.

Some vivier lorries pick up shellfish from more than one location. The main route taken by most lorries is down the western spine of the UK road network. Where a UK company is involved, the produce may be taken to the company installations or directly to the shipping point. In most cases, the Channel crossing is carried out by ferry from Poole to Cherbourg. The Eurotunnel is not used because the vivier lorries require a constant power supply in order to keep the refrigeration and aeration systems operative. Ferries supply an energy source for this purpose. Appendix B summarises some of the arrangements regarding vivier lorries on ferries.

At Poole, the cargo on British lorries is usually transferred to Spanish lorries, although sometimes, the British lorries may make the entire trip to Spain. On arrival at Cherbourg, the lorries take the quickest route to the company headquarters, usually in northern Spain (Barcelona, Basque Country, Asturias and Galicia).

4.3.2 The transport chain

Figure 4.2 shows the generalised pattern of transport for velvet crabs, from the moment they are caught in the traps by the fishermen to when they reach the consumer in the main Spanish markets.

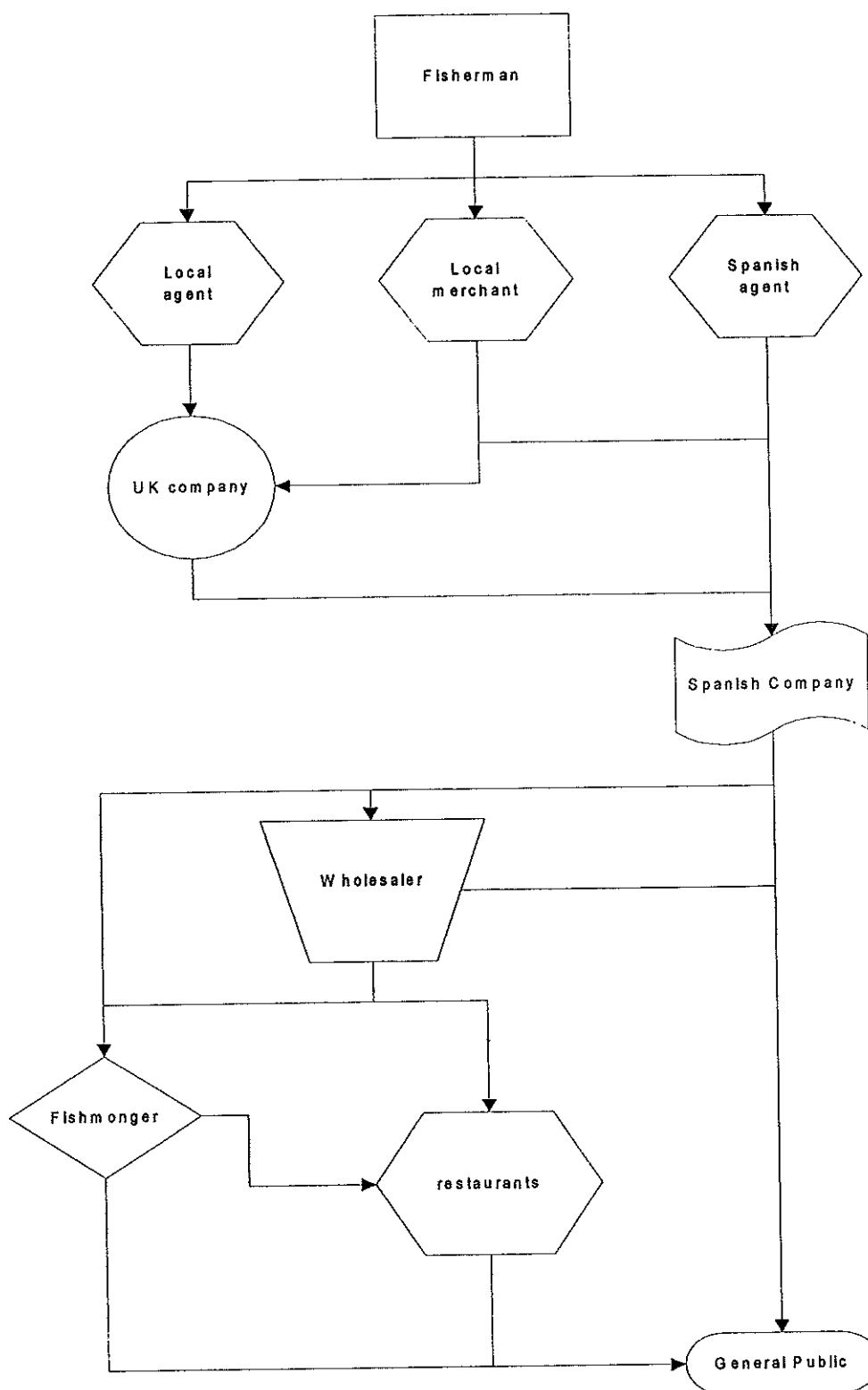


Figure 4.2 Generalised pattern of flow of velvet crab produce from fisherman to consumer.

The chart above shows how a number of routes may be used in order to bring the produce to the dining table. In some cases, the links in the chain are extremely short,

whereas in other cases, the produce may pass through various hands before reaching the consumer. Each handler implies an amount of costs and a profit margin, which are discussed in 4.6. The longer the chain, the more the profit is spread out.

In Orkney, most fishermen land to local merchants, who then sell onto UK companies such as O'Fish Shell, Sutherland Game and Scotprime, or Spanish companies such as the Asturian-based Lurreitxaso, or the Barcelona-based Maresmar. Agents for UK companies such as Deveron and O'Fish Shell also operate in the area. In the Western Isles, much of the catch is sold to Spanish companies such as Ameixa de Carril, based near Vigo, in Galicia. That part of the catch sold to local merchants is either transported off the islands and sold to UK companies such as Sandray Shellfish, Sutherland Game etc, or driven to Poole and transferred to vivier lorries belonging to Spanish companies such as Ansomar (based in Bilbao) or Viveros Vigo. As mentioned before, the live catch from Northumberland not directly exported via Spanish lorries, may be driven to Penrith and added to loads belonging to UK companies headed to Poole. UK export companies may pick up velvet crabs along a route, so by the time the load reaches Poole, the cargo may consist of produce from a variety of suppliers and areas. Figure 4.3 shows the approximate tonnage of velvet crabs imported and exported by certain UK and Spanish companies over a year.

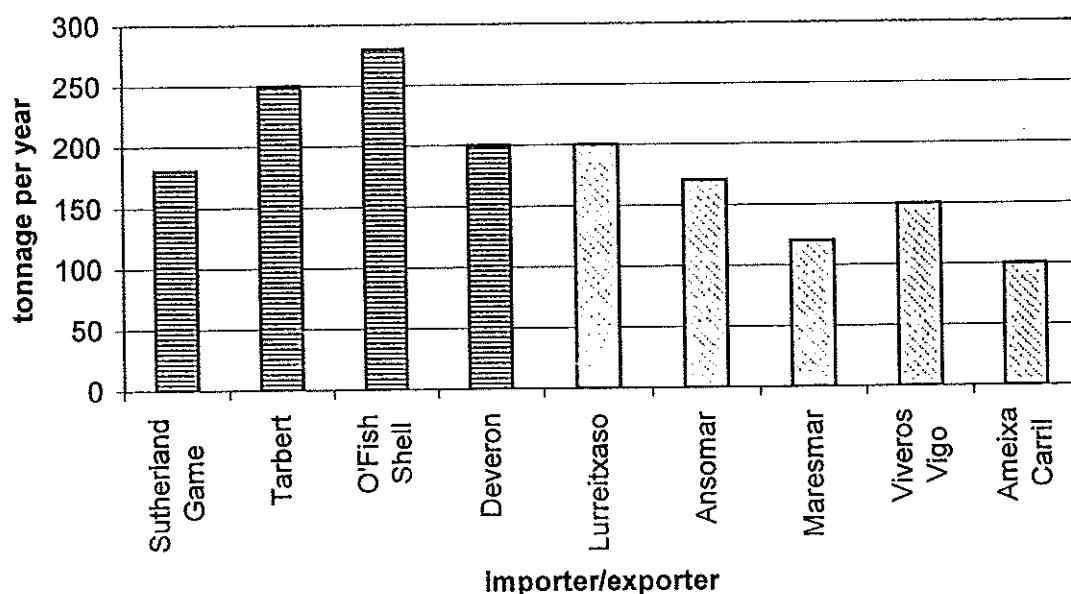


Figure 4.3 Approximate tonnage of velvet crabs imported and exported by company in a year. Red horizontal: UK exporters; Blue diagonal: Spanish importers.

Once the produce arrives at the Spanish company headquarters, it may either be distributed in vans immediately to wholesalers (including the massive Mercamadrid and Mercabarna wholesale markets) or kept in ponds until they are sold. One company interviewed is currently building ponds aimed at storing velvet crabs, other companies have huge pond complexes, with many different species, constant flow of filtered seawater and aeration supplies. The larger companies deal with most edible shellfish species, especially spider crabs, edible crabs and both the clawed and the spiny lobsters as well as velvet crabs. Mussels, octopus, oysters and scallops are some of the molluscan species marketed by these companies. As shown in figure 4.3, most companies deal in amounts ranging between 100-200 tonnes per year. Some companies process part of the velvet crab cargo and sell either direct to the public, or to supermarkets and restaurants. One company offers a range of cooked seafood platters, which can be picked up or delivered, in the manner of a takeaway pizza.

Each large city in Spain has a wholesale market for the distribution of foodstuffs. The wholesalers based in Mercamadrid and Mercabarna (Barcelona) generally receive their supply of velvet crabs towards the end of the week. These big wholesale markets are spread over a large area and are made up of a number of warehouses. Each warehouse is designated for a specific product: fruit and vegetables, seafood etc. The seafood warehouse in Mercamadrid has some 180 stalls, whereas that of Mercabarna has only around half that number. Along both lengths of the buildings are docking bays for unloading of vivier lorries.

The product is unloaded from vivier trucks and lorries from around midnight to four or five in the morning. In most cases, the large frozen product and the resistant molluscs are unloaded first. Velvet crabs appear to be among the last to be unloaded, probably in order to keep them in the water as long as possible.

The sale of the product begins at around 5am, and lasts for 2-3 hours. Some wholesalers buy velvet crabs from others within Mercamadrid or Mercabarna, to sell to their customers. Most stalls display the velvet crabs in stacks of the 9kg crates into which they were packed. Some have them floating in aerated tanks filled with seawater in order to maintain optimum conditions. In 2001, 57000kg of velvet crabs were sold in Mercabarna, which is a small amount compared with Mercamadrid,

where in the same year, 375,574 kg were sold. Not all the velvet crabs are from the UK. Figure 4.4 shows the points of origin of velvet crabs sold in December 2001 in Mercamadrid (this is representative of what occurs generally).

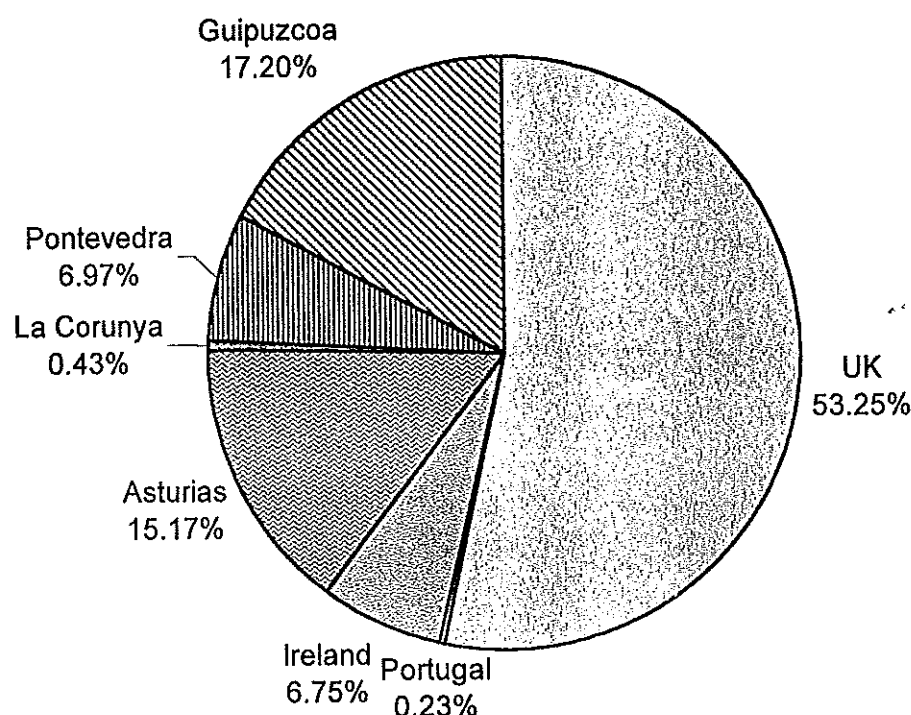


Figure 4.4 Point of origin of velvet crabs sold in Mercamadrid in December 2001, from www.mercamadrid.es, those sections in red patterns refer to areas within Spain.

As is shown by the figure, the UK is the most important source of velvet crabs, followed by various provinces of northern Spain, with Ireland supplying 6.75%, and Portugal providing an anecdotal supply. Table 4.2 shows the total weights of velvet crabs sold over the last few years in Mercamadrid

Table 4.2 Amount of velvet crabs (kg) sold in Mercamadrid since 1997, from www.mercamadrid.es

Year	1997	1998	1999	2000	2001
Weight	494,997	450,948	361,903	318,813	375,574

Different stalls specialise in different species. Those specialising in velvet crabs, with tanks on the premises, may sell up to 2000kg of produce in a week, whereas those specialising in other species but also selling velvet crabs, may sell 200kg in a week.

Figure 4.5 shows the approximate weekly sales according to managers of various wholesalers at Mercamadrid and Mercabarna.

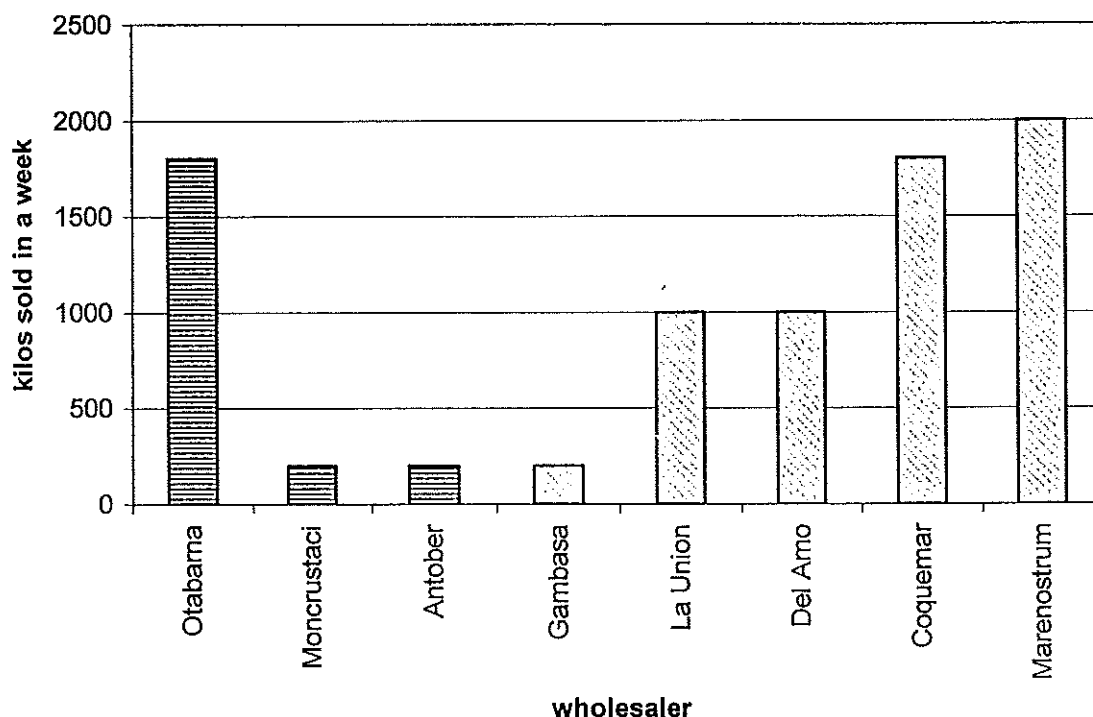


Figure 4.5 Approximate weekly sales of velvet crabs (kg) at wholesalers. Red horizontal stripes: Barcelona; Blue diagonal stripes: Madrid.

During the period of sale, velvet crabs and other seafood items are sold to a wide variety of fishmongers, other wholesalers and restaurants from all over the region. The large wholesale markets rarely sell to private individuals, as special permission is required in order to enter the premises.

Generally, velvet crabs are sold towards the end of the week, on Thursdays and Fridays, so that they are available to private customers for the weekend, which is when most shellfish are consumed in Spain.

4.4 Costs, Mortality and Gross Profit

The process of transportation of the velvet crab catch from the fisherman to the consumer involves a period of time, costs and a certain amount of mortality. It has been noted before that the velvet crab is a difficult species to transport successfully in

comparison with other shellfish species (Whyman et al, 1985). However, some companies do achieve a high survival rate and many operators recognise the importance of careful handling by the fishermen on capture as being a main influence on the subsequent survival of the produce.

In order to examine the mortality rates during different stages of transport, it is first necessary to determine the time periods of each stage. Figure 4.6 shows a map of the main transport route and the approximate time taken for each stage.

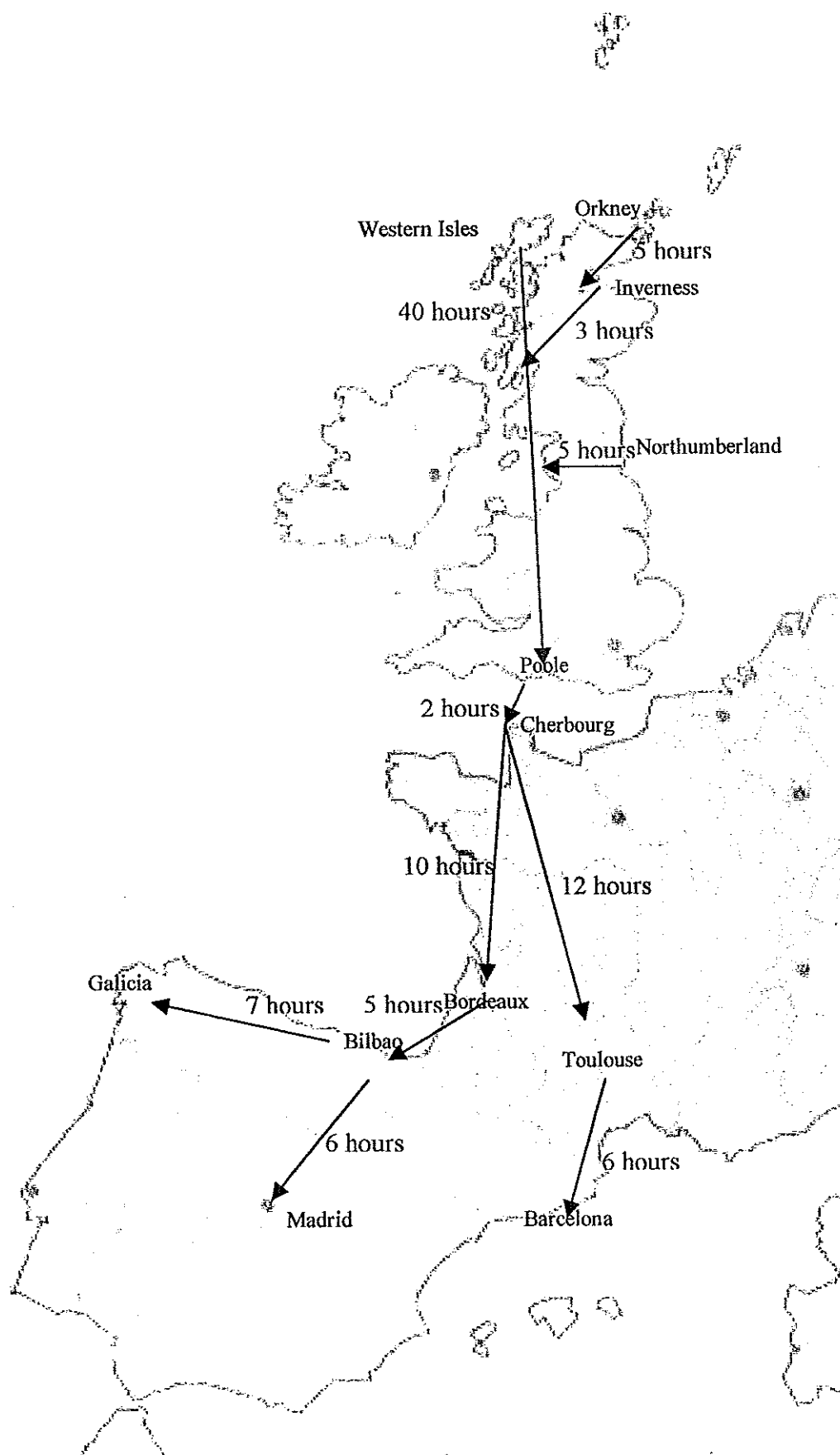


Figure 4.6 Transport routes and time taken from UK locations to Spain

Table 4.3 summarises the time spent at each stage of the transport process, from the moment of capture to the point of final sale, according to the operators interviewed.

Table 4.3 Activity and range of time period (hours) according to interviewees

stage	activity	time (hours)
fisherman	catch and mooring	12-120
merchant	ponds and packing	2-48
UK export	Ferry (Scrabster, Ullapool)	2-3
UK export	journey to Poole	30-35
Spanish import	ferry (Cherbourg)	2-3
Spanish import	journey to base (Bilbao, Vigo)	24-30
Spanish import	Ponds and distribution	2-48
Wholesaler	wholesale market	3-5
Fishmonger	on sale	4-14
totals		81-306 (193.5)

From the table, it can be seen that an average of 193.5 hours (8 days) transpire from the moment the crab is removed from the creel, to the moment of purchase by the private customer, with a range between 81 hours (3.375 days) and 306 hours (12.75 days). During this time, some operators undergo up to four complete water changes of the cargo.

According to one operator, the treatment at source may prove vital to determining the final mortality of the produce at the destination. If velvet crabs are exposed to sunlight and wind when caught, this dries the gills and may do damage to nerves. Although death may not occur immediately, this weakens the animal and makes it more susceptible to mortality during the transport process (Alan Jackson, pers. comm.). Many operators state that once the animal begins to foam at the mouthparts, this is an indication that it is in a poor condition, and should not be packed. As described in 4.3.1, the death of an individual may cause mortality among those surrounding it, thus propagating mortality within the crate.

Mortality varies greatly depending on a number of factors and between stages. The initial presence of mortality is observed at the packing stage. At this point, the catch has spent a period of time up to a few days in large wooden boxes moored at sea, and possibly up to two days in the merchant's ponds. Hearn (2001) looked at monthly

mortality in random samples from fishermen at the packing stage in Orkney. His results are shown in figure 4.7.

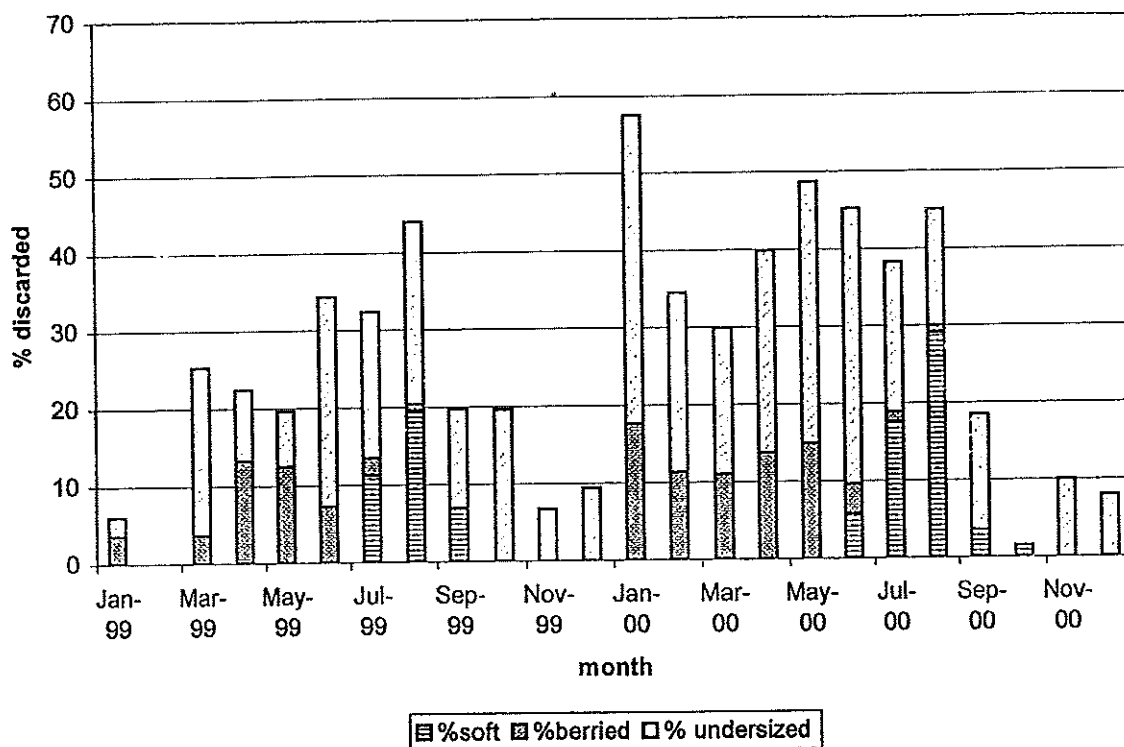


Figure 4.7 Mean monthly mortality at packing (1999-2000) from Hearn (2001)

From the figure, it can be seen that not only is there a great variety in mortality figures, but that generally, figures are slightly higher in March-April and August-October. There may be many reasons for this, not least the individual handling of the fisherman responsible for a particular sample, but the late summer figures coincide with the moulting period for velvet crabs, when shells are still soft or hardening, and crabs are particularly vulnerable. A mean mortality over the year of 11.5%, which is lower in November and December, and higher during the rest of the year, represents the general mortality of the catch, and takes into account the fact that occasional catches are in a poor condition.

However, at the packing stage, not only dead crabs are removed. Soft shelled, ovigerous and undersized animals, which may not have been discarded whilst fishing are also removed. Figure 4.8 shows the percentage of catch discarded at the packing stage during the same study in Orkney by Hearn (2001).

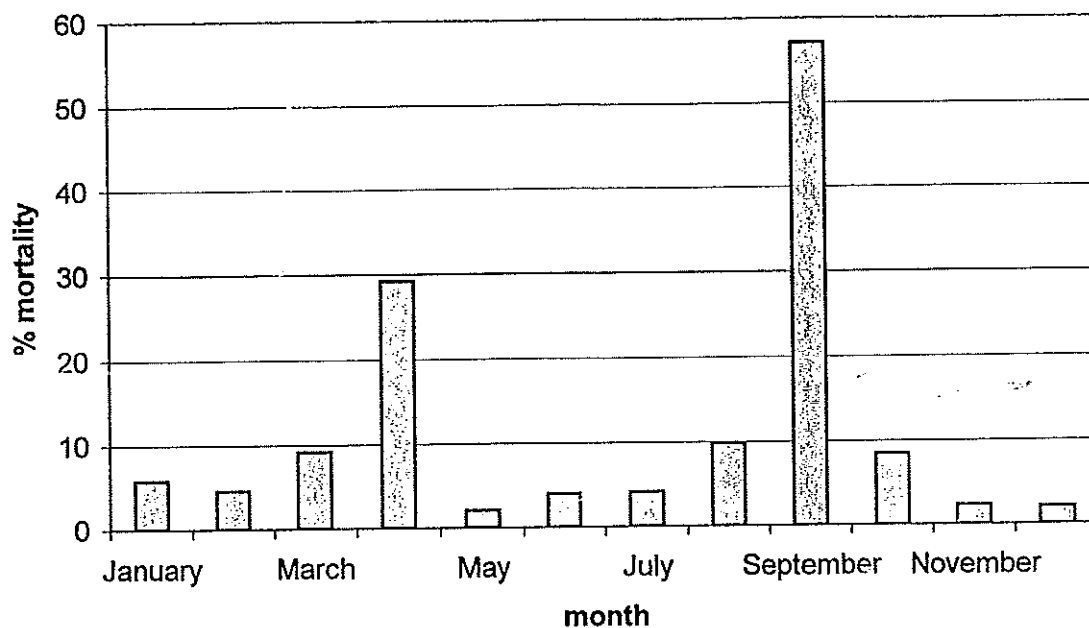


Figure 4.8 Percentage discards for various reasons in 1999 and 2000 (from Hearn, 2001).

From the graph, it can be seen that a significant part of the catch delivered to merchants is discarded, for different reasons throughout the year. At the start of the year, presence of ovigerous females in the catch account for a large portion of the discards, whereas in late summer, the presence of soft-shelled individuals make up much of the discard portion. Undersized individuals are found throughout the year. It is illegal to land undersized individuals. Some fishermen carry out this sorting process before landing their catch, thus returning the discards to the water at the place they are caught and in the quickest time, thus ensuring minimum disturbance. Others do not, and besides the ecological impact of this, they lose an average of 4% catch due to soft individuals, 5% catch due to ovigerous individuals, and 17% of their catch due to undersized individuals. This totals 25%, which, if added to the 10% mortality, means that a fisherman is potentially only getting paid for 65% of what he lands.

In terms of mortality during the transport process, this was found to vary greatly. Operators could not give definite figures, but there seemed to be a general consensus summarised as the following points:

- Mortality is variable throughout the year, highest in late summer, lowest in winter.

- Mortality in winter is virtually negligible
- Mortality up to 10% is acceptable
- Occasionally, mortality is much higher (33% quoted)

Those Spanish merchants which keep velvet crabs in ponds for a number of days after arrival in Spain find further mortality over this period of 10-15%. Some companies are looking at ways of reducing this, investigating feeding pellets and different water conditions. It is thought that the different salinity of the seawater may be a factor influencing survival in Spanish ponds (Maresmar, pers. comm.).

Mortality has an effect on price, as the consumer must eventually pay for any losses incurred in this way from the moment of purchase from the previous supplier. Prices of velvet crabs are generally quite high with respect to green and brown crabs, as they are seen as a luxury food item. As such, they vary throughout the year according to a variety of factors, including demand. Figure 4.9 shows the average prices given to fishermen in Orkney, and the average retail prices in Spain in 2000 (from Hearn, 2001).

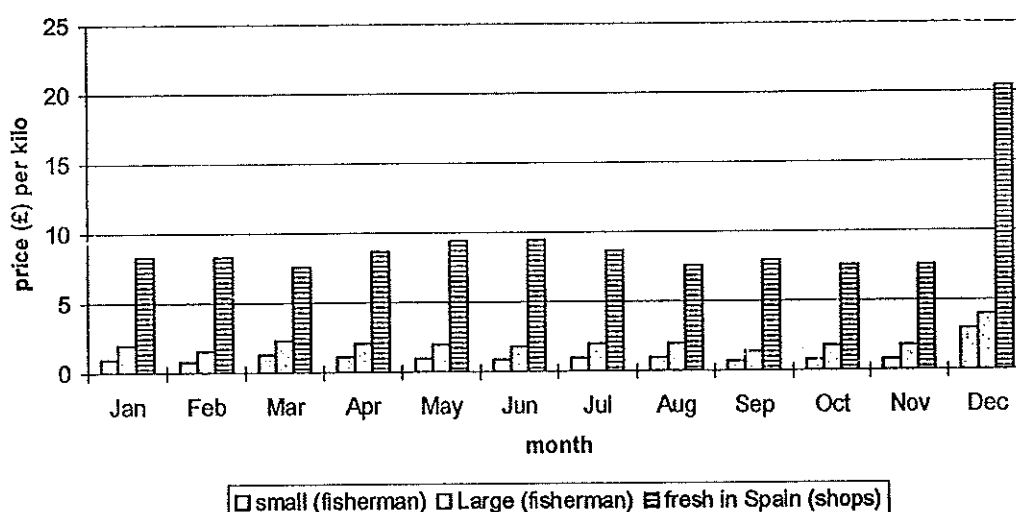


Figure 4.9 Mean monthly prices at first and last sale for velvet crabs in Orkney and Spain, 2000 (from Hearn, 2001).

It is clear from this graph that there is a price difference between large and small individuals, and a large price difference between the sale by the fisherman to the merchant, and the fishmonger to the public. In most cases, the fisherman obtains £1

per kilo more for large animals than for small. Although the price in most areas varies throughout the year, an overall average price for Orkney over the year is around £1 per kilo for small and £2 per kilo for large, with one or two merchants paying slightly more on average than the others. In the Western Isles, the prices are similar, although some vivier lorries dealing directly with fishermen actually pay less than the merchants, which is somewhat surprising. Prices in both areas are much higher at Christmas, sometimes reaching £3 and £4 per kilo for small and large respectively. In Northumberland, prices given for velvet crabs to be processed are lower than in the other areas. In addition, one merchant dealing with live produce works with a fixed price throughout the year, of £1 and £2 per kilo of small and large.

Subsequent prices of velvet crabs through the chain of transport depend on a variety of factors. Each handler has his costs, and these will depend greatly on how far the produce is moved e.g. to Poole or all the way to Spain. Merchants who simply pack the crabs may only add 20-40p to the price, which covers their costs. Those which actually transport themselves, either to Poole, or to a transfer point elsewhere in the country, such as Penrith, must sell for a higher price to cover these costs, generally 50p to £1 more.

In the same way, those UK companies must cover their petrol and ferry costs. For a UK shellfish transport company this may include up to 4 ferry trips (return from Poole-Cherbourg and return from Scrabster-Stromness or Ullapool-Stornoway). For large vivier lorries, the cost of a return ferry trip may be around £800. For some merchants with their own vivier lorries, it is sometimes worthwhile to keep the vivier lorry on the mainland and ferry 3 or 4 vanloads of produce across at a price of around £75 per return trip. The fuel costs from the Western Isles to Poole are around £700. For the Orkney Islands, the costs are even higher.

If the produce is sold at Poole to the Spanish companies, who then ferry it to Spain, the price generally ranges between £2.60-£3.60 per kilo. Those companies transporting directly to Spain may sell for £4-5, due to the added costs. Some companies apply a fixed price per lorry, plus a certain amount per kilo for the cargo.

Once in Spain, the importers try to sell their produce to wholesalers for £1 per kilo more than what they paid for. At this point therefore, the sale price is close to £5 or sometimes higher. The wholesalers then sell for 1500-2000 pts per kilo (£6-8, average: £6.60) and the fishmongers add another £3-5 on that price to sell to the general public at prices ranging from £9-15. Figure 4.10 shows the amounts sold and average monthly prices (in euros) for velvet crabs at Mercamadrid.

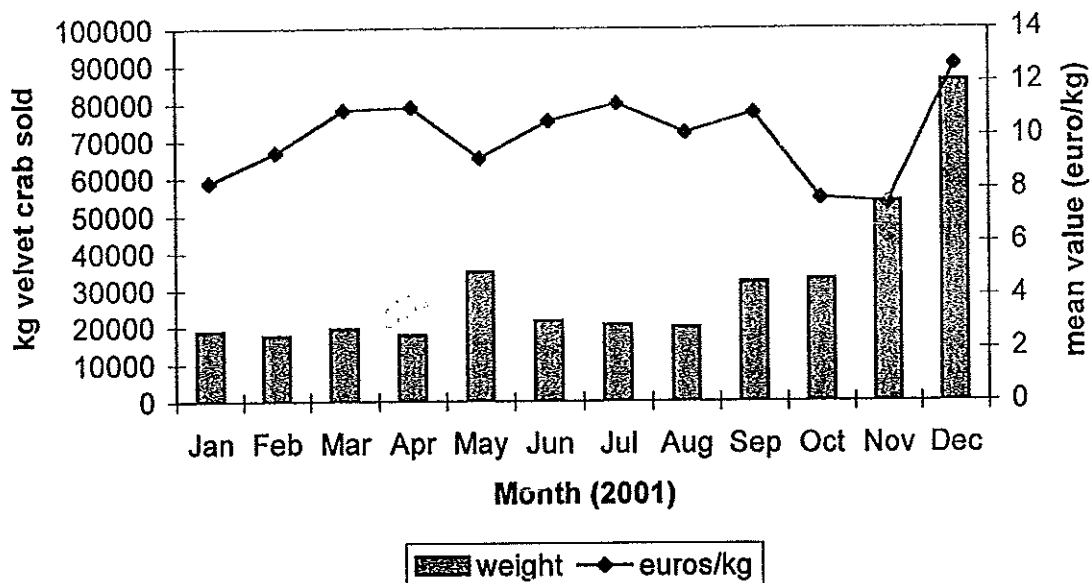


Figure 4.10 Monthly weight of velvet crabs sold at Mercamadrid in 2001 and mean monthly prices in euros (1€ = approx. £0.65) from www.mercamadrid.es

Many fishmongers buy the produce and cook it immediately, to sell freshly cooked to the public the same day. Restaurants and bars may charge a range of prices for dishes including velvet crabs, depending on the dish, the location of the restaurant and the time of year.

Notwithstanding the fluctuations in fuel prices and velvet crab mortality, the costs each handler incurs at each stage are generally quite fixed – ferry prices, labour, storage, fuel, marketing etc. The variations in the prices obtained for the product are related to market factors such as demand, competition and the amount of catch available. Generally, the more product there is available, the lower the price. Between most handlers, a price is agreed through a certain amount of negotiation. The exception to this is the stage from the fisherman to the merchant, and from the fishmonger to the public.

Table 4.4 summarises the range of prices given at each stage, and some of the main costs that each handler must cover with his share.

Table 4.4 Range of prices per kilo product and main costs incurred at each stage of velvet crab transport chain

Stage	Main costs	Range of prices (£)	Gross earnings (£)
Fisherman	Gear, fuel, bait	1.50-2.50	1.50-2.50
Merchant	Storage, personnel	1.70-2.90	0.20-0.50
Transporter	Fuel, personnel, ferry	2.60-3.90	Approx. 1.00
Importer	Fuel, ferry, personnel, marketing, (storage)	4.00-5.00	Approx. 1.00
Wholesaler	Marketing, stall, personnel	6.00-8.00	1.00-3.00
Fishmonger	Lease, personnel, processing	10.00-14.00	4.00-5.00

Essentially, it can be seen that the largest profits are being obtained at the end of the chain, at the wholesaler and fishmonger level. One reason for this is that the quantities being moved by individuals at these levels are very small compared with the bulk movement of earlier stages. Wholesalers sell velvet crabs to fishmongers in amounts close to one or two boxes or thereabouts (each box contains 9kg). The general public buy in even smaller quantities, depending on the size of the family and the meal, but a typical starter dish of velvet crabs may consist of 2 crabs per person (average weight of a velvet crab is 100g [Hearn, 2001]).

5. Discussion

In addition to information regarding the current transport chain and price and cost structure, interviewees were asked a series of questions regarding other aspects of the industry, which are discussed below.

The question of alternative methods of transport was raised among merchants. Most merchants stated that the only feasible alternative to vivier transport across the UK and France is to fly the produce. The drawback with this method however, is the expense. Some merchants have tried flying their produce, with varying degrees of success. They found that it was economically viable only at times of high demand and good prices – one merchant found that by getting his produce to the market before anyone else, he was able in part to offset the extra cost by flying. However, most agree that flying is not a practical alternative for a number of reasons. Firstly, there is not always easy access to an airport, so the journey may not be quicker. One company tried flying velvet crabs from the Western Isles to Madrid and found high levels of mortality, whereas one merchant in Orkney flew 5 tonnes weekly in the months of November and December some years ago with some success. As they are transported dry, the velvet crabs are subjected to greater levels of stress than during vivier transport. It is possible that the changes in pressure may also affect them (Maresmar, pers. comm.). There are added costs to flying besides the charter of the plane itself – landing fees, refuelling, etc. There was also some concern about the effects of the presence of seawater on the condition of the aeroplane and its safety.

The quality of velvet crabs from northern Spain is perceived to be much higher than those from the UK and elsewhere. This is because the velvet crab in Spain inhabits the seabed directly underneath mussel cultivation rafts and feed on material derived from these rafts. Thus, the animal grows much faster and tends to contain more meat than UK animals, according to Spanish seafood dealers. This difference in quality is reflected in the prices – during one week, at a Spanish distributor which also sells direct to the general public, when the price of UK velvet crabs was £7 per kilo, that of Galician velvet crabs was £20. Generally, however, unless specifically stated, the crabs tend to come from the UK. When asked about the properties making up a good quality product, most dealers replied that the larger darker animals were preferred (the

colouring of velvet crabs varies from an orange-brown to almost black). Hardness was also considered to be a factor, especially in the moulting season, and mortality within a consignment.

Some operators were in favour of having closed seasons in some areas in order to help protect the stock during the moulting and mating period, but others claimed that the way to ensure optimum quality is through good practice by the fishermen and merchants, and that a code of practice for handling velvet crabs may encourage some fishermen and packing personnel to ensure that care is taken to keep stress at a minimum level. Some merchants have introduced feedback schemes with their customers, so they can now identify the fisherman and packer of a given box of velvet crabs, as a method of controlling quality.

In conclusion, it can be said that the fishery in Orkney and the Western Isles is well established and fully or close to being fully exploited. In Northumberland however, the velvet crab fishery is more recent and currently on a much smaller scale. Some Spanish merchants have expressed an interest in making contacts with local merchants in this area regarding the possibility of commencing exportation of live produce to Spain. One of the reasons given for this interest is to increase the diversity of sources, which helps to guarantee a supply of produce at all times.

With regard to Orkney and the Western Isles, rather than increasing catches, effort should be made to improve the quality, both real and perceived of the produce. This can be done by introducing feedback schemes, a code of practice for handlers (fishermen, packers and merchants alike), informing stakeholders about those parts of the biology of the species which are affected by the fishery, and how to keep these effects within sustainable levels, and marketing the produce by using the pristine beauty of the natural surroundings as an advertisement. The malt whisky, Highland Park does this to a highly successful level, emphasizing the quality of the water, using a golden sunset over the Orkney islands as a label, and divulging the mythology surrounding the origins of the produce. All these tools make it a desirable and attractive product to the buyer.

Part of the objective of this project was to identify the transport chain, those involved and to break down the final price of the velvet crabs among its various handlers throughout the chain, whilst examining aspects that may affect cost, such as the transport method, treatment of produce and mortality. The reasons behind this were partly so that all stakeholders (including the fishermen) could be made aware of these processes, and partly, that now identified, action may be taken to improve them.

Research is currently being carried out at the University of Hull into various packing alternatives, with a view to eventually being able to successfully transport velvet crabs without the use of large quantities of water, and thus reduce both mortality and the costs of transport. As yet however, the vivier system appears to be the most viable for the Spanish market, although if other foreign markets further away are opened, provided the consumers are willing to pay the added costs, flying may be a viable option.

Various scientists have expressed an interest in creating a forum for the velvet crab where the research and commercial sectors can air their concerns and ideas, and work together to ensure that common goals are achieved, in areas such as stock management, fishing technology, and transport and storage technology, among others.

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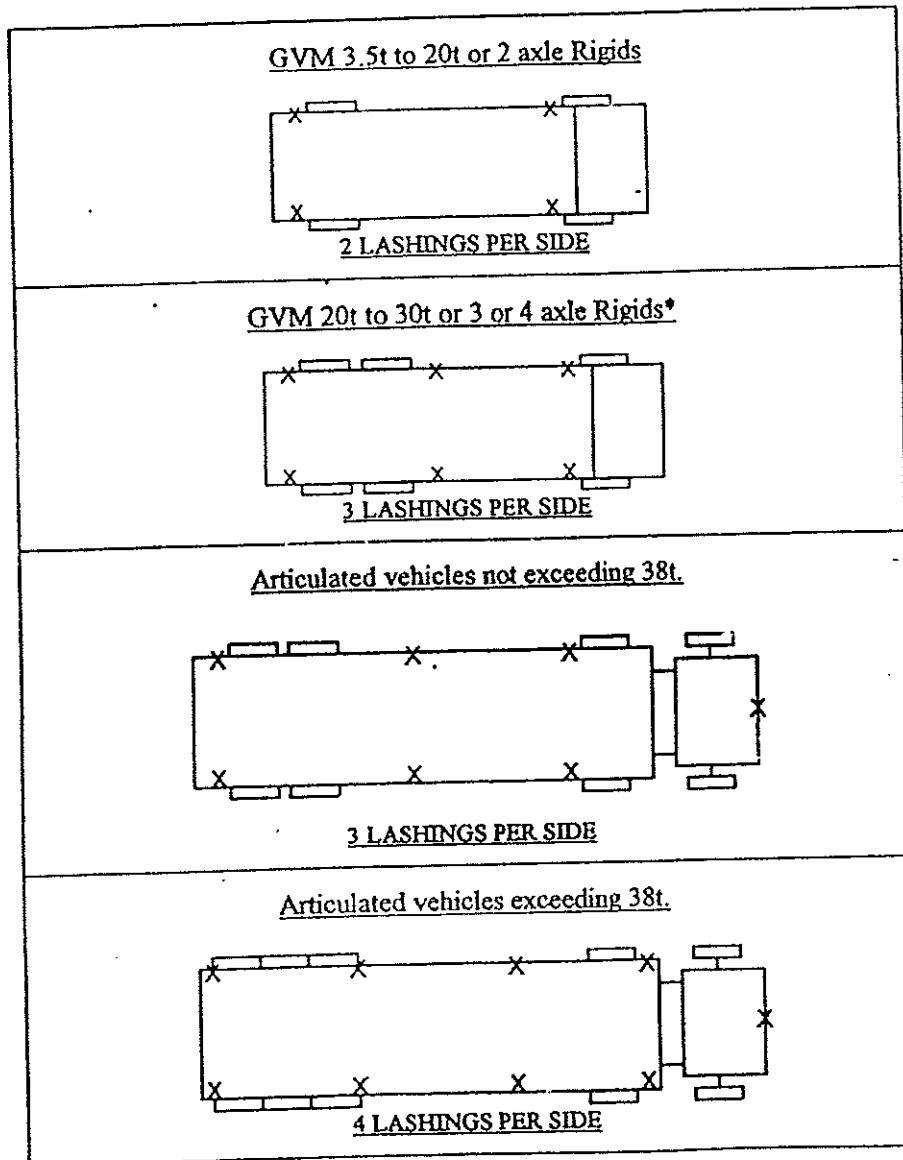
Appendix A: Contact Names and Telephone Numbers

Type	Company/contact	Location	Telephone
Merchant	OFS	Stromness, Orkney	01856 850 375
Merchant	Orkney Seafayre	Finstown, Orkney	01856 761 544
Merchant	Gary Kirkpatrick	Longhope, Orkney	01856 701 206
Merchant/Agent	Alan Breck	Kirkwall, Orkney	01856 874 573
Merchant/Agent	Alan Jackson	St. Margarets, Orkney	01856 831 700
Merchant	Robert Smith	St. Margarets, Orkney	01856 831 560
Merchant/Agent	George Costie	Westray, Orkney	01857 677 356
Merchant	Burgon Ltd.	Eyemouth	018907 50272
Merchant	Moir seafoods	North Shields	0191 257 33 77
Merchant	Live Lobsters Ltd.	Staithes, Northumb.	01947 840 917
Merchant	Hebridean Marine	Lewis	01851 702 044
Merchant	Uist Fish Market	Uist	01870 602 177
Merchant	Angus Campbell	Uist	01878 700 342
Transporter	Sutherland Game	Lairg	01549 402 131
Transporter	Deveron	Castlebay	01261 833 761
Transporter	O'Fish Shell	Argyll	01852 500 604
Transporter	Tarbert Shellfish	Argyll	01880 820 799
Spanish Merchant	Otamendi (Lurreitxaso)	Asturias	985 59 61 98
Spanish Merchant	Amelxa de Carril	Vigo	986 50 44 61
Spanish Merchant	Viveros Vigo	Vigo	986 20 55 22
Spanish Merchant	Ansomar	Bilbao	944 52 29 33
Spanish Merchant	Maresmar	Barcelona	932 63 27 24
Macro-wholesaler	Mercabarna	Barcelona	933 36 68 12
Macro-wholesaler	Mercamadrid	Madrid	917 85 00 00
wholesaler	Otabarna	Barcelona	933 35 61 12
wholesaler	Moncrustaci	Barcelona	934 09 85 85
wholesaler	Marenostrium	Madrid	
wholesaler	Coquemar	Madrid	915 077 012
wholesaler	Del Amo	Madrid	
wholesaler	La Union SA	Madrid	915 074 207
wholesaler	Gambasa	Madrid	916 421 741
wholesaler	Antober	Madrid	
Fishmonger	Peña	Madrid	918 554 128
Fishmonger	Fernando	Madrid	918 423 040
Fishmonger	Laredo	Madrid	918 444 183
Fishmonger	Cantabrico	Madrid	918 410 987
Fishmonger	Gomez Garcia	Madrid	916 370 382
Fishmonger	Vallinas Perez	Madrid	918 417 894
Fishmonger	La Bonita	Madrid	916 518 901
Fishmonger	El Corte Ingles	Madrid	914 546 000

Appendix B: Regarding vivier lorries and ferries

LASHING POINT ARRANGEMENTS

N.B. Representations show *number* of lashing points required, *positions* shown are indicative only. Refer to the appropriate Code of Practice for full requirements.



Notes:

1. GVM = Gross Vehicle Mass.
2. Four axle rigid with a GVM exceeding 30t should be fitted with four lashing points on each side.
3. Artic units should have two securing points at the front of the unit, or one central towing coupling, *in addition* to those required for the trailers as shown above.

V1:24/03/99



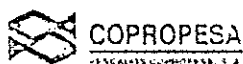
Caledonian MacBrayne
Hebridean and Clyde Ferries

Carriage of live shellfish

Drivers/shippers of Vivier tank vehicles should be aware that the facility for water changing whilst on board the Company's vessels is a concession and not a right, which is allowed subject to certain conditions including, but not limited to, the following.

1. Request for water to be made through Port office at the earliest opportunity.
2. The stowage of the vehicle deck will not be compromised to take account of extra space required for opening doors or other means of access on the vehicle.
3. Express permission must be obtained from the Chief Officer who will have consulted with the Chief Engineer as to the availability of a suitable pump.
4. The Company does not guarantee the salinity or purity of the water taken on board its vessels, nor will it be liable for damage claims in respect of any impurities howsoever introduced.
5. Shippers are to supply their own hoses and connections, and on no account are they to interfere with the vessels Firefighting (hoses) Equipment.
6. No other work (grading, selecting, shifting) to be undertaken.
7. No smoking on the vehicle deck.
8. Vehicles fitted with exposed re-circulating pumps are to have these fitted with guards for the protection of other passengers and crew.
9. The Bridge is to be informed directly the operation is completed.
10. Frequent checks will be made by ships staff to ensure that these conditions are being complied with.
11. The whole operation will be subject to weather conditions or any other circumstance as decreed by the MASTER, who, should he refuse the concession, will give his reasons for doing so. An entry to this effect will be made in the deck log book.

Appendix C: Call-cards for contacts



Benito Carleña León

MERCAMADRID
Zona de Pescados - Puesto 111
28053 MADRID

Tel: 91 507 28 79 - 74 77
Fax: 91 507 71 97
Particular: 91 507 21 51
Móvil: 673 91 21 39

Coquemar, S. L.

Francisco Javier Sanz

MERCAMADRID - Pto. 124 - 28053 MADRID
Tel y Fax Mercado 91 507 70 12 - Móvil 610 780 422
Fax G311 610 780 237



CARRETERA VILLIVERDE A VALLECAS, KM. 3.300
PUERTO 111 - MERCAMADRID
28053 MADRID

TEL. COMEST: 068. 91 507 60 01
TEL Y FAX: 91 507 42 07



Jordi Aysa López
Gerente

664 6132 64

Domicilio Social:
Apdo. 233 - Port Girona
Aigu, Coroner 1227
08063 Castelldefels
Móvil: 667 58 00 00

Viveros:
Joan Güell, 93 bajos
08020 Barcelona
Tel: 93 409 73 45
Fax: 93 339 00 24

www.moncrustas.com



Oficina y Frigorífico
NUEVOS NUMEROS
Tfno. 642 17 41 - 42
Fax 642 17 09

C/ Santa Teodora, 3
28040 FUENLABRADA Madrid

Tel: (34-91) 622 15 42 - 642 19 51
Fax: (34-91) 622 54 55 - 622 54 58



Emilio Añón Jodar
MOVIL 616963195

C/ LONGITUDINAL SPANELL I MULTISERVICI, MÓDUL 9 TEL. 93 335 01 32
08041 BARCELONA FAX 93 335 14 41



914 522 933
Fax 914 522 951

Poly. 700 - Barcelona II
Pav. 10 P 14 Pl
48170 ZARAGOZA - VICENTE
e-mail: ansomar@ansomar.com

maresmar



DAVID CENENO I MORALES
CAR. TALLERES ALIMENTARIOS S.A.

MARESMAR S.L.
CENTRAL DISTRIBUCION Y VENTA DE MARISCOS
C/ Pol. 700 - Barcelona II
Pav. 10 P 14 Pl
48170 ZARAGOZA - VICENTE
e-mail: maresmar@maresmar.com

