Fisheries & Conservation Science

The Inshore Fisheries of Wales: a study based on fishers' ecological knowledge

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INTRODUCTION

Traditional, Local, and Fisher Ecological Knowledge

Obtaining information on ecological questions from people outside the science and management realm has become widespread in the last twenty years. There are many terms for this information and even common terms have slightly different definitions in the literature. The most often used definition of Traditional Ecological Knowledge (TEK) is "a cumulative body of knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings with one another and with their environment" (Berkes et al. 2000). Whilst TEK is often associated with indigenous peoples, it is not limited to them (Gilchrist et al. 2005). The purpose of collecting TEK is to try to understand indigenous or local resource use in order to answer ecological questions (Berkes et al. 2000). Whilst TEK emphasizes a long-term historical focus, Local Ecological Knowledge (LEK) is a more current accumulation of information, based on observations from within the person's lifetime (Gilchrist et al. 2005). The proximity of users to their resource allows them to observe day-to-day changes which scientists and resource managers simply cannot monitor. LEK can include information concerning inter-annual, seasonal, lunar, diel, and food-related differences in the behaviour and movements of natural resources. Fishers' Ecological Knowledge (FEK) falls under the umbrella of LEK. FEK encompasses the above attributes of LEK; however, it is also includes information relating to market constraints and changes in technology (Johannes et al. 2000). An individual fisher's ecological knowledge is a combination of day-to-day observations at sea, information passed from previous generations, and material gathered from other sources such as other fishers, the media, managers, and fisheries scientists. Another term, Globalised Harvesting Knowledge (GHK), also exists; however, its use is much less common. GHK is the knowledge from large-scale, industrialised fisheries that operate over large areas. This knowledge is based on the efficient capture of valuable commercial species, regardless of location, and selling to the highest paying processor. GHK is not local in any sense (Murray et al. 2006).

Fishers possess an intimate knowledge of the current state of the waters they work upon and each generation has adapted fishing practices to the patterns in stock migrations and behaviours of that time. Information collected from these generations and pieced together can be used to develop a sequence of patterns and changes that could reveal long-term processes in a fishery (Ames 2007). Traditional fisheries science can show only a snapshot of what is happening in one small location during expensive research cruises. Conversely, fishers have first-hand observations of changes on a fishing ground over time scales of weeks, months, years and more importantly decades (Carr and Heyman 2012).

Welsh Fisheries and Management

All commercial fishing operations in Welsh waters are subject to EU and UK regulations. This regulation is achieved through secondary legislation (also known as Statutory Instruments) which are set by Welsh ministers. Additionally, in 2010 the Welsh Government created a national Wales Marine Fisheries Advisory Group and three regional Inshore Fishery Groups (North, Mid and South Wales) as a stakeholder-led approach to fisheries management in Welsh inshore waters (Wales Environment Link 2014). As with all EU countries, Welsh waters are managed under the Common Fisheries Policy (CFP) which the Welsh Government directs and must adhere to the Marine Strategy Framework Directive (MSFD) established in 2008. The MSFD uses the ecosystem approach to manage human activities (including fisheries) that impact the marine environment, with an emphasis on environmental protection and sustainable use. The aim of the MSFD is to achieve Good Environmental Status (GES) in all Member States by 2020; however, the Member States must develop their own marine strategy to achieve these goals (European Commission 2015). The Ecosystem Approach to Fisheries Management (EAFM) used within the CFP and the MSFD views the ecosystem as more than just the organisms, and incorporates the physical, biological and human components. This approach to fisheries management addresses fisheries impacts on the marine ecosystem, interactions between different fisheries, interactions between fisheries and aquaculture, as well as all other human activities that interact with the marine environment. Of vital importance to this system of management is information on the spatial dynamics of the fishery. This spatial information includes habitat and species distributions, physical and biological parameters, and the distribution and interaction of human activities. Of utmost importance to the success of this management is knowing where fishing is occurring, what is being caught, and how it is being caught (Carocci et al. 2009). Where fishing is occurring can be determined from Vessel Monitoring Systems (VMS); however, in Welsh waters these are only required on vessels greater than 15 meters in length and on all scallop vessels (which use Succorfish VMS technology). Of principal importance to the EAFM is active engagement with stakeholders, which includes fishers (Carocci et al. 2009). Using fishers' knowledge in this approach to management is an ideal way to incorporate fishers into the management process.

In 2013, Welsh vessels landed a total of 13,300 tonnes of shellfish and demersal fish which represents 3% of the total landings in the UK by UK vessels. The total landings of all species landed into Welsh ports by UK vessels has increased from 2009 to 2013. There has not been an increase in any species from 2009 to 2013; nonetheless, the landings for most species has been constant (MMO 2014a). The Welsh fleet operates from ports all over Wales, with the most active ports being Milford Haven, Fishguard, Holyhead, Saundersfoot and Swansea (see Appendix 2). From 2002 to 2012, the number of fishers in Wales decreased by 27% and Wales has the highest proportion of part-time fishers in the UK (35%) (MMO 2014a). The fisheries in Wales are predominantly for shellfish species, with a very small portion landing demersal fish. The most landed species into Welsh ports by UK vessels are scallops, whelks and crabs. Even though shellfish species are the most important commercial species, there is a severe lack of consistent and quality data for these species (with the possible exception of scallops) in the UK and therefore sound stock assessments have not been achievable at regional levels (HM Government 2012).

Aims of the questionnaire

This study set out to design a GIS-based questionnaire to administer to commercial fishers across Wales. The three main aims of the Fishers' Knowledge Questionnaire were to: 1) map current fishing effort and past fishing grounds, 2) determine the reasons why fishers target particular grounds, and 3) assess the historical changes in target species behaviour, abundance and size. As well, a better understanding of the socio-economics guiding the Welsh fishing fleet was deemed a fundamental objective.

MATERIALS AND METHODS

GIS Based Questionnaire

A GIS-based questionnaire was developed in collaboration with exeGesIS SDM Ltd. This GIS software was based on similar software developed for The Countryside Council for Wales (CCW), which is now part of Natural Resources Wales (NRW), in collaboration with the North Wales Fisherman's Cooperative Limited, Bangor Mussel Producers Limited and the Welsh Federation of Sea Anglers. That project, FishMap Môn, focused mainly on the waters around the Isle of Anglesey and out to 12 nautical miles and was funded by the European Fisheries Fund and the Welsh Assembly Government (Natural Resources Wales 2014).

A paper copy of the present questionnaire was created prior to software development in order to trial the questions with fishers and receive feedback. The pilot paper questionnaire was trialled on three fishers with varying target species and gear and was adjusted based on the feedback.

The layers used in the GIS questionnaire layout included all major cities, towns and villages along the coast of Wales, small and large scale admiralty charts, the mean high water boundary line, and the boundaries of the Scallop Order 2012. The inclusion of admiralty charts was considered very important as fishers would be familiar with this type of map and would be able to locate fishing grounds based on water depth and marine features such as sand banks. The ability to zoom in and out of the map was also considered an important feature of the software as marine features and fishing reference points could be used when zoomed in.

The questionnaire was divided into two main sections: one with questions pertaining to fisher and vessel details; and the other requiring the fisher to draw areas of marine use and answer questions pertaining to those areas. Previous studies that have gathered fishers' knowledge to inform fisheries management have used hard copy maps, asked fishers to draw fishing areas and then digitised the maps into GIS software (Bergmann et al. 2004; Hall-Arber and Pederson 1999; Leite and Gasalla 2013; Shepperson et al. 2014). This study designed the questionnaire as GIS software and therefore fishing areas were drawn in ArcGIS and the digitising step was eliminated. The first section of the questionnaire obtained information on personal contact details, fisher details, vessel information, and bait use for potters. The drawing exercise consisted of seven functions: fishing, hotspots, sea bass ranking, migrations, nursery areas, conflict areas and economic importance; however, this report only presents results from the fishing, conflict areas, and economic importance sections.

Fishing Function: involved drawing areas where the fishers harvest specific species. The species of interest for this questionnaire were brown crab, lobster, common prawn, common whelk, sea bass, king scallop, queen scallop and spider crab. Each species was designated by a different colour and areas were drawn by the interviewer based on directions from the interviewee. Completion of drawing a fishing area first prompted a question regarding whether the area represented a current fishing location, one that has been fished in the last five years or whether it was last fished over five years ago. Areas fished over five years ago were referred to as historical fishing locations and fishers were asked their reasons for discontinuing fishing in this location. If the area drawn was for current fishing activity or activity within the last five years, a series of questions was prompted based on that fishing area relating to fishing activity, gear specifications, environmental conditions, species abundance, and variation by sexes and sizes. Questions were specific to the species fished with additional questions on spawning for king scallops, queen scallops and sea bass, sorting method for prawns, and prevalence of damage for whelks.

Conflict Function: required the fisher to identify any areas of his marine use that presented a conflict of interest with another marine user and when this conflict occurs. This conflict of interest could be with other fishers, conservation measures, recreational users, other industries, etc.

Economic Importance Function: allowed the fisher to rank the top five most economically important fishing areas and indicate the reasoning for this importance.

The structure of the interview was both closed and open ended questions, with the opportunity for the researcher to take additional notes if extra information was given by the interviewee. Where possible, drop-down menus were used to select an answer as this eliminated the possibility of a typing error and therefore aided analysis.

The questionnaire was reviewed by the Bangor University College of Natural Sciences Ethics Committee and approved for use. All questionnaires were conducted in person, as opposed to a telephone survey or a posted or e-mailed survey. These passive forms of surveying were not considered appropriate due to the complexity of the questionnaire. It was necessary to conduct the interviews face-to-face primarily due to the mapping exercise using GIS software. As well, the length of the questionnaire, the presence of sensitive questions and the requirement to potentially further explain questions rendered passive forms of surveys impractical.

Data from the interviews were saved in a Microsoft Access database and polygons, points, and arrows from the drawing exercise were saved as ArcMap shapefiles in a geodatabase. Analysis of the data was conducted in ArcGIS version 10.2.2, R version 3.0.2, Microsoft Excel and Microsoft Access. Unless otherwise stated, all percent frequencies were calculated based on the number of areas that the variable in question was observed in, as opposed to the number of fishers that have observed the variable in question. For example, when calculating the increases in brown crab abundance, percent frequencies were calculated based on the total number of brown crab fishing locations, as opposed to the total number of brown crab fishers. Chi square tests were performed between the changes in species' abundance and size observed in fishing areas and the fishers' experience level to determine whether more experienced fishers have different observations than newer fishers in the industry. The experience level was calculated as the number of years the fisher had been fishing.

Study Site and Subjects

The target population was defined as all active commercial fishers for brown crab, European lobster, common prawn, common whelk, sea bass, spider crab, king scallop and queen scallop in Wales and the sampling unit was skippers or owners (if they actively fish) of the commercial vessels. Whilst many studies promote targeting older fishers as they are considered more knowledgeable, this study did not target a particular age group as current fishing practices were a main subject of the questionnaire. In addition, it is informative to compare the results of more experienced fishers and less experienced fishers to discover the time frame of possible changes. The study area was stratified spatially by North, Mid and South Wales. For this study, North Wales was designated as from the Dee Estuary to Tremadog Bay, Mid Wales from Tremadog Bay to Cemaes Head south of the mouth of the River Teifi by Cardigan, and South Wales was considered as Cemaes Head to the Welsh boundary through the Bristol Channel (Figure 1).

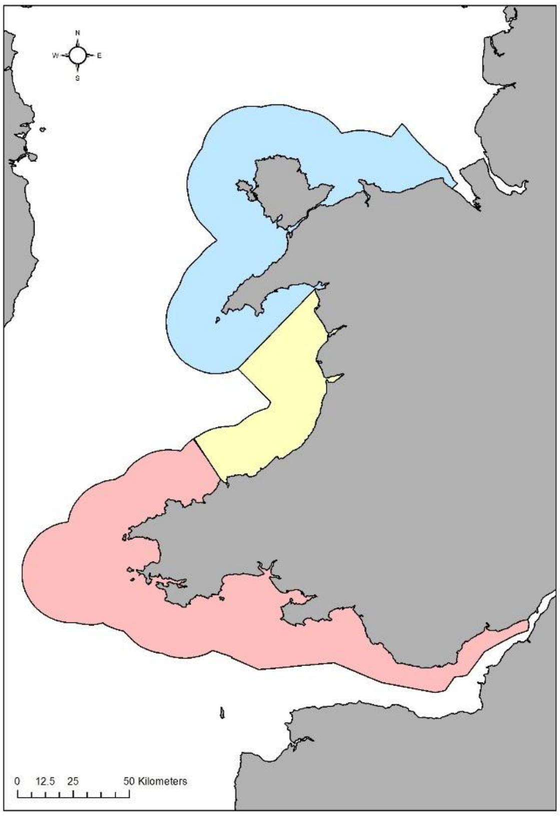

Figure 1: Designation of the three regions of Wales out to the 12 nautical mile limit. Blue area = North Wales, yellow area = Mid Wales, red area = South Wales.

The first fishers to be contacted were those already involved in the European Fishery Funded project "Sustainable Use of Fisheries Resources in Welsh Waters" and were therefore already willing to participate. The various fishing associations around Wales were contacted and asked to circulate flyers and information sheets to the members of their associations to spread the word about the questionnaire. In some cases, the association employees contacted their members on the project's behalf and elicited participation. In addition, some fisher association and Inshore Fishery Group meetings were attended to introduce the questionnaire to the fishers and arrange appointment times. Furthermore, flyers were circulated in as many fishing ports as possible in such establishments as bait shops, chandleries, cafés near the harbour/quay, and harbour masters' offices. As each questionnaire was completed, the fisher was asked to recommend any other fishers that he thought would be willing to participate. This non-random technique is known as snowballing and has been used in many LEK studies. Fishers were primarily contacted via telephone as it was discovered that not many fishers regularly use or check email.

Prior to commencing the questionnaire, each fisher was asked to read and sign a data protection consent form outlining the purpose of the data collection and who would have access to the information. Once the consent form was signed the questionnaire began. Fishers were not pressured to answer questions that they either did not want to answer or did not feel they could confidently answer.

The interviews took place from August 2013 to January 2015, with the majority taking place between February and April 2014. These interviews took place in any location that was convenient to the fisher and included fishers' houses, cafés, fishing association offices, gear sheds, places of work and at ports. On average, the questionnaires lasted one hour, however, it sometimes took much longer depending on how many fishing locations the fisher had and how much he had to say.

The data collected from the questionnaires, specifically the spatial distribution of the fishing areas, was monitored throughout the data collection period to ensure that all areas were being represented. In this way effort soliciting participants could be adapted to focus on missing areas and decrease the potential for a spatial bias.

RESULTS

Questionnaires were conducted with 66 fishers, with information pertaining to 76 vessels. Whilst very few fishers declined to participate, many scheduled interviews were cancelled by fishers prior to occurring or fishers were not contactable when details for the meeting needed to be arranged. Not all of the questions were answered by each fisher; however the responses they did provide were used where possible. Table 1 shows the distribution of the fishers interviewed across the three regions of Wales. A fishers' designation to a region was based on their home port. The results are based on fishing areas that are either currently fished or have been fished in the last 5 years.

Table 1: The number of fishers and vessels interviewed in North, Mid and South Wales from 2013 - 2015.

Region	Number of Fishers	Number of Vessels
North	29	30
Mid	11	13
South	26	33
Total	66	76

The August 2014 United Kingdom Fishing Vessel List (MMO 2014b; MMO 2014c) prepared by the Marine Management Organisation Statistics and Analysis Team reports that there are 408 Welsh vessels registered in the UK; however, upon comparison with the EU Fleet Register for the UK (DG MARE 2015) and eliminating replicate entries, 399 Welsh vessels were identified. Table 2 shows the division of the Welsh fleet by primary and secondary gears used (see Appendix 1 for gear code descriptions). Based on the number of registered Welsh vessels from the MMO vessel list, 19% of the Welsh fishing fleet was interviewed for this study. It is most likely that the percentage is much higher as the MMO list is for registered vessels and may include vessels which are not actively fishing. By consulting the number of Welsh vessels landing in Welsh ports (Appendix 2) and using the month which had the highest number of vessels landing (221 Welsh vessels landed in Welsh ports in July 2014), 34% of the active Welsh fishing fleet was interviewed with this questionnaire. The proportions of vessels using each gear type are fairly similar between the MMO/EU database and the current study; however, no otter trawlers or beam trawlers were interviewed as this study focused on eight specific species, only one of which is targeted by trawlers.

Table 2: Gear use according to MMO and EU fleet databases compared to gear use from Fishers' Questionnaire.

Gear	Total number of vessels using gear type (MMO)	% of vessels using gear type (MMO)	Total number of vessels using gear type (Questionnaire)
DRB	3	0.7	0
DRH	1	0.3	0
FPO	233	58	66
GND	1	0.3	2
GNS	119	30	26*
GTR	3	0.8	0
HMD	23	6	9
LHP	59	15	8
LLS	6	2	1
OTB	28	7	0
SB	3	0.8	1
TBB	9	2	0

* The tangle nets fishers use to catch spider crabs were added to the GNS (set gillnets) gear category. It is not clear from the EU Fleet Register codes description which code tangle nets are categorised under.

337 fishing locations were described by the fishers interviewed; 272 were current fishing locations, 19 were locations that have been fished in the last five years, and 46 were locations that were fished last over five years ago. These fishing locations cover 10, 742 km^2 of Welsh waters.

Fishers

The average age of the fishers interviewed was 52 years; however, owners and skipper were targeted for this questionnaire, therefore this represents the average age of skippers and owners in the Welsh fishing fleet as opposed to all fishers. The age of fishers interviewed ranged from 25-74 years. These fishers have been actively fishing for between five and 63 years, with an average of 31 years of fishing experience. This corresponds to 2077 combined years of fishing experience. The average age that these fishers started fishing was 20 years old. Seventy-five percent of the fishers considered themselves fulltime fishers, with the remaining 25% stating they fish between 10 and 90% of the time. Eighty percent of the fishers interviewed are members of at least one fishing association. The fishers interviewed target an average of three species each; however, some fishers target up to six species and some focus solely on one species.

Vessels

The fishers were asked a series of questions regarding their vessels. Table 3 shows mean vessel characteristics for the vessels interviewed in the current study as well as the August 2014 vessel details from the MMO United Kingdom vessel lists (MMO 2014b; MMO 2014c). The calculations made were based solely on the vessels with a home port in Wales. The vessel summary statistics are similar to those obtained from the MMO vessel list, with the exception of vessel power. This is most likely due to the fact that this questionnaire did not include vessels using trawls as they do not tend to target the species of interest. Furthermore, the MMO figures are based on all registered vessels, many of which may not be actively fishing.

Table 3: Comparison of vessels details from current study and Marine Management Organisation (MMO) August 2014 United Kingdom vessel list.

Vessel Details	Average ± SE	Range	Number of vessels	MMO Average ± SE	MMO Range	MMO Number of Vessels
Overall Length (m)	8.3 ± 0.3	4.3 - 17	72	7.2 ± 0.2	3.7 – 43.2	399
Power (KW)	84.6 ± 7	5 - 294	72	60.5 ± 2.8	1 - 537	399
Tonnage	6.0 ± 1	1 - 47	64	5.6 ± 1.1	0.13 - 388	399
Age of vessel	25 ± 1.7	1 - 75	70	25 ± 0.7	1 - 77	351
Number of crew	1.8 ± 0.1	1 - 5	70	NA	NA	NA

Species

This questionnaire was used to survey fishers targeting brown crab, European lobster, common prawn, common whelk, king scallop, queen scallop, spider crab, and sea bass. Table 4 shows the number of fishing areas identified for each target species, as well as the total and mean areas of those fishing areas. On average, the fishing areas for sea bass and prawns are much smaller than the fishing areas for other species. In addition, whelk fishing areas are considerably larger than the other fishing areas.

Table 4: Number, total area and mean area of the current fishing areas and fishing areas fished in the last five years by fishers interviewed.

Target Species	Number of Fishing Locations	Total Area of Fishing Locations (km^2)	Mean Area of Fishing Locations (km^2)
Brown crab	66	3678	72
Lobster	72	4273	77
Prawn	22	527	29
Whelk	31	6640	245
King scallop	17	1276	113
Spider crab	21	1085	60
Sea bass	60	1269	33

Brown Crab (*Cancer pagurus*)

Forty-six brown crab fishers were interviewed and 66 brown crab fishing areas were identified, totalling 3678 km^2. Twenty-eight brown crab fishing locations were highlighted in North Wales, 13 in Mid Wales, and 25 in South Wales.

Fishers harvest brown crabs with D shaped parlour pots and soak their pots between 24 and 96 hours. The average soak time for 65 brown crab fishing locations was 52 hours, with 48 hours being the most common soak time. These fishers bait their pots with a variety of species (see Appendix 3); however, the most commonly used species for bait are scad, flatfish and dogfish. Fishers obtain their bait from personal bycatch, supermarkets, processors' waste, other fishers' target species, other fishers' bycatch, fish farm waste, buyers/merchants, bait suppliers, and fish mongers. The vast majority of fishers obtain their bait from their shellfish buyer/merchant. Many of the fishers also use some of their bycatch as bait, but this usually accounts for only a small portion of their bait. Numerous fishers also mentioned that bait is very expensive. The number of pots fished in 54 brown crab locations varied dramatically amongst fishers with a range of 24 to 4500 total pots and an average of 334 pots per fishing location. Thirty-one percent of the brown crab fishers have lobster escape hatches on some of their pots. These escape hatches are of different sizes and range from only 20 pots with escape hatches to 250 pots with escape hatches. On average, fishers each lose 27 pots per year; however, some fishers report losing only a couple pots and other fishers have reported losing 200 pots per year. For the 44 brown crab fishers that provided a response, a total of 1167 pots are lost each year in Welsh waters. The winter of 2013 had very extreme weather and many fishers lost the majority of their pots, for this reason, fishers were asked about how many pots they lose in an average year. There are a variety of reasons why fishers lose their pots, with the most common being due to storms and extreme weather. The other reasons for losing their pots include cut ropes, snagged on seabed, towed away, stolen, snapped bridles, tourists removing, and worn out.

Respondents report fishing for brown crab for an average of nine months of the year and 117 days per year, with some fishing for as few as 15 days per year, whilst others fish as many as 315 days per year. The majority of brown crab fishing locations are fished from April to October; however, 45% of the locations are fished every month (Figure 2).

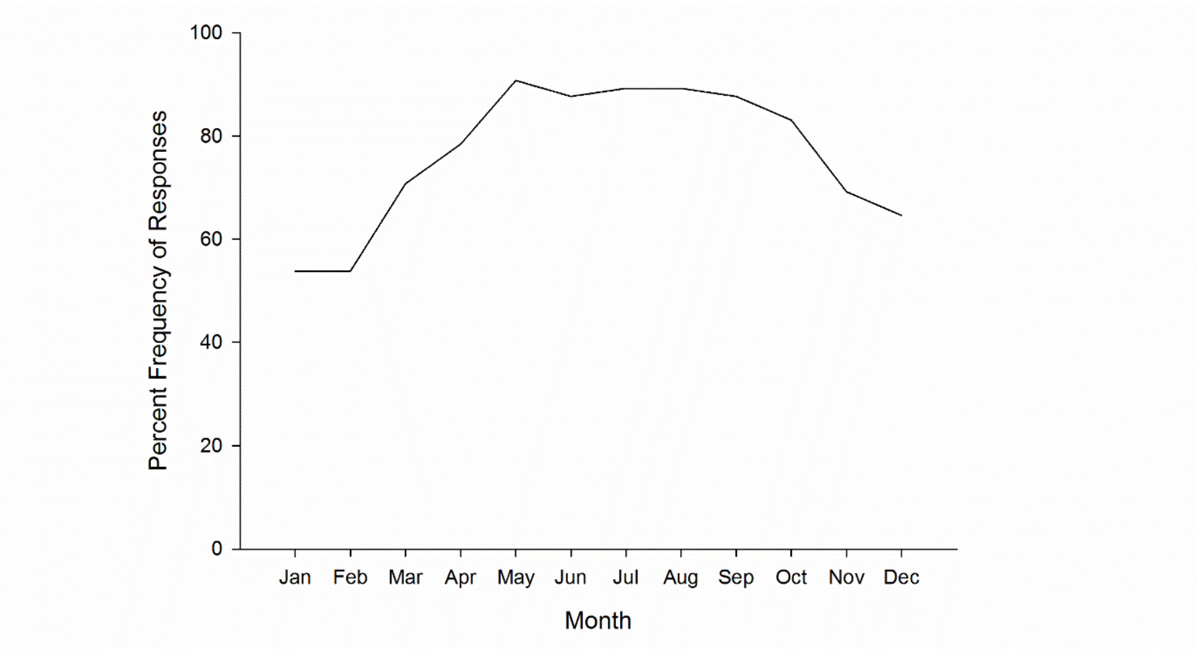

Figure 2: The percentage of identified brown crab fishing locations in Welsh waters that respondents indicated they fished each month (Data represents the fishing activity of an average year).

The observations of substrate types in the brown crab fishing areas were very mixed with 54% of the fishing areas containing at least two types of substrate. The most prevalent substrate reported was rock (88% of the areas contain at least some rock substrate); however, gravel, sand and mud substrates were also fairly common (32%, 32% and 28% respectively).

Fishers have noticed a decrease in abundance of brown crabs in 46% of the areas fished and no change in 36% of the areas. Fishers have observed an increase in abundance in only 3% of the fishing areas. With respect to brown crab size, no change has been observed for the majority of the fishing areas (55%) (Figure 3). The three most common reasons given for the decrease in brown crab abundance were increased fishing effort, climate change and an increase in spider crabs. The majority of the fishing in areas in Mid Wales (77%) and South Wales (50%) had perceived decreases in brown crab abundance, whilst the majority of the fishing areas in North Wales (50%) were reported to have no change in brown crab abundance (Figure 4). A chi squared test found no relationship between the observed changes in brown crab abundance (x^2=44.02, d.f.=30, P=0.05) or size (x^2=40.31, d.f.=30, P=0.099) and the experience level of the fisher.

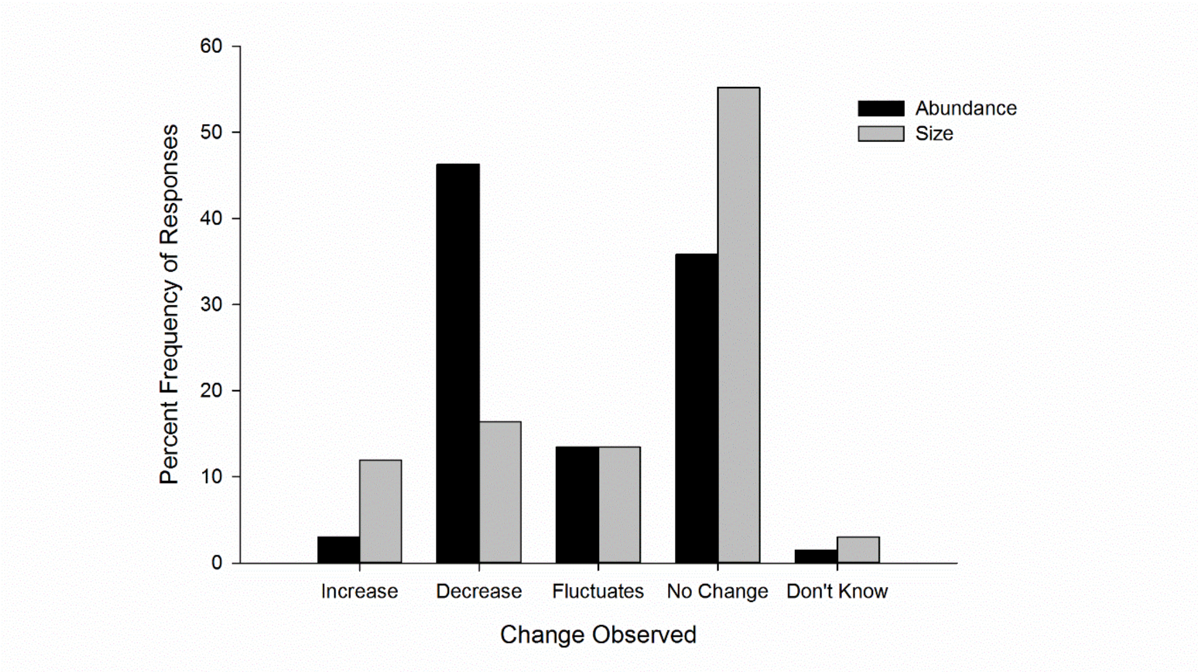

Figure 3: The percentage of identified brown crab fishing areas where respondents observed changes in brown crab abundance and size.

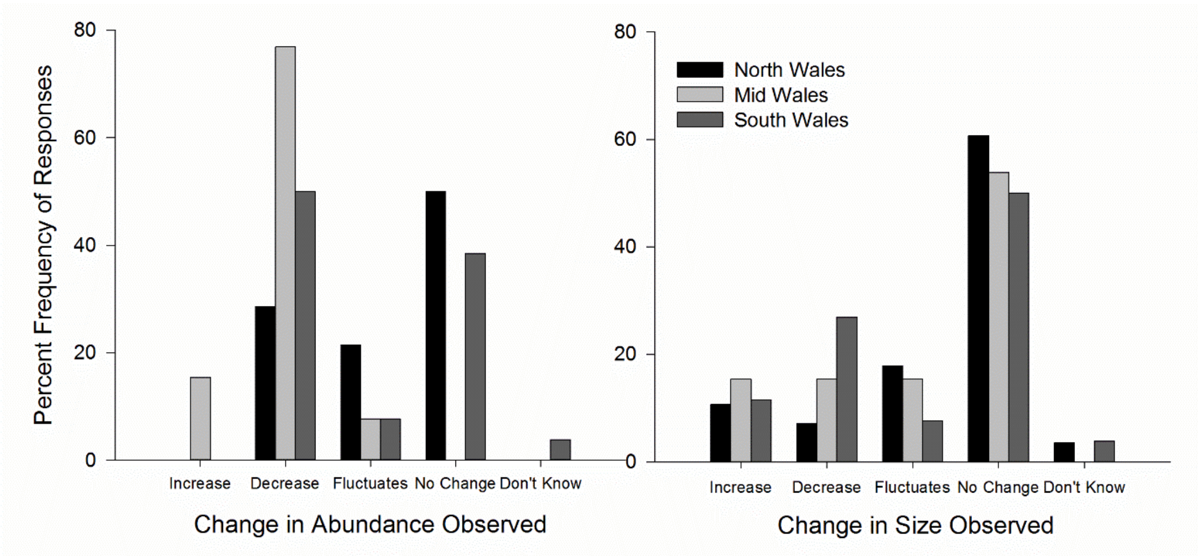

Figure 4: The percentage of identified brown crab fishing areas in North, Mid and South Wales where respondents observed changes in brown crab abundance and size.

Fishers were asked which months they observe berried female brown crabs. The results indicate that this species tends to carry eggs in the winter; however, some fishers have observed berried females throughout the entire year (Figure 5). Additionally, a greater proportion of fishers in South Wales have observed berried brown crabs throughout the year than in the other two regions of Wales. Berried crabs are not seen or fishers cannot recall when they are observed in 52% of the areas identified. This indicates that berried brown crabs may not be detected frequently.

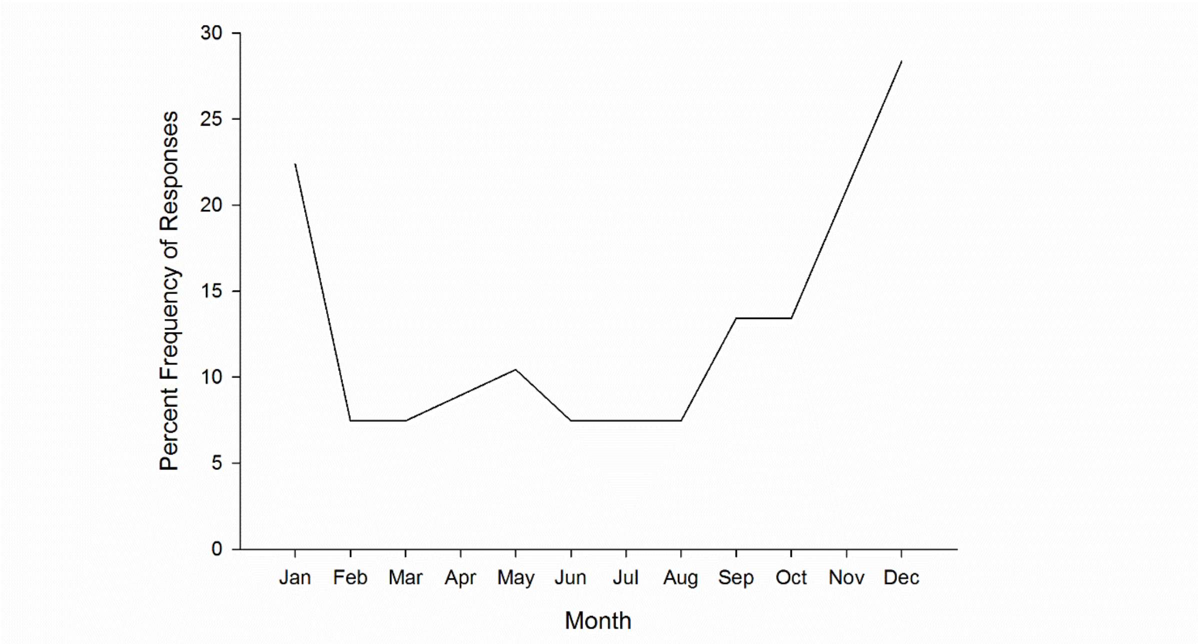

Figure 5: The percentage of brown crab fishing areas where respondents observed berried brown crabs each month.

Fishers were asked which months they observe undersized brown crabs (<130mm carapace width in North and Mid Wales, <140mm carapace width in South Wales) and 68% reported seeing undersized brown crabs all year. This was consistent for North and South Wales, but not Mid Wales (the difference in Mid Wales is based on the observations of one fisher with five brown crab fishing areas). The average legal size of brown crabs that fishers catch was also recorded and the most frequent response for North Wales was 160mm carapace width, 130mm for Mid Wales and 140mm for South Wales.

Fishers have also noted several environmental conditions that seem to result in either an increase or decrease in brown crab catches. Fifty-four percent of the 46 fishers that answered this question reported an increase in crab catches when the water temperature increases; however, 11% reported the opposite response to increased water temperature. Environmental conditions associated with rough weather (wind, swells, storms and turbidity) were also commonly cited by fishers as conditions that increase brown crab catches.

Brown crab fishers continue to fish in particular fishing areas based on a variety of reasons; however, the most frequent response was that they fish in their current areas based on the previous catch levels (65%). Other important factors are the proximity to their home port (33%) and territory (23%). In many areas of the Welsh waters, fishers have designated territories that many have been traditionally fishing for many years. In this way conflict can be avoided.

Finally, the fishers were asked if they had any comments or concerns regarding brown crabs. This question was completely open and could refer to the market, the fishing operations, the biology of the species, etc. Of the fishers that did voice comments or concerns, the most common comment referred to the poor price of brown crabs. Other concerns that were mentioned regarded the expense of fishing (expensive bait and fuel), the conflicts of fishing (too much effort, mobile gears impacting grounds and brown crabs used as whelk bait), biological observations (the prevalence of black spot disease and the absence of berried females), and a lack of enforcement.

European Lobster (*Homarus gammarus*)

Fifty-five lobster fishers were interviewed and 72 lobster fishing areas were identified, totalling 4273 km^2. Thirty-three lobster fishing areas were highlighted in North Wales, 13 in Mid Wales, and 26 in South Wales.

Fishers harvest lobsters using D shaped parlour pots and soak their pots between 24 and 168 hours. The average soak time for 72 lobster fishing locations was 54 hours, with 48 hours being the most common soak time. Similarly to brown crab fishers, lobster fishers bait their pots with a variety of species (see Appendix 3); however, the most commonly used species for bait are scad, flatfish and dogfish. Fishers obtain their bait from personal bycatch, supermarkets, processor's waste, other fishers' bycatch, fish farm waste, buyers/merchants, bait suppliers and fish mongers. The vast majority of lobster fishers obtain their bait from their shellfish buyer/merchant. Many of the fishers also use some of their bycatch as bait and a small portion of the lobster fishers buy their bait from supermarkets. This is similar to brown crab fishing because they are caught at the same time in the same pots; however, some fishers only target lobsters. Additionally, some of the fishers mentioned that using rotten bait is better for catching lobsters, as brown crabs are more attracted to fresh bait, and they believe that brown crabs in the pots deter lobsters from entering. The number of pots fished in 69 lobster areas varied dramatically amongst fishers with a range of 6 to 4500 total pots and an average of 312 pots per fishing area. Twenty-five percent of the lobster fishers have lobster escape hatches on some of their pots. These escape hatches are of different sizes and range from only 12 pots with escape hatches to 250 pots with escape hatches. On average, fishers lose 25 pots per year each; however, some fishers reported losing zero pots and other fishers have reported losing 200 pots per year. For the 63 lobster fishers that provided a response, a total of 1573 pots are lost each year in Welsh waters. It is important to note that 1167 of the pots that are lost in lobster fishing areas are the exact same pots that were reported lost in brown crab fishing areas since fishers use the same pots to catch both species. There are a variety of reasons why fishers lose their pots, with the most frequent being due to storms and extreme weather. The other reasons for losing their pots include cut ropes, snagged on seabed, towed away, stolen, snapped bridles, tourists removing, being driven over by boats, and worn out.

Respondents report fishing for lobster for an average of nine months of the year and 121 days per year, with some fishing for as few as 15 days per year, whilst others fish as many as 305 days per year. The majority of lobster fishing areas are fished from May to October; however, 44% of the locations are fished every month (Figure 6).

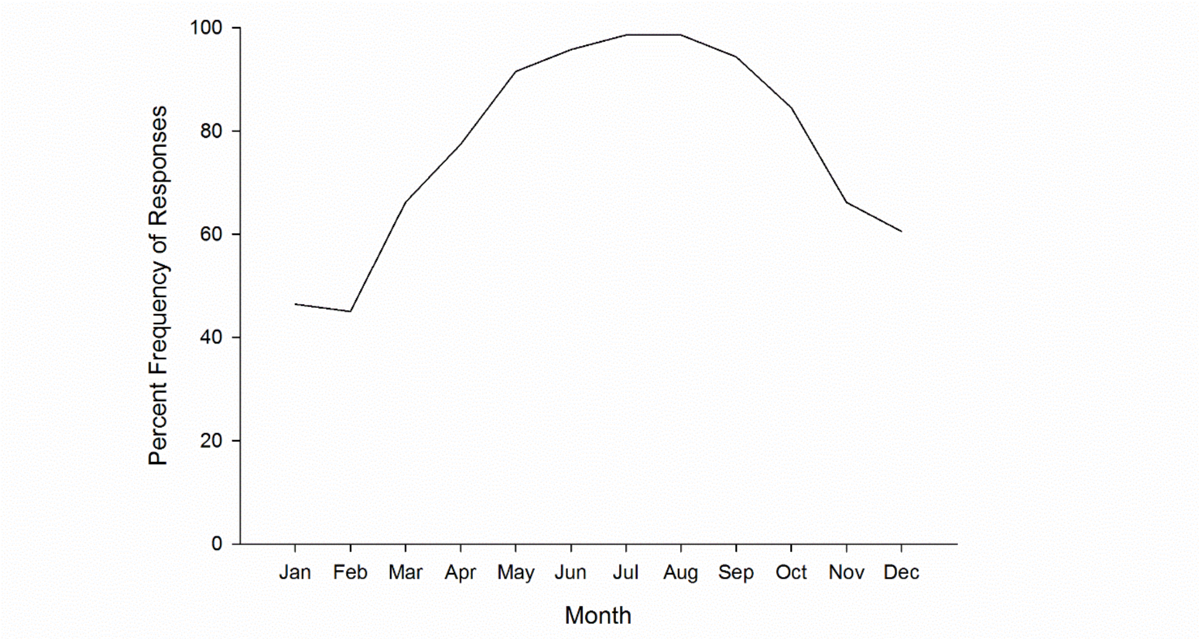

Figure 6: The percentage of identified lobster fishing areas in Welsh waters that respondents indicated they fished each month (Data represents the fishing activity of an average year).

The observations of substrate types in the lobster fishing areas were very mixed with 59% of the fishing areas containing at least two types of substrate. The most prevalent substrate reported was rock (90% of the areas contain at least some rock substrate); however, gravel, sand and mud substrates were also fairly common (35%, 35% and 32% respectively).

Fishers have observed an increase in lobster abundance in 29% of the areas fished and no change in abundance in 39% of the locations fished. With respect to lobster size, fishers have noted a decrease in lobster size in 36% of the fishing areas and no change in size in 49% of the areas fished (Figure 7). Eighty percent of the fishers who reported decreased lobster abundance believed this to be due to overfishing. Many of the fishers suspect this is due to intense fishing on large lobsters which has decreased predator pressure on small lobsters and allowed more space for them. Most fishing areas in North Wales have seen an increase in the abundance of lobsters and a decrease in their size. In Mid Wales, most fishing locations have seen decreases in abundance and no change in lobster size. Most fishing locations in South Wales have seen no change in the abundance and either a decrease or no change in lobster size (Figure 8). A chi squared test found no relationship between the observed changes in lobster abundance (x^2=38.29, d.f.=30, P=0.14) or size (x^2=35.49, d.f.=30, P=0.23) and the experience level of the fisher.

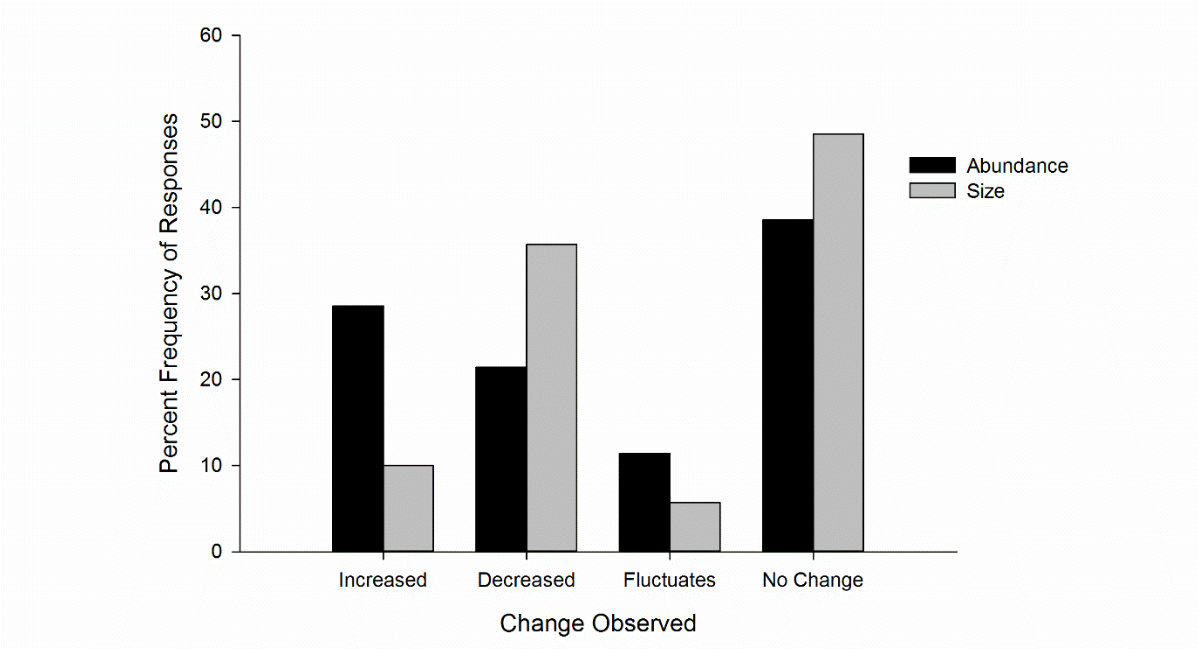

Figure 7: The percentage of identified lobster fishing areas where respondents observed changes in lobster abundance and size.

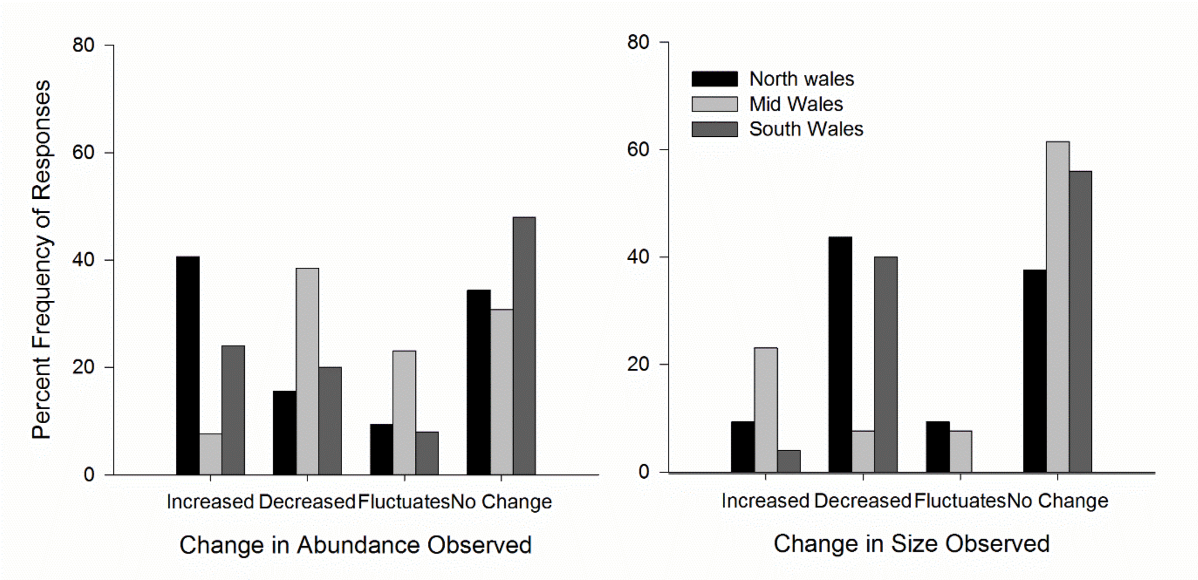

Figure 8: The percentage of identified lobster fishing areas in North, Mid and South Wales where respondents observed changes in lobster abundance and size.

Fishers were asked which months they recall seeing berried lobsters and the pattern of responses suggests that berried lobsters are prevalent throughout the year; however, the responses indicate an increase in September (Figure 9). Fifty-seven percent of the lobster fishers interviewed reported that they v-notch berried lobsters. A v-notch is a mark cut into the tail flipper immediately to the right of the middle tail flipper. A lobster cannot be landed if it has a v-notch (or any cuts or markings) on the tail flippers (Acheson and Gardner 2011). Of the fishers that indicated what percentage of berried lobsters they v-notch, 31% of the fishers v-notch 5% of the berried lobsters they catch and 24% of the fishers v-notch every berried lobster they catch. Most fishers who v-notch have been doing so for between five and 15 years (68%); however some fishers (10%) have been v-notching for over 20 years. Many fishers indicated that they started v-notching when the Welsh Government started a v-notching scheme whereby fishers were paid to v-notch lobsters, and have continued v-notching even though the scheme does not exist anymore. Of the fishers that v-notch, many stated that they v-notch all crippled berried lobsters, but make a decision on the others depending on the catch for that day.

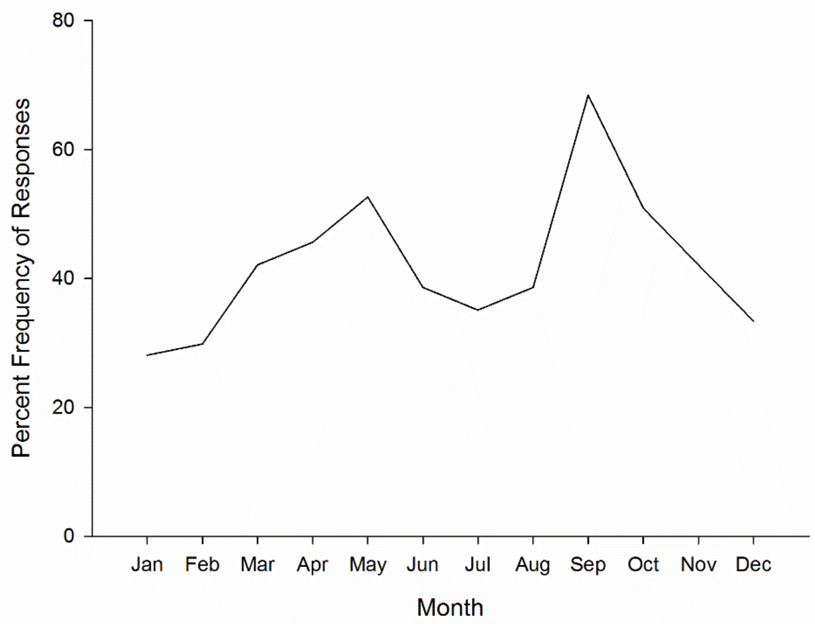

Figure 9: The percentage of lobster fishing areas where respondents observed berried lobsters each month.

As with berried lobsters, undersized lobsters are prevalent throughout the year. The average legal size of lobsters that fishers catch was most frequently recorded as 90mm carapace length in all three regions in Wales. It is important to note that the minimum landing size for lobsters is 87mm in North and Mid Wales and 90mm in South Wales.

An overwhelming majority of the lobster fishers were in agreement that there are increased lobster catches with increased water temperature. The most common environmental condition to decrease lobster catches was easterly winds.

The most often cited reason why lobster fishers return to these specific fishing areas is previous catch levels (56%). Proximity to port (33%) and territory (26%) were also frequently mentioned. Other reasons for the fishing areas' importance include sheltered from weather (14%), less competition (6%), boat size (3%), no trawlers (1%), less tide (1%), and seasonal price (1%).

Of the fishers that voiced a concern or comment regarding lobsters and the fishery, the static market price (15%), the increase in fishing effort (11%), and the need for a ban on berried lobsters (11%) were the most common concerns. The following management measures were suggested which indicates that the lobster fishers feel there needs to be more management for the fishery:

- Pot limits (6%)
- More enforcement (6%)
- Maximum landing size (4%)
- V-notch scheme (4%)
- Pan Wales minimum landing size (4%)
- Mandatory escape hatches (2%)
- Quotas (2%)
- String length limit (2%)

Common Prawn (*Palaemon serratus*)

Eighteen prawn fishers were interviewed and 22 prawn fishing areas were identified, totalling 527 km^2. Four prawn fishing areas were highlighted in North Wales, 12 in Mid Wales, and six prawn fishing areas in South Wales.

Fishers harvest prawns with both round pots and D shaped pots with a variety of mesh sizes for the body and ends of the pots. They soak their pots between 24 and 168 hours. The average soak time for 22 prawn fishing areas was 66.5 hours, with 48 hours being the most common soak time. Prawn fishers bait their pots with less variety of species than brown crab and lobster fishers (see Appendix 3). The most commonly used species for bait is herring. Fishers obtain their bait from personal bycatch, supermarkets, processors' waste, buyers/merchants, and fish mongers. The majority of prawn fishers obtain their bait from their shellfish buyer/merchant. A portion of the prawn fishers interviewed obtain their bait from supermarkets (both bought and as waste) and processor waste. The number of pots fished in 22 prawn areas varied dramatically amongst fishers with a range of 30 to 1000 total pots and an average of 286 pots per fishing area. On average, fishers lose 21 pots per year each; however, some fishers report losing no pots and other fishers have reported losing 100 pots per year. For the 19 prawn fishers that provided a response, a total of 396 pots are lost each year in Welsh waters. There are a variety of reasons why fishers lose their pots, with the most frequent (68%) being due to storms and extreme weather. The other reason for losing their pots include cut ropes, snagged on seabed, towed away, and stolen.

Respondents report fishing for prawns for an average of seven months of the year and 71 days per year, with some fishing for as few as 15 days per year, whilst others fish as many as 195 days per year. The prawn fishing areas are fished most intensely from November to February (Figure 10).

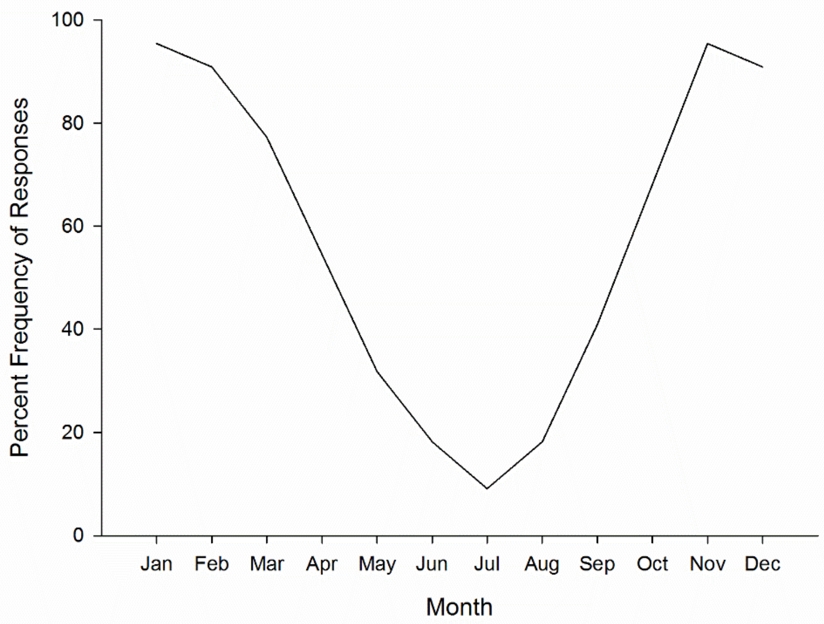

Figure 10: The percentage of identified prawn fishing areas in Welsh waters that respondents indicated they fished each month (Data represents fishing activity of an average year).

The observations of substrate types in the prawn fishing areas were extremely mixed with 95% of the fishing areas containing at least two types of substrate. The most prevalent substrate reported was mud (81% of the areas contain at least some mud substrate); however, gravel, rock and sand substrates were also common (43%, 57% and 52% respectively).

The majority of fishers have seen fluctuating prawn abundances, whilst a decrease in abundance has been observed in one third of the fishing areas. As well, most fishers have not detected any change in prawn size over the years (Figure 11). In North and South Wales, prawn abundance has mostly been reported as fluctuating from year to year; however, in Mid Wales the prawn abundance has been identified as either decreased or fluctuating. With respect to changes in prawn size, fishers in North and Mid Wales have not seen any changes in prawn size in fishing areas and there does not seem to be any trend in prawn size changes in South Wales (Figure 12). A chi squared test found no relationship between the observed changes in prawn abundance (x^2=20.40, d.f.=18, P=0.31) or size (x^2=27.55, d.f.=27, P=0.43) and the experience level of the fisher.

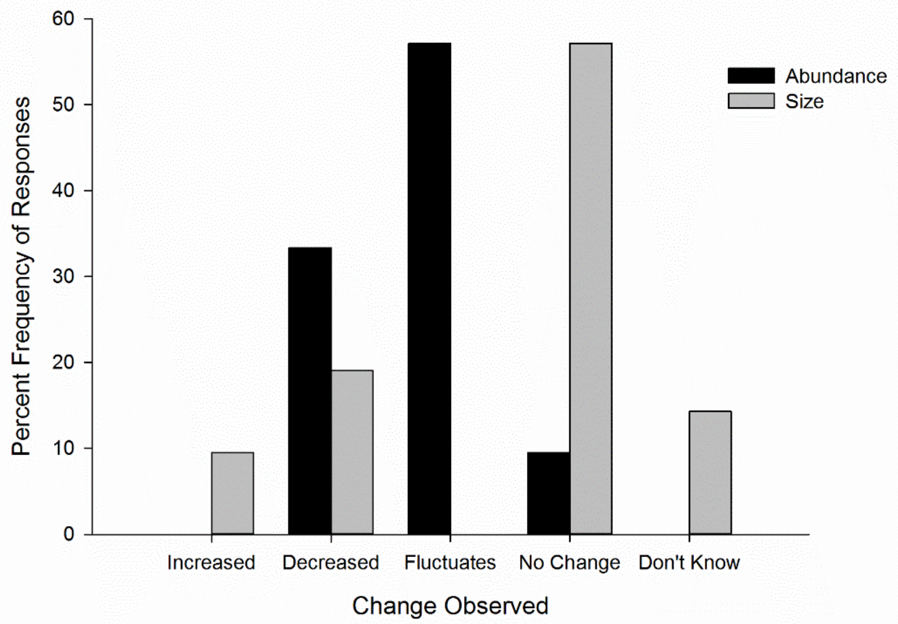

Figure 11: The percentage of identified prawn fishing areas where respondents observed changes in prawn abundance and size.

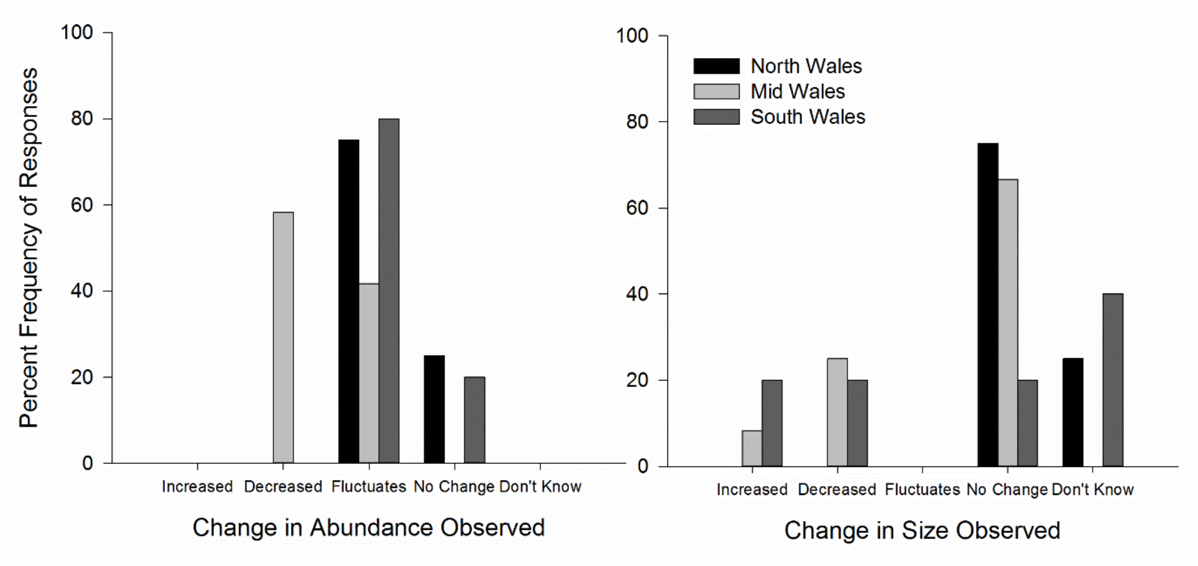

Figure 12: The percentage of identified prawn fishing areas in North, Mid and South Wales where respondents observed changes in prawn abundance and size.

Fishers were asked which months they observe berried prawns and the results suggest they are most prevalent in the winter months (Figure 13). These results should be interpreted with caution as most prawn fishers are only fishing for prawns in the winter months so may only observe berried prawns in these months. It is possible that prawns are berried in the summer months and the fishers are not catching them.

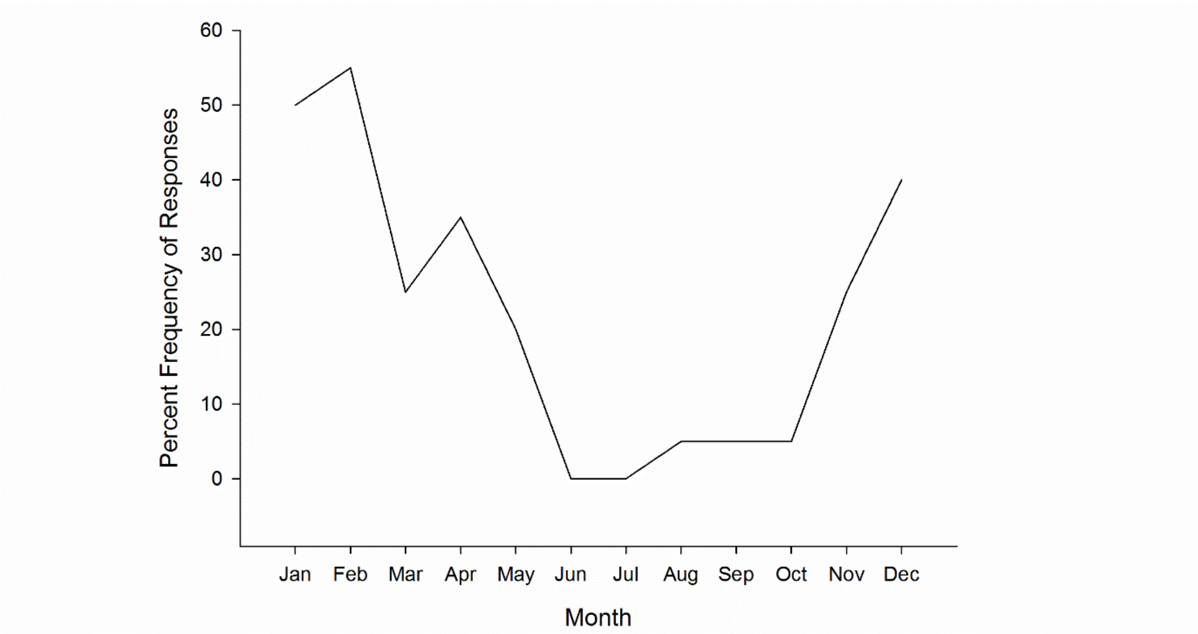

Figure 13: The percentage of prawn fishing areas where respondents observed berried prawns each month.

There was high agreement between the fishers as to the positive effects of turbidity, and to a smaller degree high salinity and decreased temperature, on prawn catches.

The majority (77%) of the prawn fishing areas are revisited because of previous catch levels. Other reasons stated were shelter from weather (23%), proximity to port (23%), territory (14%), less competition (5%), less tide (5%), boat size (5%), and seasonal price (5%).

Contrary to the brown crab and lobster fishers, the prawn fishers have much less concerns about the species and fishery. The most common comment that arose was that there appeared to be no pattern to the prawn catches.

Common Whelk (*Buccinum undatum*)

Nineteen whelk fishers were interviewed and 31 whelk fishing areas were identified, totalling 6640 km^2. Eleven whelk fishing areas were highlighted in North Wales, six in Mid Wales, and fourteen whelk fishing areas in South Wales.

Fishers harvest whelks with both stand-up and lie-down whelk pots and these pots are both handmade and bought. The fishers soak their pots between six and 72 hours. The average soak time for 31 whelk fishing areas was 30 hours, with 24 hours being the most common soak time. Whelk fishers are much more specific when it comes to bait species than brown crab and lobster fishers (see Appendix 3). The predominant species used for bait are crab and dogfish. Many fishers did not specify which species of crab they use; however, brown crab, spider crab, velvet crab and green crab were mentioned by some whelk fishers. Fishers obtain their bait from personal bycatch, supermarkets, processor's waste, fish farm waste, other fishers' bycatch, buyers/merchants, and fish mongers. The majority of whelk fishers obtain their bait from either their shellfish buyer/merchant or as personal bycatch. Many of the whelk fishers mentioned the very high price of bait. The number of pots fished in 26 whelk areas varied amongst fishers with a range of 80 to 1125 total pots and an average of 585 pots per fishing area. Whilst many fishers have reported that they do not lose any pots, multiple fishers stated that it is extremely variable and they could lose from two to 400 pots in a year. For the 21 whelk fishers that provided a response, a total of 1031 pots are lost each year in Welsh waters, with an average of 49 pots lost per fisher per year. There are a variety of reasons why fishers lose their pots, with the most frequent being that they are towed away and lost in storms and extreme weather. The other reasons for losing their pots include snagged on seabed, stolen, tourists removing, and chaffed ropes.

Respondents report fishing for whelks for an average of seven months of the year and 121 days per year, with some fishing for as few as six days per year, whilst others fish as many as 305 days per year. Fishing for whelks is fairly consistent throughout the year and there does not appear to be a particular season for whelk fishing; however, there is slightly less fishing in the winter months as the weather inhibits fishing (Figure 14).

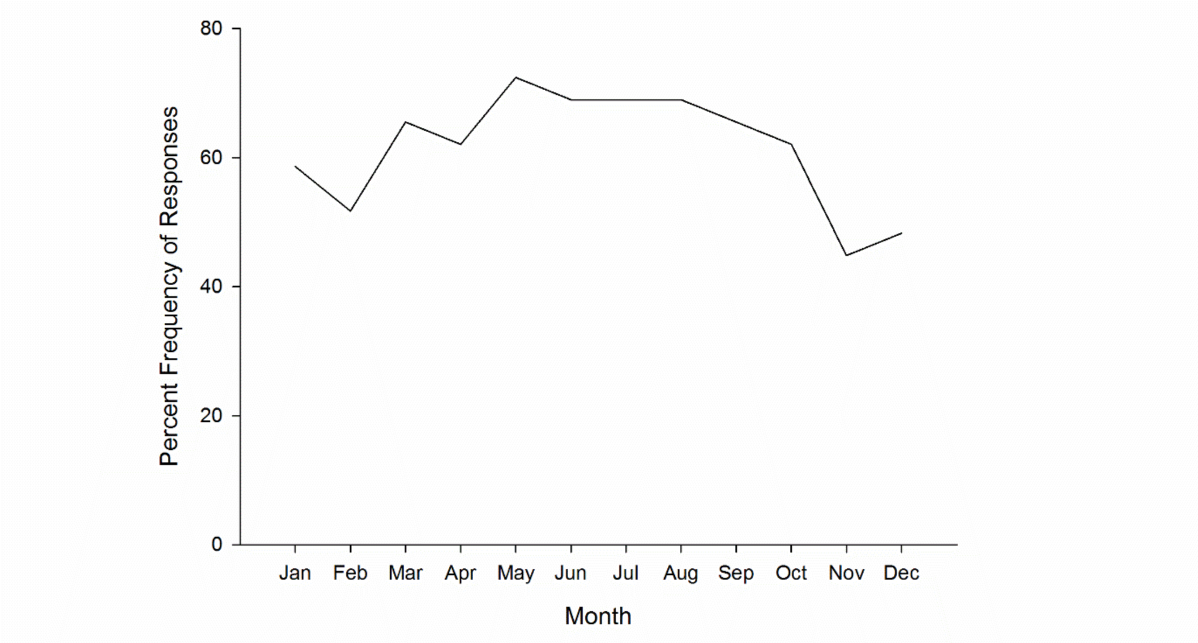

Figure 14: The percentage of identified whelk fishing areas in Welsh waters that respondents indicated they fished each month (Data represents fishing activity in an average year).

The observations of substrate types in the whelk fishing areas were mixed with 79% of the fishing areas containing at least two types of substrate. The most prevalent substrate reported was mud (82% of the areas contain at least some mud substrate); however, gravel and sand substrates were also fairly common (43% and 57% respectively).

There was not much agreement among fishers as to the changes observed in whelk abundance, except that no increases have been detected (Figure 15). When separated by regions, there is still little agreement amongst fishers in North and Mid Wales as to changes in abundance; however, in South Wales, 64% of the fishers have seen no change. The majority (74%) of whelk fishers have not detected any change in whelk size from year to year. This is particularly true for North and South Wales, with more mixed responses in Mid Wales (Figure 16). A chi squared test revealed a relationship between the observed changes in whelk abundance and the experience level of the fishers (x^2=26.64, d.f.=14, P=0.02), with more experienced fishers reporting abundance fluctuations rather than decreases or no changes. There was no relationship found between the observed changes in whelk size (x^2=20.57, d.f.=14, P=0.11) and the experience level of the fishers.

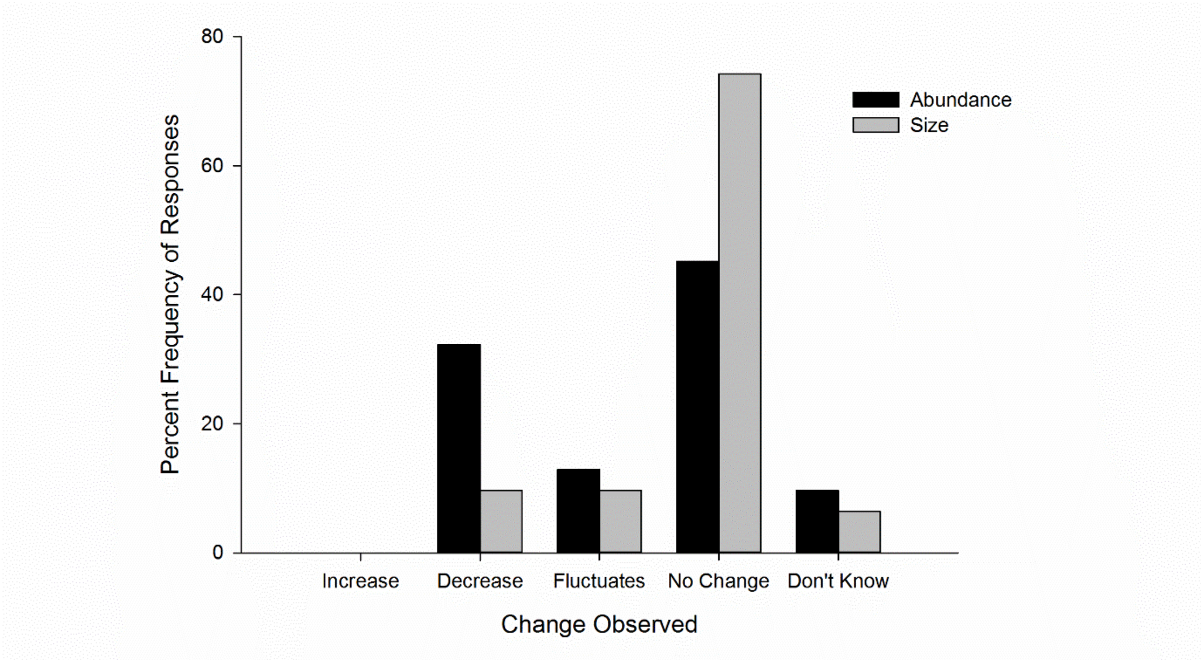

Figure 15: The percentage of identified whelk fishing areas where respondents observed changes in whelk abundance and size.

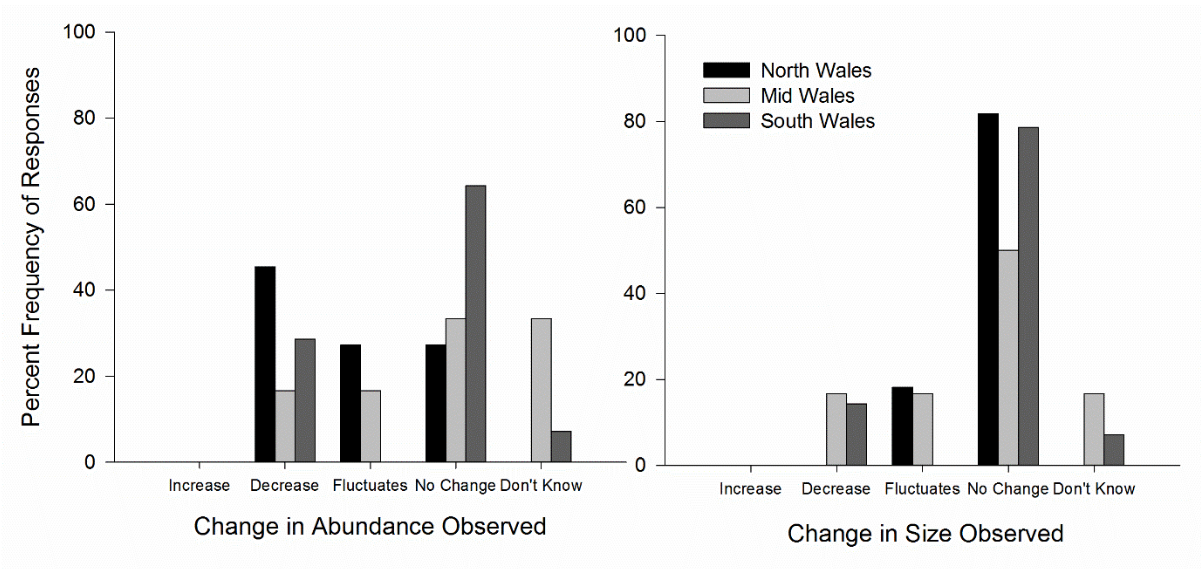

Figure 16: The percentage of identified whelk fishing areas in North, Mid and South Wales where respondents observed changes in whelk abundance and size.

Fishers were asked whether they see different size whelks in different fishing areas. Seventy-nine percent of the fishers interviewed noted that there was a difference in whelk size by fishing area. The water depth was identified as influencing the size of whelks; however, there was not a consensus among the fishers as to the pattern. Of these fishers that identified a pattern with water depth (six fishers), 50% observe smaller whelks in shallow water and 50% observe smaller whelks in deep water. Other suggestions for the different sizes were that larger whelks are on softer ground or in more tidal areas.

Fishers indicated that a small proportion of their catch is undersized whelks that are discarded (Figure 17).

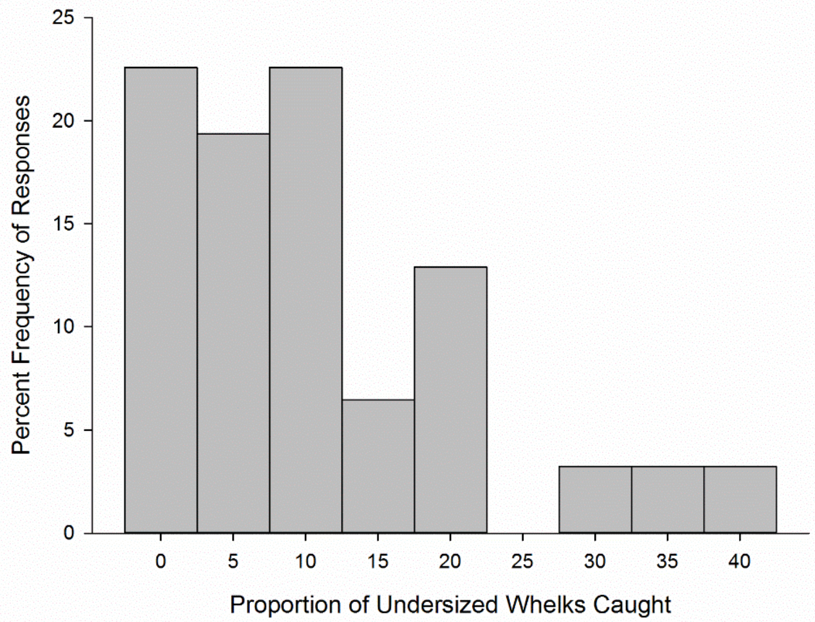

Figure 17: The percentage of identified whelk fishing areas where the respondents observed the proportion of undersized whelks per catch.

Fishers were asked whether there are any environmental conditions that affect their whelk catch and increased temperature, turbidity, whelk breeding, swells, strong tides and rough weather were mentioned. Sixty-three percent of the whelk fishers interviewed believe that an increase in water temperature results in a decrease in catch. Interestingly, one fisher mentioned that it is the change in temperature from warm to cold or cold to warm that affects the catch, not the actual water temperature.

The whelk fishers interviewed indicated that previous catch levels (68%) is the primary reason they return to their specific fishing areas. Other reasons mentioned include shelter from weather (26%), proximity to port (23%), it was a lucky find (10%), territory (3%), and it is less tidal (3%).

There were very few comments or concerns from whelk fishers, nevertheless, some fishers mentioned the good price for whelks and others mentioned a need for management due to the high level of fishing effort.

King Scallop (*Pecten maximus*)

Eight king scallop fishers were interviewed and 17 king scallop fishing areas were identified, totalling 1276 km^2. There are three locations that are fished for king scallops in Welsh waters: off Anglesey, off the Llyn Peninsula and in Cardigan Bay. Three king scallop fishing areas were highlighted off Anglesey, six areas were highlighted off the Llyn Peninsula, and eight areas were highlighted in Cardigan Bay. The following results present information from only those king scallop fishing areas that are currently fished, as opposed to those currently fished and fished in the last five years as is presented for the other species.

Fishers use king scallop dredges to harvest king scallops. The vessels used have from two to seven dredges per side. Respondents report fishing for king scallops for an average of four months of the year and 42 days per year. In some areas, respondents fished only once or twice per year, whilst other areas were fished up to 135 times per year. There is a definite season for king scallop fishing as there is management legislation restricting scallop dredging. However, even within the scallop fishing season, the most fished months are November to January (Figure 18). This may be because the season starts in November and abundances have dropped by February. As seen in Figure 18, the fishing areas in Cardigan Bay are fished for more months than the fishing areas off Anglesey and the Llyn Peninsula. Also, from November to February, all the fishing areas in Cardigan are in use, whereas the fishing areas off Anglesey or the Llyn Peninsula are never all in use. Many of the fishers interviewed fish for king scallops in more than one location in Wales, therefore the high level of activity in Cardigan Bay may indicate that this is a priority location above the others.

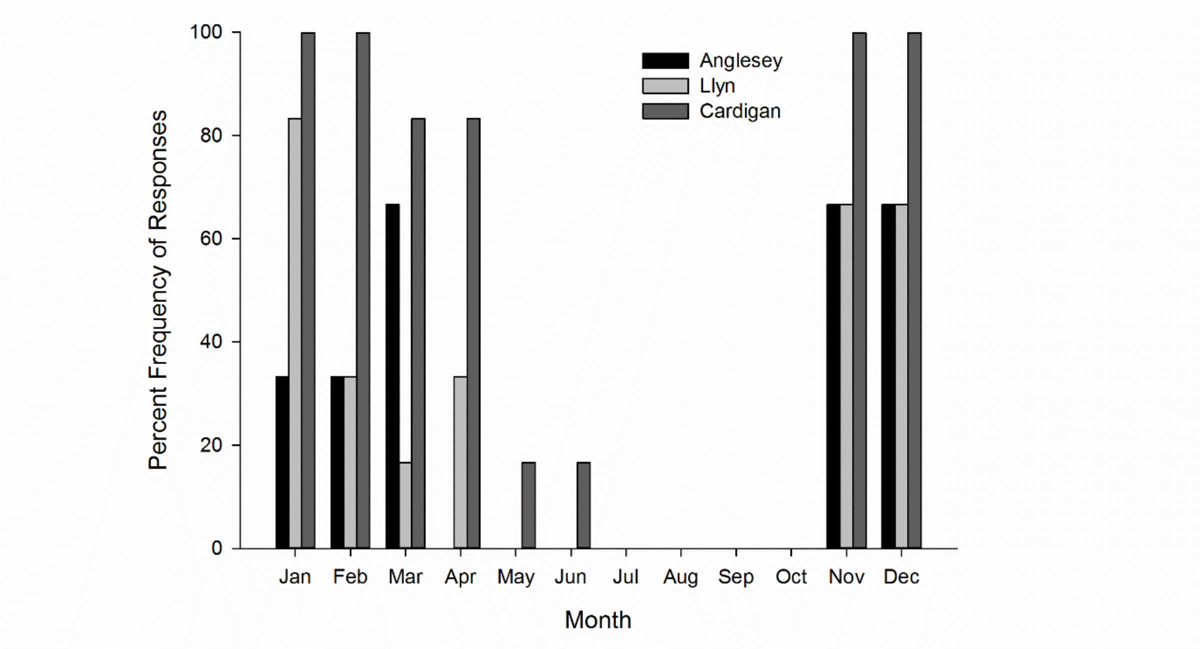

Figure 18: The percentage of three identified king scallop fishing areas in Welsh waters that respondents indicated they fished each month (Data represents fishing activity in an average year).

The observations of substrate types in the king scallop fishing areas were completely mixed with every fishing area containing at least two types of substrate. All of the fishing areas were reported to contain gravel and 80% of them also contained sand.

The observations of abundances of king scallops in the three locations of Welsh waters fished for scallops are very mixed (Figure 19); however, a larger percentage of fishing areas off the Llyn Peninsula (50%) appear to have increased abundances of king scallops. As well, most fishers in Cardigan Bay have either seen no change in abundances or a decrease. With respect to king scallop size, there has been no change observed off Anglesey, but no consensus on size changes off the Llyn Peninsula and Cardigan Bay (Figure 19). A chi squared test found no relationship between the observed changes in king scallop abundance (x^2=10.27, d.f.=12, P=0.59) or size (x^2=10.21, d.f.=9, P=0.33) and the experience level of the fisher.

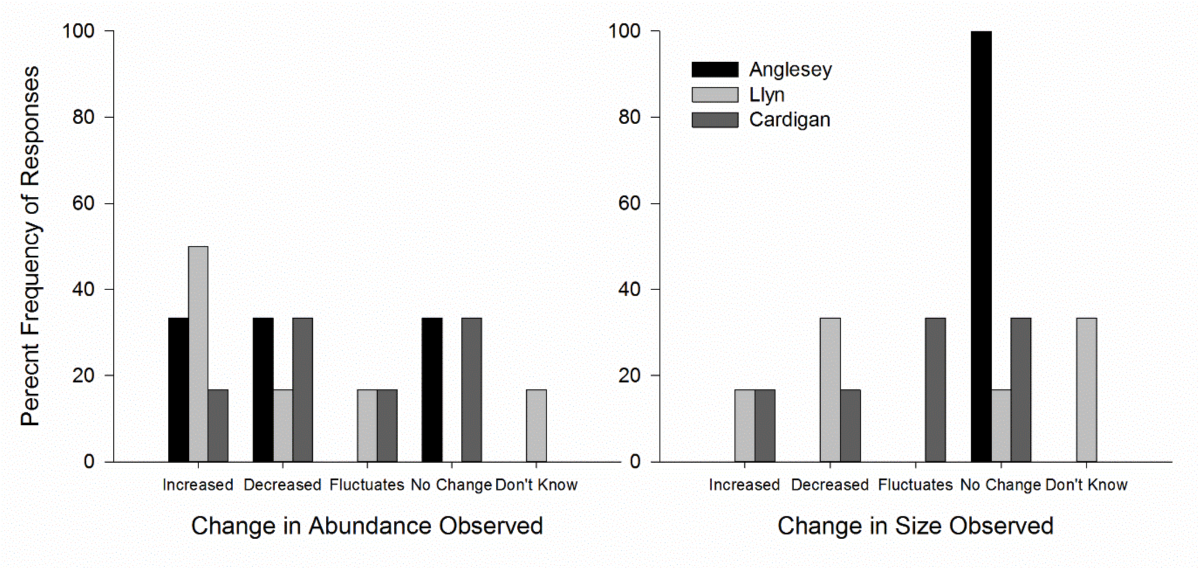

Figure 19: The percentage of the three identified king scallop fishing areas where respondents observed changes in king scallop abundance and size.

King scallops with full gonads have been seen in November in 91% of the king scallop fishing areas (Figure 20). It is important to note that there is no king scallop fishing in the summer months, therefore it is impossible for fishers to know whether king scallops have full gonads in those months. In addition, fewer fishers are king scallop fishing in May and therefore not able to assess gonad fullness.

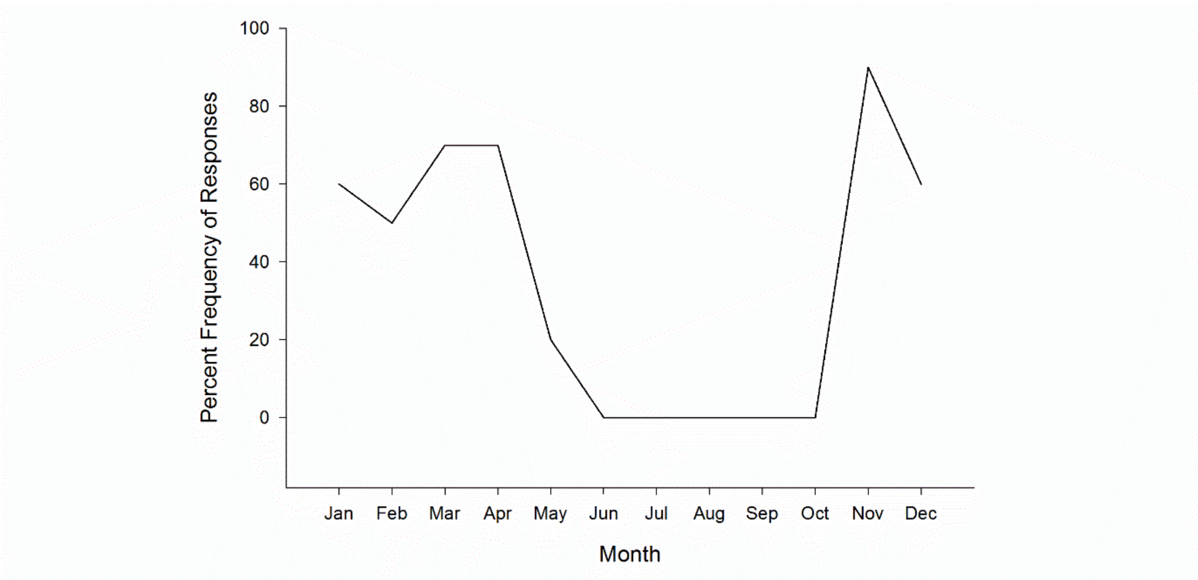

Figure 20: The percentage of king scallop fishing areas where respondents observed king scallops with full gonads month.

King scallop fishers return to these particular fishing areas each year for a variety of reasons. The most common reason is due to previous catch levels (60%), with proximity to port (47%) also being very important in determining where they fish. Other less common reasons for fishing in these locations were territory (13%), not closed for conservation (13%), and to scope for scallops (7%).

When asked if they had any comments or concerns about the current king scallop fishery, the fishers expressed the following concerns:

1. There has been an increase in non-local vessels
2. There are too many vessels fishing in the same areas
3. Since the scallop area closure, they take more risks fishing
4. The closed areas should be opened
5. There should be a rotational fishery where areas are left to recover for two years before fished again

Queen Scallop (*Aequipecten opercularis*)

Only one queen scallop fisher was interviewed, therefore, for confidentiality, the data will not be presented.

Spider Crab (*Maja squinado*)

Eighteen spider crab fishers were interviewed and 21 spider crab fishing areas were identified, totalling 1085 km^2. One spider crab fishing area was highlighted in North Wales, twelve areas in Mid Wales, and eight areas were highlighted in South Wales.

Fishers harvest spider crabs using D shaped parlour pots, inkwell pots, tangle nets and gill nets. The majority (76%) of the spider crab fishing areas identified are fished using tangle nets or gill nets. Spider crab fishers soak their pots between 24 and 72 hours. The average soak time for five spider crab fishing areas using pots was 48 hours. The number of pots fished in four spider crab areas ranged from 152 to 600 total pots with an average of 428 pots per fishing area. On average, fishers lose 29 pots each per year; however, some fishers report losing only a couple pots and other fishers have reported losing 50 pots per year. For four fishers that use pots, 115 pots are lost each year in Welsh waters. The only reason for losing pots that was stated was storms and extreme weather. Spider crab fishers soak their tangle and gill nets between 24 and 72 hours, with an average soak time for 16 fishing areas of 47 hours. Spider crab fishers use from 91 to 800 m of nets with a variety of mesh sizes.

Respondents report fishing for spider crab for an average of five months of the year and 59 days per year, with some fishing for as few as ten days per year in an area, whilst others fish as many as 170 days per year in an area. The majority of spider crab fishing areas are fished from May to August (Figure 21).

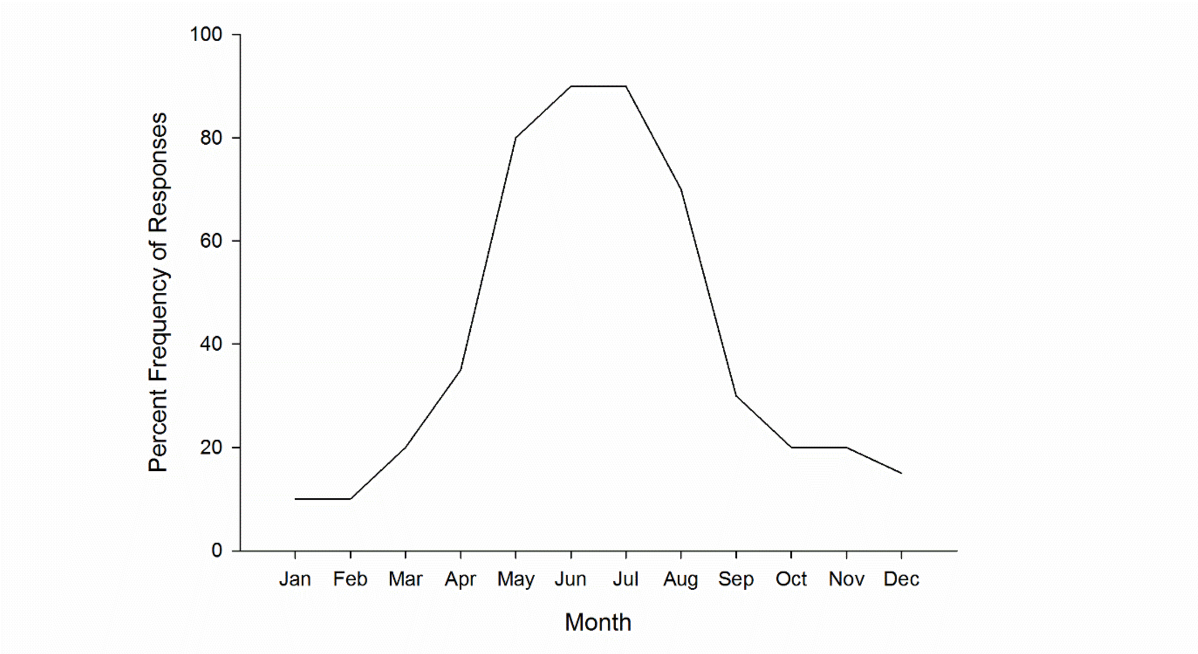

Figure 21: The percentage of identified spider crab fishing areas in Welsh waters that respondents indicated they fished each month (Data represents fishing activity in an average year).

The observations of substrate types in the spider crab fishing areas were mixed with 50% of the fishing areas containing at least two types of substrate. The most prevalent substrates reported were sand and rock (65% of the areas contain at least some sand substrate and 50% some rock substrate); however, gravel and mud substrates were also somewhat common (35% and 20% respectively).

A decrease in abundance has been observed in 57% of the spider crab fishing areas and no abundance change has been observed in 43% of the areas. Conversely, an increase in size has been noted in 24% of the areas and a decrease in size in 29% of the areas (Figure 22). Two common explanations arose from fishers who have observed changes in abundance: overfishing and climate change. Twenty-two percent of the fishers interviewed believe there has been overfishing and 38% of the spider crab fishers believe the spider crabs are moving north due to climate change. This could explain why there is an increase in abundance seen by some fishers in Mid Wales, yet no fishers in South Wales (Figure 23). A chi squared test found no relationship between the observed changes in spider crab abundance (x^2=32.78, d.f.=24, P=0.11) or size (x^2=22.22, d.f.=24, P=0.14) and the experience level of the fisher.

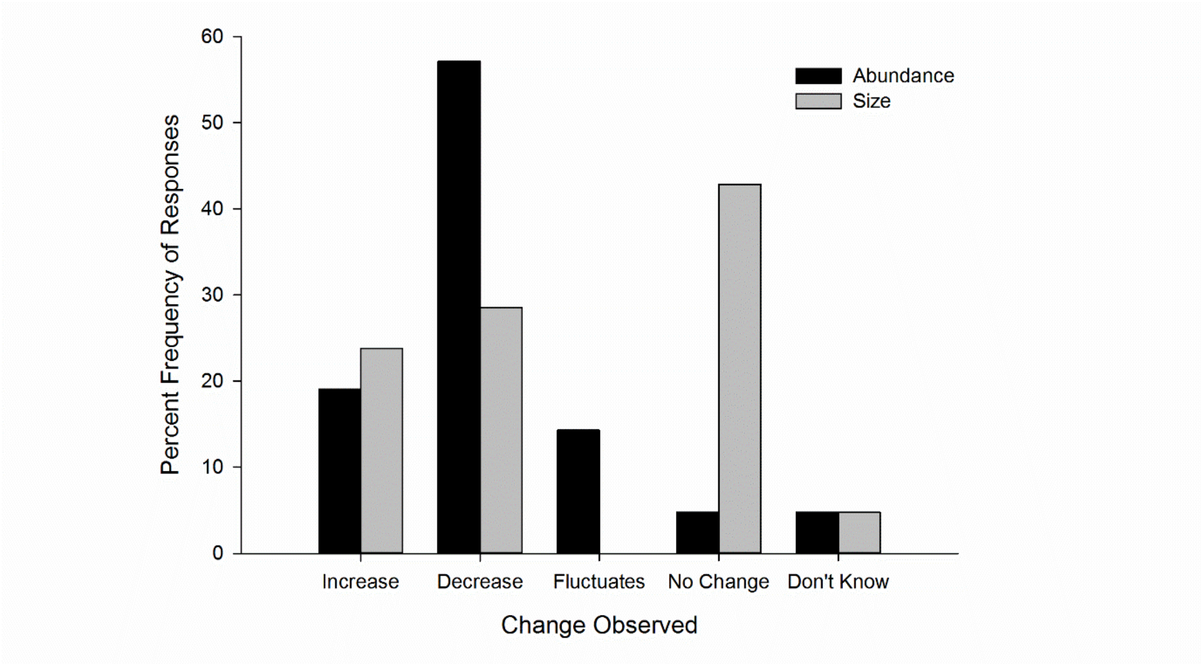

Figure 22: The percentage of identified spider crab fishing areas where respondents observed changes in spider crab abundance and size.

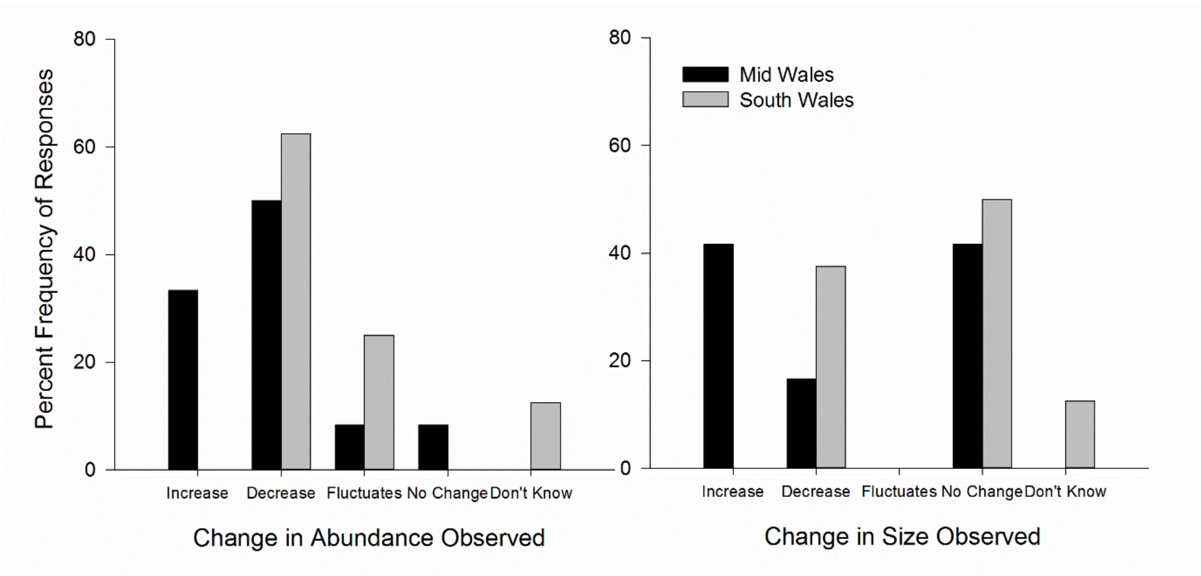

Figure 23: The percentage of identified spider crab fishing areas in Mid and South Wales where respondents observed changes in spider crab abundance and size.

When asked which months fishers observe berried spider crabs, the majority had observed them in August and September, though they have been observed by at least one fisher from May to November (excluding June) (Figure 24). Half of the spider crab fishers interviewed had either not seen berried spider crabs or could not recall which months.

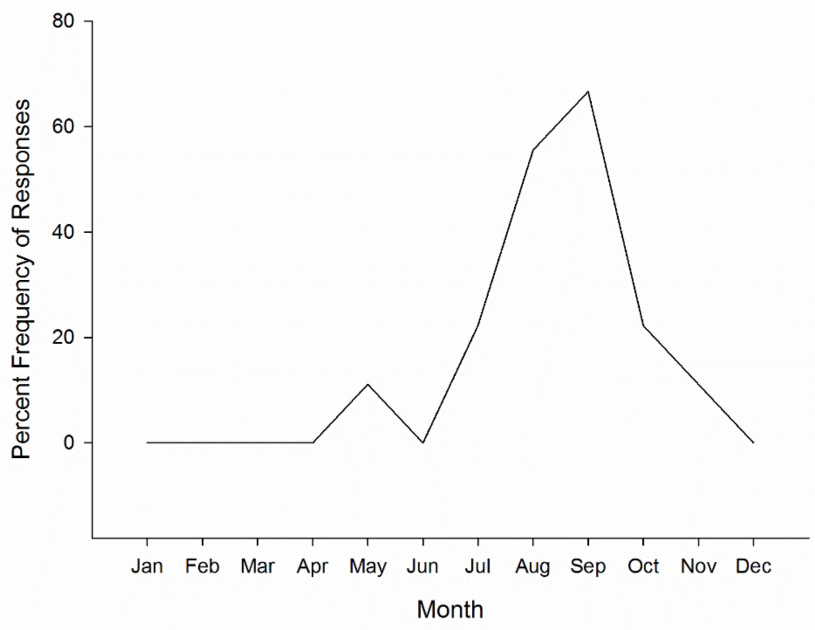

Figure 24: The percentage of identified spider crab fishing areas where respondents observed berried spider crabs each month.

Spider crab fishers return to the stated fishing areas based primarily on previous catch levels (76%). Other reasons for fishing in these areas include proximity to port (14%), shelter from weather (10%), less competition (5%), less tide (5%), flat ground (5%), and the seasonal price (5%).

Similarly to prawn fishers, very few of the spider crab fishers had comments or concerns regarding the species or fishery. Multiple fishers mentioned the movement of spider crabs northward likely due to warming waters, as well as noting that very few female spider crabs are caught. Other comments included the recent drop in market price for spider crabs, a call for an increased minimum landing size, the fear that increasing spider crabs could lead to decreases in lobsters, and that in the last few years almost half of the spider crabs caught are missing claws.

Sea Bass (*Dicentrarchus labrax*)

Twenty sea bass fishers were interviewed and 60 sea bass fishing areas were identified, totalling 1269 km^2. Fourteen sea bass fishing areas were highlighted in North Wales, ten in Mid Wales, and 36 fishing areas were highlighted in South Wales.

The sea bass fishers interviewed harvest sea bass using gill nets, rod and lines, drift nets, longlines, and trammel nets. The majority (59%) of the sea bass fishing areas identified are fished using rod and line, and 25% of the fishing areas are fished using gill nets. Not many of the fishers interviewed use drift nets, longlines or trammel nets. Fishers using gill nets soak their nets between one and 24 hours, with an average soak time for 15 sea bass fishing areas of 11 hours. As very few fishers using drift nets, longlines and trammel nets were interviewed, this data will not be presented.

Respondents report fishing for sea bass for an average of six months of the year and 40 days per year, with some fishing for as few as six days per year in an area, whilst others fish as many as 132 days per year in an area. The most active months for sea bass fishing are July, August and September; however, there is sea bass fishing in at least 10% of the fishing areas all year long. The seasonal trends in fishing activity for fishers using gill nets and rod and line show greater use of rod and line in July to September and a greater use of gill nets in September to November. Gill nets are used throughout the year whereas there appears to be little fishing with rod and line in the winter months (Figure 25).

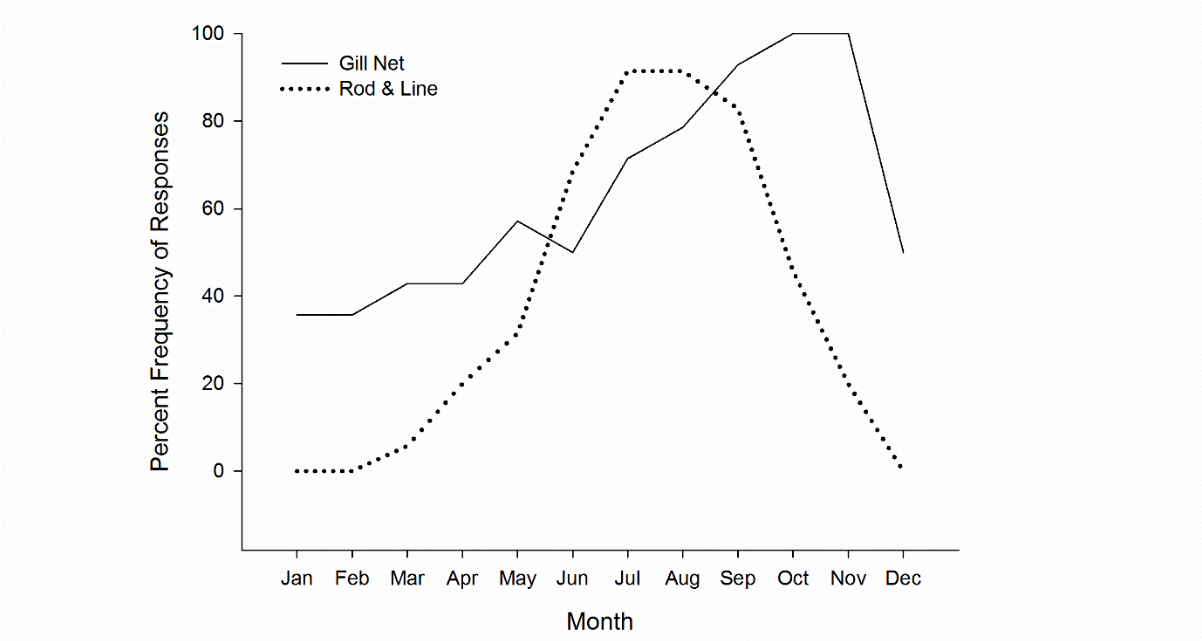

Figure 25: The percentage of sea bass fishing areas in Welsh waters that respondents indicated they fished each month using gill nets and rod and line (Data represents fishing activity for an average year).

The observations of substrate types in the sea bass fishing areas were not very mixed with only 21% of the fishing areas containing at least two types of substrate. The most prevalent substrates reported were sand and rock, with 54% of the areas contain at least some sand substrate and 49% containing some rock substrate. With respect to gear types, the majority of fishing areas using gill nets, drift nets, longlines, and trammel nets contained sand substrate, yet the majority of the areas fished using rod and line gear contained rock substrate.

Fishers have seen increases, decreases and no changes in the abundance and size of sea bass (Figure 26); however, when divided by regions in Wales, it appears the decreased abundance has predominantly been observed in South Wales, the increased abundance in Mid Wales, and no change or an increase in abundance in North Wales. Increased size appears to be predominantly in Mid Wales, the decreased size predominantly in South Wales and no change in abundance predominantly in North Wales (Figure 27). A chi squared test revealed a relationship between the observed changes in sea bass abundance and fishers' experience (x^2=64.39, d.f.=16, P<0.01) and sea bass size and fishers' experience (x^2=63.49, d.f.=14, P<0.01). It appears that fishers with more experience have observed an increase in sea bass size and no changes in sea bass abundance.

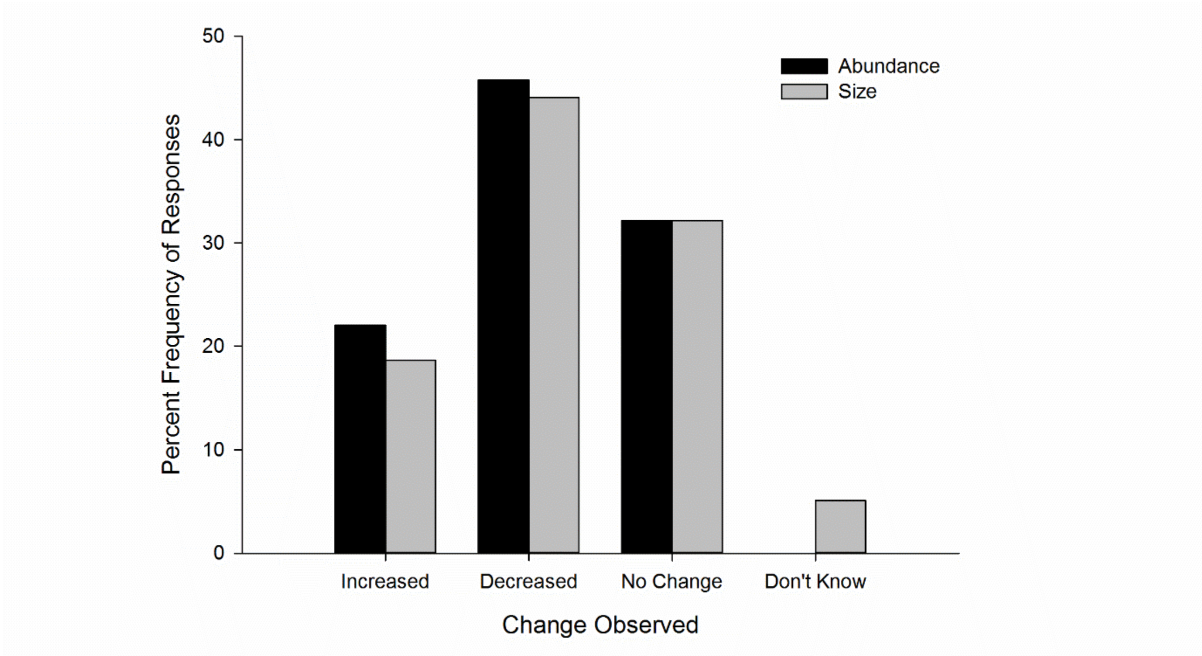

Figure 26: The percentage of identified sea bass fishing areas where respondents observed changes in sea bass abundance and size.

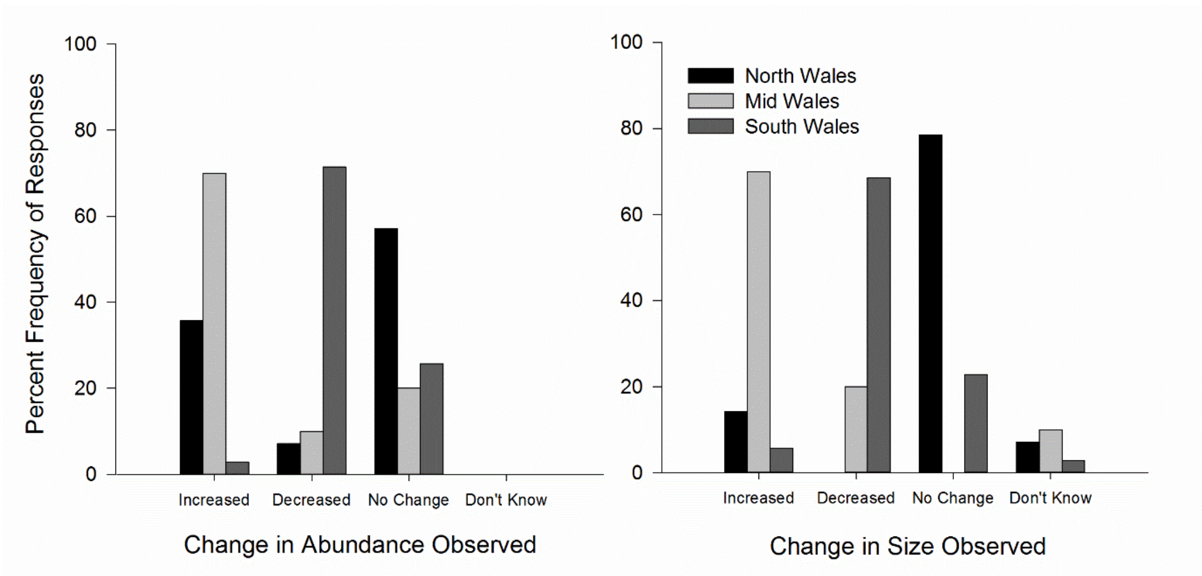

Figure 27: The percentage of identified sea bass fishing areas in North, Mid and South Wales where respondents observed changes in sea bass abundance and size.

Of the 59 sea bass fishing areas indicated by fishers, 21 were recorded as areas where sea bass spawn. Spawning seems to occur between March and May in the majority of the fishing locations (Figure 28). Only one sea bass fishing areas was reported as an area where sea bass do not feed, though which months this occurs was only indicated for 50 fishing locations. While it appears that sea bass feed more from June to October, this may be because during this time more fishers are fishing for sea bass

(Figure 28). The low numbers in January to April is most likely because there are few fishers fishing at this time. According to a few fishers, the fish that first arrive in March are feeding on crab, razor clams and lugworms and then by May and June are feeding on sandeel and whitebait. In July and August the sea bass are feeding on mackerel and sandeel and in September they are also feeding on whiting. For the remainder of their feeding time in October and November they are feeding on whiting.

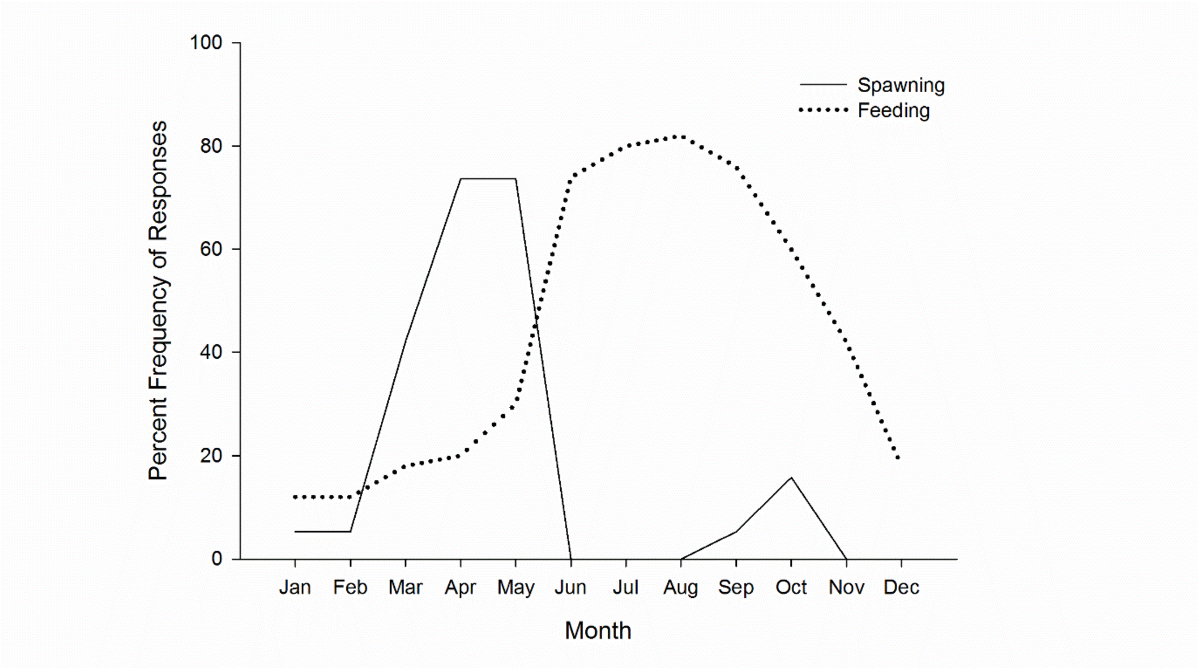

Figure 28: The percentage of identified sea bass fishing areas that respondents believe spawning (solid line) and feeding (dotted line) take place each month.

From the information gathered regarding the average legal sized sea bass that fishers catch, it would appear that the sea bass caught in North Wales may be slightly larger (Table 5). Disregarding the locations where longlines, drift nets, and trammel nets are used due to low numbers interviewed, there does not appear to be an obvious difference in the average size of sea bass caught with gill nets or rod and line (Table 6).

Table 5: Mean, median and mode of above legal sized sea bass caught in North, Mid, and South Wales.

Location	Mean ± SE	Median	Mode	Number of Fishing Areas
North	48 ± 1.9	47.5	42	12
Mid	44 ± 0.6	45	45	9
South	42 ± 0.9	41	40	28

Table 6: Mean, median and mode of above legal sized sea bass caught by different fishing methods in Welsh waters.

Fishing Method	Mean ± SE	Median	Mode	Number of Fishing Areas
Gill net	45 ± 1.7	42	42	12
Rod & line	44 ± 1	45	45	31
Drift net	39 ± 1.5	39	NA	2
Longline	48	48	48	1
Trammel net	42	42	42	3

Sea bass fishers return to the stated fishing areas based primarily on previous catch levels (78%). Other reasons for fishing in these areas include shelter from weather (11%), proximity to port (11%), presence of bait fish (7%), territory (3%), habitat features (3%), absence of trawlers (2%) and exclusion from nursery areas (2%).

Whilst most sea bass fishers interviewed did not have any comments or concerns regarding the species or fishery, the issues that were highlighted referred to fishers without licenses and recreational anglers selling on the black market, not enough buyers for all the catch, the need for a standard minimum landing size across Wales, and the fear that if sea bass becomes a quota species the fishers will not get quota because of no track record. Additionally, it was suggested that sea bass caught by rod and line should receive a better price due to the quality of the fish.

Conflicts of Interest

To better understand the competition for marine use, we asked fishers to identify areas of Welsh waters where a conflict of interest occurs. Whilst the word ‘conflict’ is used to describe these areas, they do not necessarily result in “one party asserting its interests at the expense of the other party’s interests” as is the definition of conflict (FAO 1998). In most cases the conflict involves competition for space or the desire to be able to fish in a particular area. Fifty-three percent of the fishers interviewed identified sixty-one areas of conflict which cover 3388 km^2. Table 7 shows that similar numbers of conflicts were reported for North and South Wales; however, the smaller number of conflict areas that were reported for Mid Wales are much larger. There were a similar number of conflicts per fisher for the three regions of Wales.

Table 7: The average area, total area and total number of conflict areas identified by fishers for the three regions in Wales.

Region	Average Area (km^2) ± SE	Total Area (km^2)	Total Number	Conflicts per Fisher
North	39.14 ± 16	978.49	25	0.86
Mid	353.32 ± 139	3533.24	10	0.90
South	71.78 ± 18	1866.21	26	1.00

For the conflict areas identified by mobile gear fishers, the most prevalent conflict is with conservation areas. There are many more areas closed to mobile gear than static gear. Sixty-seven percent of the conservation conflict areas reported were the closed area for scallop fishing in Cardigan Bay. This would explain why the average area of the conflict areas in Mid Wales are much larger than elsewhere in Wales. Fishers using static gear identified a much larger variety of conflicts of marine use, with hobby potters and fishers targeting the same species as the most prevalent conflicts (Figure 29).

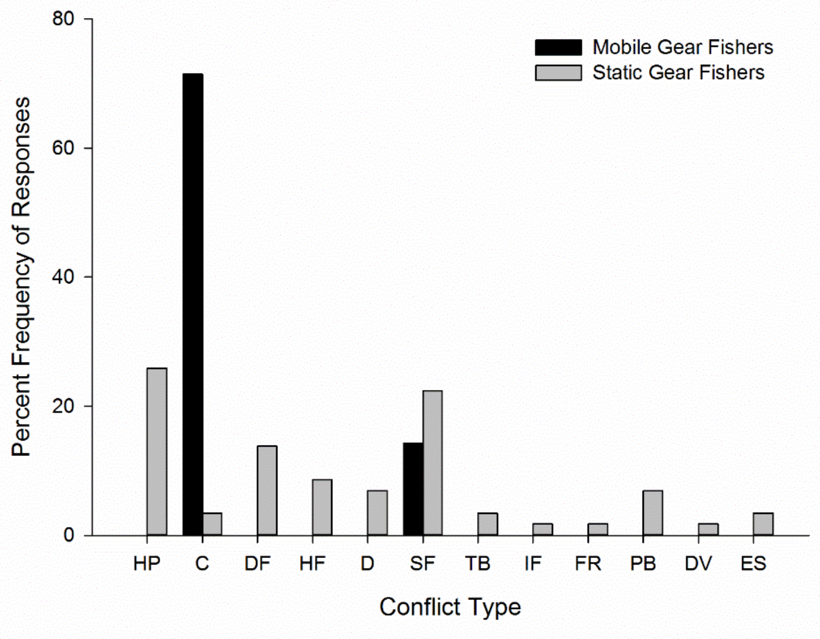

Figure 29: The percentage of twelve different conflicts types identified by mobile and static gear respondents. HP: hobby potters, C: conservation, DF: fishers targeting different species, HF: hobby fishers, D: divers, SF: fishers targeting the same species, TB: tourism boats, IF: illegal fishers, FR: firing range, PB: pleasure boaters, DV: development, ES: energy sector.

The specific issues fishers have with hobby potters are that many may be setting more pots than they are legally allowed. Hobby potters are allowed to set five pots, must have a hobby potting permit, and may only keep two lobsters, one crawfish, five crabs (either brown crab, velvet crab or spider crab), one kilogram of prawns, and five kilograms of whelks. Furthermore, they must abide by the commercial fishing legislation of minimum landing size and v-notch return which fishers believe some may not. Additionally, some fishers believe that the hobby potters may be selling their lobsters to buyers, which can impact commercial fishers financially. Many fishers have indicated that this conflict has been going on for many years and that it has escalated in the last five years. The conflicts with hobby potters highlight the issue of a lack of enforcement that was mentioned by many fishers. Proper enforcement of hobby potters could perhaps resolve some of the issues surrounding commercial potters and hobby potters. As for divers, fishers stated that divers take catches out of the fishers' pots and are even suspected of cutting the fishers' ropes. With respect to tourism boats and pleasure boats, fishers say they anchor on buoys, drag pots away, and that during certain times of the year there are a lot of them on the water in the way. Concerning fishers of the same species, the main issues are competition for space and high levels of effort from large vessels. Many of the small inshore fishers feel the effort of the large vessels is much too high and that it is affecting the catch levels for the smaller vessels. This applies to large lobster and crab vessels as well as large vessels trawling for sea bass. Regarding fishers of different species, the issue is only with pot fishers. The conflict involves mobile gear (scallop vessels, trawlers and Belgian beamers) either towing through fishers' pots or fishers not being able to set pots in particular areas because they will be towed away.

Table 8 shows the average duration of each category of conflict. The conflicts involving hobby potter, hobby fishers, divers, tourism boats and pleasure boats are concentrated in the summer months when the weather is good and many members of the public are on holidays. Conversely, the conflicts involving conservation, fishers targeting the same species, development, and the energy sector are continual.

Table 8: The average annual duration of the conflicts of marine use identified by fishers and the number of conflict areas that were used in the calculations.

Source of Conflict	**Average Annual Duration of Conflict (months) ± SE**	**Number of conflict areas**
Hobby potters	4 ± 0.3	15
Conservation	12	7
Fishers targeting different species	7 ± 1.3	10
Hobby fishers	5 ± 1	4
Divers	4 ± 0.7	3
Fishers targeting the same species	11 ± 0.8	15
Tourism boats	3	1

Illegal fishers	3	1
Firing range	4	1
Pleasure boaters	6 ± 1	4
Development	12	1
Energy sector	12	2

Economic Importance

Fishers were asked to rank their top five fishing areas based on their economic importance (one being the most important economically) and explain the reason why it is so important. Of the top ranked fishing areas, the most common reason for their economic importance was catch abundances (48%), with distance from port/less fuel (11%) and ability to fish all year (11%) as the next most frequent answers. Other reasons for economic importance included catch quality (9%), presence of other important species as bycatch (9%), species' price (7%), shelter from weather (4%), absence of competition (4%), and territory (2%).

Historical Fishing

Fishers were asked to identify any areas where they used to fish, but have not fished in over five years. These were termed historical fishing areas. Forty-six historical fishing areas were defined with a total area of 3828 km^2. Thirty-three percent of the fishers who identified historical fishing areas no longer target that species. Fishers also stated when they last fished in the historical area and why they no longer fish there. The most common reason these areas are not currently fished is because they are now closed due to conservation legislation. This reason only applies to scallop fishers. Other reasons fishers discontinued fishing in these areas are poor catch (21%), competition (14%), too far from port (10%), poor price for catch (7%), not profitable (7%), they have downsized their fishing operations (5%), and because they have increased their effort on a different species (5%). The majority of the fishers with historical fishing areas (70%) stopped fishing in these areas in the 2000s.

When investigating the reasons fishers have stopped fishing in areas by the species they were targeting, too much competition from vessels targeting the same species was the only reason for leaving the area for brown crab and prawn fishers, while increasing effort on another species was the only reason for leaving the area for spider crab fishers. Economic factors were the only reasons fishers targeting sea bass stopped fishing in these areas. Fishers targeting lobsters and whelks had a greater variety of reasons for either moving areas or quitting fishing for those species. As previously mentioned, conservation was the main reason for scallop fishers (Figure 30).

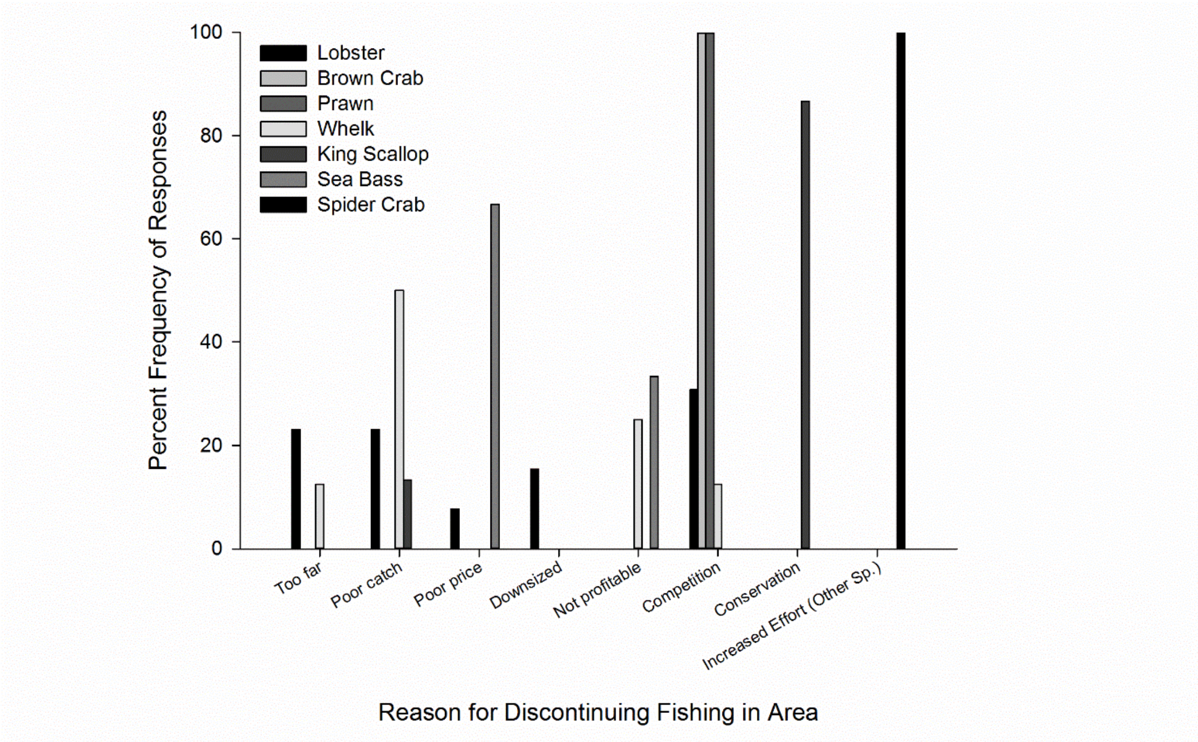

Figure 30: The percentage of identified historical fishing areas where respondents discontinued fishing by target species.

Further Research

Finally, fishers were asked if there was any research that they felt needed to be addressed. The following areas of research were suggested:

- Crayfish ecology
- Lobster escape hatches
- Effects of increased lobster minimum landing size
- Lobster movement
- Lobster growth after moult
- Pot limits
- Effects of large offshore potting boats on inshore potting fishery
- Brown crab offshore breeding
- Spider crab movement
- Prawn life cycle

- Prawn movement
- Whelk behaviour
- Whelk movement
- Better method to sort whelks to ensure removal of undersized
- Whelk abundance recovery after intense fishing
- Sea bass feeding fidelity
- Sea bass spawning areas
- Sea bass nursery areas
- Sea bass size at maturity
- Migration of sole, skates and rays
- Breeding habits of sole, skates and rays
- Scallop dredging impacts
- Effects of no fishing on scallop grounds
- Scallop tagging
- The market for dogfish
- Recent increase in squid in Cardigan Bay
- Thornback ray decline in Mid Wales
- Development of herring and sprat fisheries
- Mechanisms of ghost fishing
- Impacts of fishing gear on seabed
- Mapping effort and catch data

The only areas of research that were mentioned by more than one fisher were pot limits, whelk movement, lobster growth after moult, and spider crab movement.

Additionally, there were responses in the questionnaire that indicate that further investigation is required on the following topics:

- The mechanism behind the two morphologies of whelks
- The use of commercial species as bait
- The behaviour of berried brown crabs (very rarely caught)
- The extent of ghost fishing
- Improving enforcement for hobby potters

DISCUSSION

Whilst most studies using fishers' ecological knowledge aim to understand and hopefully answer specific ecological questions, this questionnaire aimed to gather a general understanding of the inshore fisheries of eight important commercial species in Wales. The questionnaire covered a broad range of topics; however, the focus was to relate these topics spatially and find consensus to extract observed trends.

The results indicate that the Welsh fishing fleet is dominated by vessels under 10m owned or skippered by men predominantly in their 50s. Of the seven fisheries for which sufficient data was gathered, the brown crab, lobster and whelk fisheries operate all year, the prawn and king scallop fisheries operate in the winter, and the spider crab and sea bass fisheries predominately operate in the summer months (Figure 31).

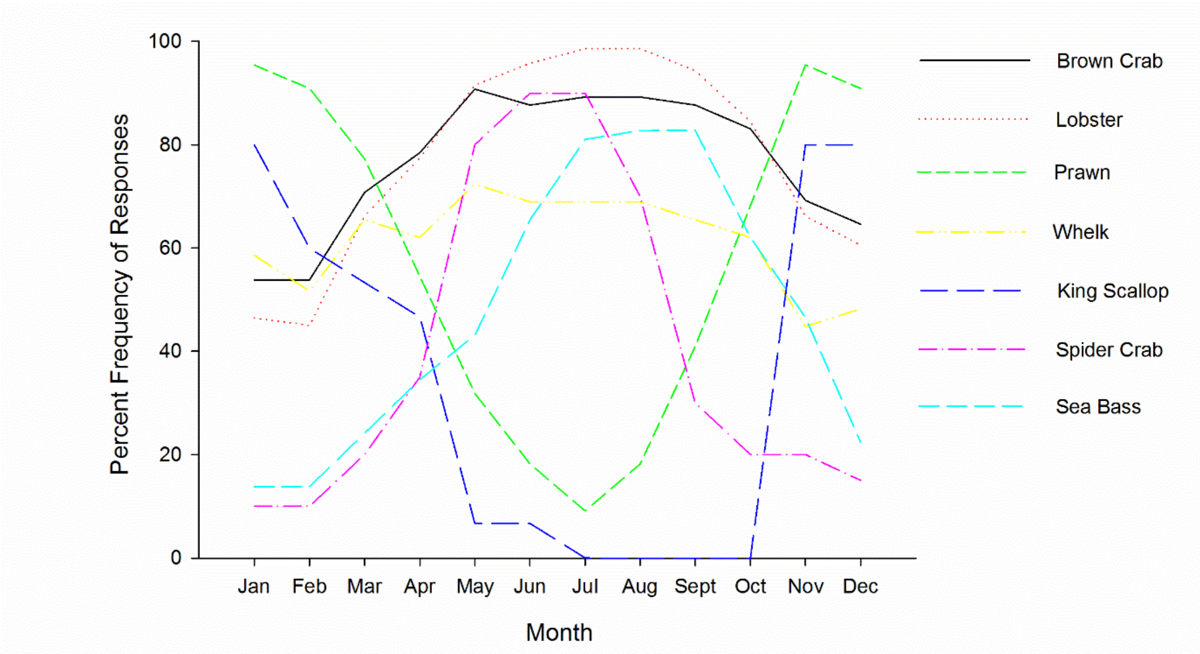

Figure 31: The annual average fishing activity by month in Welsh waters as reported by fishers

Throughout Wales, there have been observed changes in species' abundances and sizes over the years. The changes with the most consensus were a decrease in spider crab abundance, fluctuating abundances of king scallops, and no change in the size of brown crabs, prawns, whelks and king scallops (Figure 32).

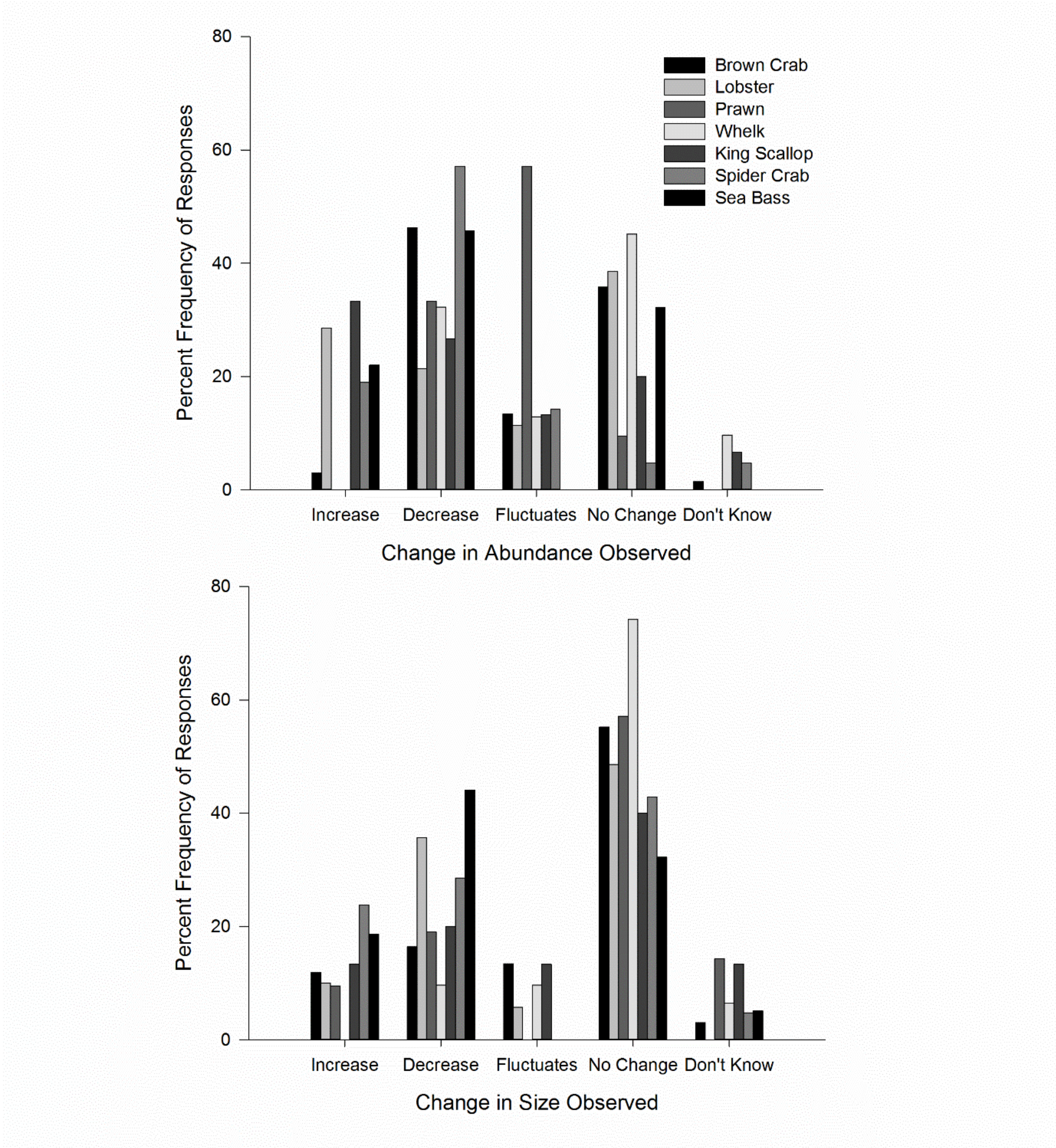

Figure 32: Changes in species' abundance and size observed by fishers across Wales.

When the results are examined with respect to the three regions in Wales (North, Mid and South), they are somewhat different (Figure 33). The consensus in North Wales is that prawn abundances fluctuate and that there has been no change in size for brown crabs, prawns, whelks, and sea bass. In Mid Wales, the consensus it that sea bass are more abundant, brown crabs are less abundant, the size of sea bass has increased, and there has been no change in the size of brown crabs, lobsters, prawns and whelks. The consensus in South Wales is that there have been decreases in the abundance of spider crabs and sea bass, fluctuations in the abundances of prawns, no change in the abundance of whelks, a decrease in the size of sea bass and no change in the size of whelks.

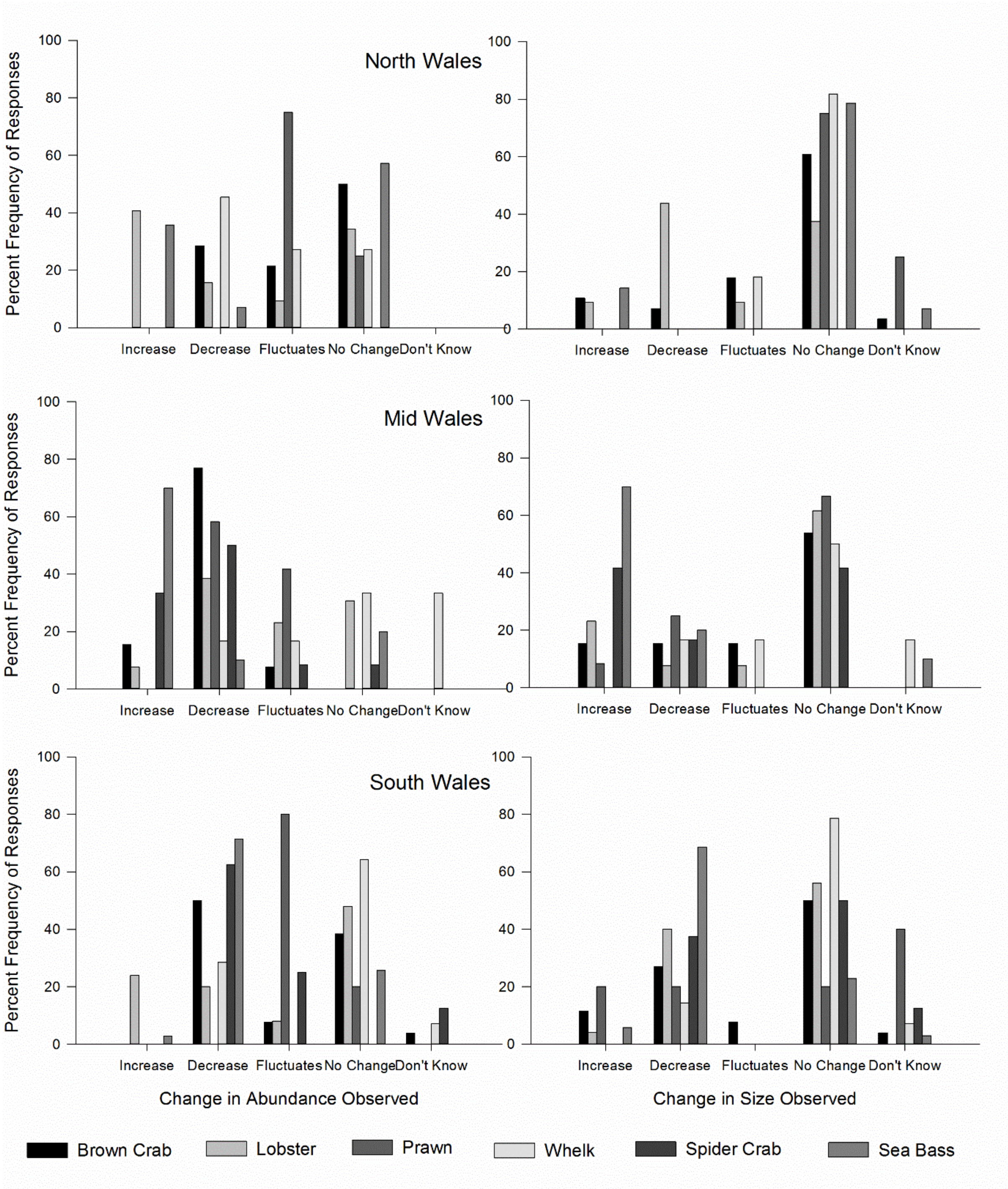

Figure 33: Changes in species' abundance and size observed by fishers in North Wales (top two figures), Mid Wales (middle two figures) and South Wales (bottom two figures).

Whilst many studies state that fishers' knowledge is invaluable and must be integrated into fisheries management, there are few solid examples of exactly how that can be done. One of the main barriers to joining these two sources of information may be that fisheries science is very quantitative and fishers' knowledge tends to be mostly qualitative. Geographic Information Systems (GIS) are an ideal way to unify these disparate data sources (Close and Hall 2006; De Freitas and Tagliani 2009; Hall and Close 2007) and visualise the interactions between fisher, environmental, and biological variables.

The examples in the literature of FEK in use for fisheries management are very specific and highlight that there is not a standard way of using FEK for management purposes; it depends on the missing information in the scientific data and the uncertainties in existing management measures. Usually the FEK is collected to answer a particular question or fill in a specific gap in fisheries knowledge. Previous studies have found that FEK can assist fisheries management by: 1) supplying further information to be used in stock assessments (Neis et al. 1996); 2) providing feedback on management measures (Blyth et al. 2002; Jenkins and Garrison 2013; Neis et al. 1996); 3) imparting knowledge on the status of poorly understood species or data-poor fisheries (Aswani and Hamilton 2004); 4) generating novel ideas and questions; 5) contributing to spatial planning and the establishment of marine protected areas (Aswani and Lauer 2006); 6) directing surveys spatially and temporally (Aswani and Hamilton 2004; Bergmann et al. 2004; Davis et al. 2004; Johannes et al. 2000); and 7) facilitating support for future management programs.

Due to the variety of topics covered in this study, there are a variety of ways in which the data collected can benefit the fishing industry and individual fishers, and fisheries management. There was a great deal of information gathered in this questionnaire pertaining to stock structure which could be useful for scientific assessments. Information on spawning grounds (presence of scallops with full gonads, berried crustaceans, or ripe sea bass), juvenile habitats (areas where more undersized caught), and spatial patterns in morphology (areas where small whelk and large whelk morphologies are caught) could be combined with tagging, genetic and morphological studies to identify stocks (Hutchings 1996; Neis et al. 1999). Moreover, the information obtained on effort distribution and level can be used with landings data in catch per unit effort (CPUE) estimates used to monitor stock sizes (Neis et al. 1999).

One criticism that is often heard from industry regarding fisheries science is that sampling has not been undertaken in the correct location or at the correct time of year. The information collected from this questionnaire can now be used in future survey designs to ensure that the appropriate locations and seasons are targeted, which may give industry greater confidence in research results.

Although the questionnaire's primary focus was not to compile a collection of fishers' views, fishers were asked to express their concerns and comments on the species that they harvest, as well as identify and describe areas of conflict. A report (Nautilus Consultants 2000) prepared for the National Assembly of Wales in 2000 stated that the fishing associations in Wales are often short-lived as they struggle to maintain membership and volunteers for the administration. Without these strong and well-developed associations, it can difficult for fishers to find an avenue to express their opinions and views. This document is one method to allow fishers' views to be heard. One view that was repeatedly mentioned, especially by pot fishers, was a need for increased enforcement and for more management measures.

A more controversial use of this data involves spatial planning and the establishment of protected marine areas. Fishers expressed concern over the use of their data for these purposes; however, due to the data protection consent form their data cannot be shared. Individual fishers would have to give permission for their data to be used by another party. Nonetheless, the information collected could be of use to fishers in that with this collated information they can critically evaluate proposed spatial management plans, such as Marine Conservation Zones (MCZs), and proposed developments such as wind farms (Williams and Bax 2007). They now possess a portfolio of evidence of their fishing activities.

Further Work

The work of this study can be extended in many ways. Whilst the historical fishing areas section did create a database of 46 historical fishing areas, it would be advisable to interview retired fishers to obtain a more detailed picture of the historical fishing in Wales. Historical fishing information is important to be able to understand the dynamics of a fishery over time and the appropriate time scale for changes. This information could be used, for example, to determine changes in species distributions over time. The historical section of the questionnaire only enquired about locations, species and time scales, as an increase in biases is expected with the length of time an interviewee is expected to recall (Daw et al. 2011). However, this section could be expanded in further work to include an estimation of changes in fishing effort. It is important to view changes in species distributions, abundances and sizes with information on whether fishing practices have also changed, as an increase in abundance could be due to improved technology instead of an increase in population.

The scope of the current study only allowed for information to be gathered on eight commercially important species in Welsh waters; however, a logical extension to this study would be to collect FEK on the other species harvested in Welsh waters. A study by Richardson (2006) which interviewed Welsh fishers regarding all the species they harvest, found that 21 whitefish species and 15 shellfish taxa were harvested in Welsh waters. Including all these species would reveal a more comprehensive picture of the Welsh fishing fleet, and it might also highlight some additional sector and species interactions and overlaps. None of the species addressed in this questionnaire are quota species and it would be interesting to investigate how fisher dynamics differ between strictly managed fisheries and fisheries with much less management. It would be especially important to gather information on those species for which formal stock assessments are not currently possible.

As fishing is an economic activity, fishers actively seek additional or improved catches and therefore their fishing practices and observations are updated rapidly (Anuchiracheeva et al. 2003; Grant and Berkes 2007). For this reason, the database of fishers' knowledge for the Welsh fleet should be updated periodically, perhaps every five years. In this way, the dynamics of the fleet can be monitored in finer detail and a time series can begin to develop.

Limitations of this study

There are a few limitations on how the data collected in this study can be used. The literature on LEK strongly recommends locating "experts" from the communities being studied to ensure that the most representative individuals are the ones providing the information. These studies argue that not all fishers' knowledge is equal (Davis and Wagner 2003). This study, however, did not identify local "experts" first as the survey area was very large and spread out, and interviews were difficult to obtain. More importantly, as this study aimed to create a picture of current fishing activity and practices, all fishers were considered a valuable source of information. Because there was a wide range of fishing experience among the fishers interviewed (five to sixty-three years), chi squared tests were performed on the answers regarding species' changes in abundance and size to determine whether experience affected the responses. This was only the case for responses to whelk abundance, sea bass abundance and sea bass size. A study by Dimech et al. (2009) found that the responses of fishers regarding questions on a long-term exclusive fisheries management zone were influenced by the fishers' dependence on fishing as income; in other words, what portion of their time (full-time/part-time/seasonal) was committed to fishing. In the current study, fishers were asked about this, so in future analysis it may be possible, and preferable, to give more weight to responses from full-time fishers as they spend more time at sea.

It is necessary to test LEK data for validation prior to incorporation into management plans (Gilchrist et al. 2005). As is the case of the data in this study, most LEK is qualitative and difficult to validate. However, there are some ways the presented data could be validated before being used in management plans:

1. Fishing activity for larger vessels and scallop vessels could be compared with VMS data
2. Fishing effort for shellfish species could be compared to Shellfish Returns that fishers are required to complete for the Welsh Government. However, both are based on data from fishers
3. Bottom types (habitat) of fishing areas could be compared to habitat maps produced by Natural Resources Wales

The information that cannot be validated is long-term changes that fishers have observed. Whilst a research survey could be undertaken in specific locations to measure abundance and size, there is not available data for past abundance and size levels.

Maps are a very useful method of displaying a great deal of detailed and complex information in a concise and accessible way. Due to the specifics of the data protection consent form signed by the fishers prior to the questionnaire, no maps could be presented in this report or published elsewhere. Displaying fishers' information can lead to issues with respect to intellectual property and confidentiality, as well as advertise fishing locations (Maurstad, 2002).

Finally, it is difficult to determine how the subsample of fishers interviewed actually represents the entire Welsh fishing fleet (that harvest the species of interest to this study). The national and EU databases for registered vessels do not produce the same number of vessels and do not represent the active fishing fleet, just those registered. In addition, the MMO UK vessel list does not report which gears are used on each vessel and even though the EU fleet register does report gears, it does not specify within the pot and trap category which kind of pots are used, therefore it is not possible to distinguish a whelk potter from a prawn potter, for example. This makes the process of extrapolating the extent of the Welsh fishing fleet extremely difficult.

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APPENDICES

Appendix 1: Gear codes as specified from the EU Fleet Register

DRB: boat dredges

DRH: hand dredges operating from a boat

FPO: pots and traps

GND: drift nets

GNS: set gill nets (anchored)

GTR: trammel nets

HMD: mechanised dredges including suction dredges

LHP: handlines and pole-lines (hand operated)

LLS: set longlines

OTB: bottom otter trawls

SB: beach seines

TBB: beam trawls

Appendix 2: The number of registered Welsh vessels landing in Welsh ports each month from September 2013 to August 2014 (T. Croucher, Welsh Government Enforcement, pers. comm).

Port	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Aberdaron	1	0	5	6	8	8	10	9	7	6	5	5
Aberdovey	0	0	1	1	1	1	3	2	2	0	1	0
Aberffraw	0	0	1	1	0	1	1	1	1	0	0	0
Abersoch	0	0	1	1	3	3	3	3	3	3	3	2
Aberystwyth	5	4	7	6	7	7	8	6	5	4	6	6
Amlwch	6	1	3	3	3	5	6	6	6	7	9	7
Bagillt	0	0	0	1	4	5	3	0	0	1	1	0
Barmouth	0	0	1	2	2	2	1	1	2	1	0	0
Burry Port	0	0	6	21	14	5	5	7	9	20	3	1
Caernarfon	2	0	1	2	1	1	1	1	1	1	3	1
Cardigan	2	3	7	6	5	7	8	6	6	8	6	6
Cemaes Bay	0	1	1	0	0	0	0	0	0	0	0	0
Conwy	0	1	2	4	4	5	9	5	2	4	4	1
Fishguard	11	13	16	18	21	19	18	14	12	12	14	12
Holyhead	8	6	12	14	13	16	18	17	16	8	16	5
Llanelli	0	0	0	5	4	3	4	1	3	3	0	0
Milford Haven	11	7	14	25	24	34	32	22	23	34	33	25
Morfa Nefyn	6	5	8	9	8	8	7	7	6	7	10	9
New Quay	5	4	5	5	3	5	5	3	6	5	5	5
Neyland	1	1	1	3	5	6	8	5	6	3	4	4
Penrhyn	0	1	2	0	0	0	2	0	0	0	1	1
Porth Colmon	1	1	1	1	1	1	1	1	1	1	1	1
Porthcawl	0	0	2	2	3	4	2	2	3	6	2	1
Porthgain	0	0	2	3	3	3	5	5	5	5	3	4
Pwllheli	0	0	5	5	5	8	9	7	6	5	6	2
Rhoscolyn	0	0	2	1	1	2	4	3	2	2	0	0
Rhosneigr	0	0	0	1	1	1	1	1	1	2	1	0
Rhyl	0	0	0	0	0	0	0	0	0	0	1	0
Saundersfoot	6	5	11	12	14	17	15	12	12	11	10	8
Solva	1	1	3	4	5	5	5	6	7	4	5	0
St. Davids	0	0	0	0	0	1	1	1	1	0	0	0
Stackpole	1	0	0	1	1	1	1	1	1	1	1	1
Swansea	2	2	1	6	9	15	15	16	16	13	9	7
Tenby	0	0	0	5	6	9	8	8	7	5	3	3
Trearddur Bay	0	0	0	1	0	0	0	0	0	0	0	0

Trefor	0	0	0	1	2	2	2	2	2	2	1	1

Appendix 3: Bait species used by the fishers interviewed when targeting brown crab, lobster, common prawn and common whelk and the percent frequency of fishers that use each bait.

Bycatch	**Brown Crab**	**Lobster**	**Prawn**	**Whelk**
Bass (Farmed)	5.1	5.6	6.7	0.0
Bull huss	2.6	0.0	0.0	0.0
Cod	2.6	2.8	6.7	0.0
Conger eel	0.0	5.6	0.0	0.0
Crab (all species)	0.0	0.0	6.7	94.4
Dab	23.1	25.0	0.0	5.6
Dogfish	25.6	19.4	0.0	94.4
Fish waste	2.6	2.8	0.0	0.0
Flatfish	17.9	19.4	0.0	0.0
Flounder	25.6	30.6	6.7	5.6
Gurnard	20.5	13.9	0.0	5.6
Haddock	2.6	2.8	6.7	0.0
Hake	5.1	5.6	6.7	0.0
Herring	23.1	8.3	60.0	11.1
Mackerel	10.3	11.1	20.0	0.0
Mullet	2.6	2.8	0.0	0.0
Nile perch	0.0	2.8	0.0	0.0
Plaice	7.7	11.1	0.0	0.0
Pollock	2.6	2.8	0.0	0.0
Ray/Skate	15.4	13.9	0.0	0.0
Redfish	0.0	5.6	0.0	0.0
Rockling	0.0	2.8	0.0	0.0
Salmon (frames)	15.4	19.4	33.3	5.6
Scad	41.0	30.6	26.7	0.0
Smooth hound	0.0	0.0	0.0	5.6
Spider crab	0.0	2.8	0.0	11.1

Wrasse	5.1	8.3	0.0	0.0

Most whelk fishers did not specify which crab species they use as bait and many fishers did not specify the species of flatfish they use. For this reason, the list includes flatfish, as well as, species of flatfish such as plaice, dab and flounder.