UNITED NATIONS UNIVERSITY
Fisheries Training Programme

Final Project 2013

COMPARATIVE STUDY ON THE EFFICIENCY OF THREE DIFFERENT TYPES OF CRAB POT IN ICELAND FISHING GROUND

Yosvani Medina Cruz[1] and Ogunfowora Olatunbosun[2]

1- Fisheries Research Center Avenue 3th & 246 Barlovento, Sta Fe. Playa, La Havana, Cuba
yosvanimedina@gmail.com; yosvani@cip.alinet.cu
2-National institute for Freshwater Fisheries Research (NIFFR) New-bussa Nigeria.
bosunoguns@yahoo.com

Supervisors
Jónas Páll Jónasson
Haraldur Arnar Einarsson
P.O.Box 1390, Skulagata 4, 121 Reykjavik Iceland.
Marine Research Institute

ABSTRACT

A fishing trial was carried to evaluate the efficiency and performance of 3 pot types, Conical, Carapax and a New type imported from China. The trial was carried out at different depth across 24 sampling station in Kollafjordur Bay in South Western Iceland. Results from the trials proved that the New pot type is more efficient than the two others tested as evidenced by higher catches across all the sampled stations and also at various depth (5-28m). Also catch per unit effort (CPUE) was higher in the New type pot as compared to the other types. The escape gap in one of the tested pot (Carapax) was ineffective as it was not able to release smaller sized crab due to its small opening. There was no remarkable difference in the soak time of 48hr and 72hr, but it is recommended that 48hr be used to avoid entrance of starfish which were the most common by-catch encountered in the trial. The New type pot was more efficient than the others in this trial and also handles better and occupies less space on deck.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1 INTRODUCTION

Many fisheries of the world have not been adequately managed and catches are declining, especially in the artisanal sector which is having considerable impact not only on the consumer in the riparian countries but also on the local people. Many people who rely on fisheries are in a lower income group and their livelihoods depend directly on the sustainability of the fishing industry. However, the world's fisheries are in crisis as a result of unsustainable fishing practices. Fishermen are catching less, despite staying at sea for longer and traveling further out (FAO, 2012).

Whereas trawls and long-lines may be difficult to operate on some fishing grounds, demersal traps can be the predominant gear used in such habitats. Furthermore, the increased concern on the impacts of towed gears on seabed habitats has also highlighted the potential benefits of non-towed fishing gears. Therefore, there has been increased research by fisheries scientists on the catch rates of fish traps in recent years (Mustafa *et al*., 2005).

While there is at present low rate of commercial pot fishing in Iceland, fish pots of various types are being utilised all over the world. Examples of such baited pots include pacific cod pots in Alaska, sea bream pots in New Zealand, snapper pots in Australia (Furevik, 1994). Fishing with baited pots can be a viable alternative to traditional fishing gears if reasonable catch rates can be achieved (Eno *et al*., 2001).

Iceland is located in the intersection between large submarine ridges and these features of the bottom topography around Iceland play a major role in determining the flow of the Ocean current in Iceland. On the other hand, investigations carried out have shown cyclonic circulation in Iceland water (Valdimarsson and Malmberg, 1999). The cyclonic circulation create vertical currents dragging nutrients from the bottom to the surface thus favouring the development of the macrobiome that plays an important role in the food chain (López-Salgado *et al*., 2000).

With the ever increasing global demand for fish and markets now becoming larger for sea products, more unutilised species are now been considered. The crab fisheries in Iceland are an underexploited resources, which when fully utilised could become relevant, adding to the increasing earning from it fishing industry and subsequently adding to the country’s gross domestic product (GDP).

One of the most recent inhabitants in Icelandic waters is the Atlantic rock crab (*Cancer irroratus*). In 2006 there was the first report of the occurrence of this species in Icelandic waters (Gislason, *et al*., 2014). Despite its recent colonization in Iceland waters, the rock crab is currently the dominant brachyuran crab species in some areas of Iceland fishing ground. They have been found to be with maximum size similar to that is found in its native habitat and they show a seasonal variation in catch, lower in spring than in late summer and fall (Gislason, *et al*., 2014).

This species is native to the northwest Atlantic, ranging from Newfoundland and Labrador to South Carolina and eastern Florida. They are found mostly inshore on sand, gravel and rocky substrate, inhabiting these areas alongside the American lobster. The rock crab typically occurs in shallow waters in its more northern habitats but it can found in deeper sandy-bottom as well. Most of these distributional patterns vary seasonally, especially in the southern areas (Bigford, 1979).

In Iceland the rock crab exists without its main competitor the American lobster and other large decapod species (DFO, 2002). On the other hand in comparison to its two main competitors the native crab species, the European green crab (*Carcinus maenas*) and the spider crab (*Hyas araneus*). The rock crab seems to becoming a dominant crab species off the southwest coast of Iceland, depending on its size and generalizes diet (Gislason, *et al*., 2014).

To date towed fishing gears and some passive gears has been the main subject of studies on fishing gear in Icelandic waters. Statistics from the Iceland Ministry of Fishing and Agriculture reveals that traps or pots are rarely used in Icelandic fisheries., There are only small incidence of usage in fresh water to catch eel (*Anguilla anguilla*) and relatively small scale commercial fisheries for whelk (*Buccinum undatum*) (Icelandic Ministry for Fisheries and Agriculture, 2014). However some research has been done on the use of fishing pots in Iceland. Einarsson, (1988) tested two variant of conical trap, the Japanese styled trap with and without plastic collar and an Alaskan style trap and most recently on invasion of crabs using some pots without actual investigation into the efficiency of the sampling devices (pots).

The objectives of this study are:

- To investigate the efficiency (CPUE) of pots in Icelandic water by comparing old conical shape trap to newer designs.
- To assess the effect of depth alteration and different soak time on pots performance
- Investigate the selectivity of the escape windows in the Carapax pot type.

The overall goal of this project is to recommend the most suitable and efficient pot types to harness the under exploited crab fisheries in Iceland.

2 LITERATURE REVIEW

2.1 Pot and trap fisheries

Fishing pots are almost universal and seem to have been independently invented many times in many different cultures. The choice of bait that is preferred by the targeted fish is crucial, as is placing the pot where it can easily be encountered by targeted species. Baited fishing gear effectiveness is directly related to the behavior of the target species, and this includes rhythm activity, feeding motivation, sensory and locomotors abilities (Stoner, 2004).

Globally, traps and pots have the less catch rate when compared with other fishing gears such as seine nets, trawls, gillnets, hooks, long lines and dredges (Watson *et al*., 2006). However they are of more value in regions with coral reef and outcrop where fishing with trawl and other types of gear are prohibited (Thomsen *et al*., 2010). Also, they are ideal in artisanal fisheries due to the low cost of maintenance with an additional advantage of catching live high quality fish. Information concerning benthic impacts of pots and traps are very limited. Studies like Eno *et al*., (2001), suggest that the impacts from using pots and traps are very, thus they may be more environmentally friendly than other gears used at the bottom. It should be noted that despite potential environmental benefits, an uncontrolled fishing effort of pot fisheries can lead to collapse of fisheries as witnessed in the Bermuda fisheries of fishes in coral reefs (FAO, 2012; Butler *et al*., 1993).

Fishing traps and pots origin cannot be credited to a particular culture as the act of gathering and fishing started in different culture, region since the beginning of civilisation. Primitive trapping is one of the earliest forms of fishing (Slack-Smith, 2001).

Bait type affects catches as target species are influenced and easily lured by the odors of some bait types than others (Whitelaw *et al*., 1991; Furevik and Lokkeborg 1994). According to Balik *et al.,* (2002), effect and efficiency of bait is best known by experienced fishermen.

The words “pot” and “trap” according to (FAO, 2012) are sometimes substituted or interchanged with each other and are used to describe baited devices used to catch fish, crab and shellfish. The main difference between them been the size, as traps are usually larger, while the pots are smaller making them easily transported or moved from place to place either by boat or by hand and more recently in some case the pot frames are made that the pots can be folded (collapsible pots) with the purpose to save space when they are store on deck of the boat (Slack-Smith, 2001). Pots are used all over the world and come in a variety of shape from circular, rectangular, conical, to oval. Despite this variation in size and shapes the all pots share a common mode of operation which is to attract or lure desired species into the device easily and making it difficult for it to get out (Slack-Smith, 2001).

2.2 ‘Ghost’ fishing with pots

The losses in pot fisheries appear to be increasing concurrent with a shift to more durable gear and designs. This generalization is applicable to the crab trap fishery, where historic changes in trap wire along with the increased number of traps have exacerbated ghost trap impacts. The replacement of galvanized wire by vinyl-coated wire in the 1970s resulted in more durable traps with a longer ghost fishing period (Guillory *et al*., 2001). The problems associated with derelict crab traps are multi-faceted. The traps contribute to mortality and by-catch, exacerbate user group conflicts, create visual pollution, and may cause damage to sensitive habitats. Overall, ghost fishing mortality is dependent upon number of ghost traps, location, season, length of the ghost fishing period, and mortality rate per trap (Moore and Jennings, 2000).

Several studies have documented mortalities rate in ghost traps. Blue Swimmer crabs (*Portanus pelagicus*) mortalities in Australia averaged from 112 to 671 crabs/trap over one year (Campbell and Sumpton, 2009). Arcement and Gillory, (1993) in blue crab (*Callinectes sapidus*) found mortalities of 17.3 crabs/trap (without escape rings) and 5.3 crabs/trap (with escape rings) over a three-month period. On the other hand Kimber, (1994) reported tanner crab mortalities rate in cod pot of 39% (52 crab/pot). However Guillory *et al.*, (2001) recommended the adoption of several measures to reduce the ghost fishing mortality in crab such as equipping trap with escape window and install degradable wall panels or tie-down strap to reduce the length of ghost fishing period.

2.3 Rock crab fisheries

The rock crab is one of the more prevalent species inhabiting inshore water of Atlantic cost of Canada and the US and in this area their territory overlaps with American lobster habitats and they are therefore caught as incidental catch in lobster fisheries. The rock crab fishery is a growing industry where the landings have grown from a few 100 tons in the 1970s to over 5,500 tons in 2000 for the southern Gulf of St. Lawrence (DFO, 2002). Between 2006 and 2011, total annual recorded landings averaged 4,734t, with an average of 4,300t from the directed fishery and 434t from the by-catch fishery. There is no estimate of quantities of rock crab caught and used as bait during the lobster fishery, although the extent of the bait by-catch in lobster gear may be decreasing with the adjustment of escape mechanisms in lobster traps which could reduce the retention of smaller rock crabs (Canadian Science Advisory Secretariat, 2013). The development of this fishery throughout Atlantic Canada has been limited by the rock crab's small size, low meat yields, and high processing costs. Some research has concluded that rock crab resources were abundant and well distributed in some area of Canadian fishing grounds and that a modified snow crab pot with 3-3/4” mesh size and a variety of bait types proved efficient in harvesting of this species and reduce the by-catch of lobster in rock crab pots (DFO, 2000).

The Rock crabs are both predators and scavengers, so they have an important role in the ecosystem; feeding on a variety of other invertebrates. Strong, crushing claws allow them to prey on heavy-shelled animals such as snails, clams, abalone, barnacles, and oysters. Rock crabs have a well-developed sense of smell, which allows them to detect and locate food at a distance, therefore this behaviour make them easy to catch by baited pots (Bigford, 1979).

3 METHODOLOGY

Four sampling trips were conducted from 17 to 25 January 2013. A total of twenty-four stations were sampled in the water of Kollafjordur Bay (South-west Iceland) between Þerney and Geldinganes small keys, as illustrated in Figure 1.

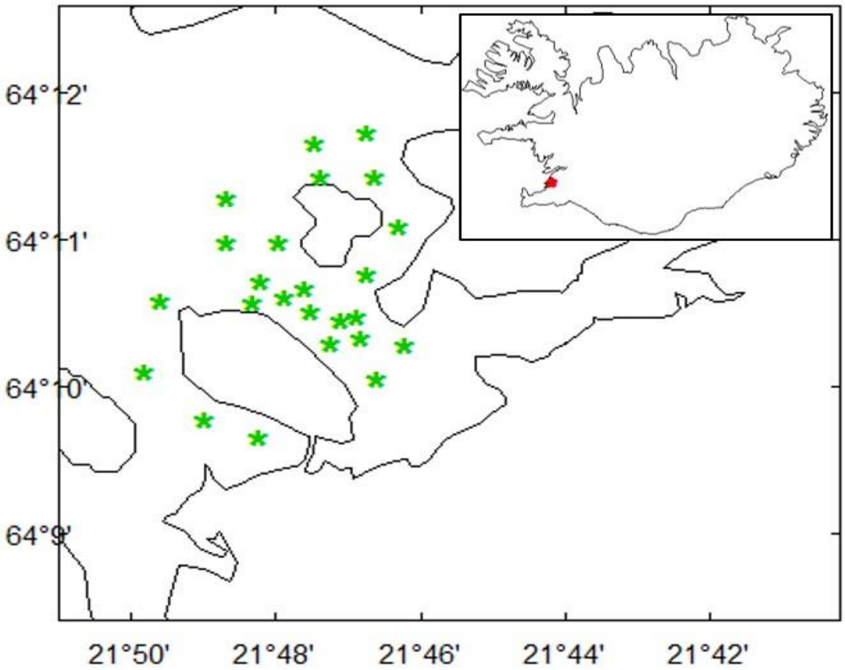

Figure 1. The red point in the small Iceland map shows the area monitored and the green points show the different stations sampled

Three different types of crab fishing pots where compared for efficiency and the effect of depth alteration and different soak time on performances. A New Type (C) of collapsible pot was used to compare catch efficiency with two other pots (Conical (A) and Carapax (B)) used in a similar study in Iceland (Gislason *et al*., 2014). The three types of pots tested are shown in Figure 2. The Conical pot has a base with diameter of 125 cm, height of 61 cm, top diameter of 70 cm, mesh size 7 cm and one entrance with a funnel of 50 cm diameter, the Carapax has a frame 76 cm in length, width of 37 cm, height of 31 cm, two entrance and a mesh size of 5 cm and the New type has length of 80 cm, width of 38 cm, height of 36 cm, mesh size 1.5 cm, and two entrance valve of 23 cm width.

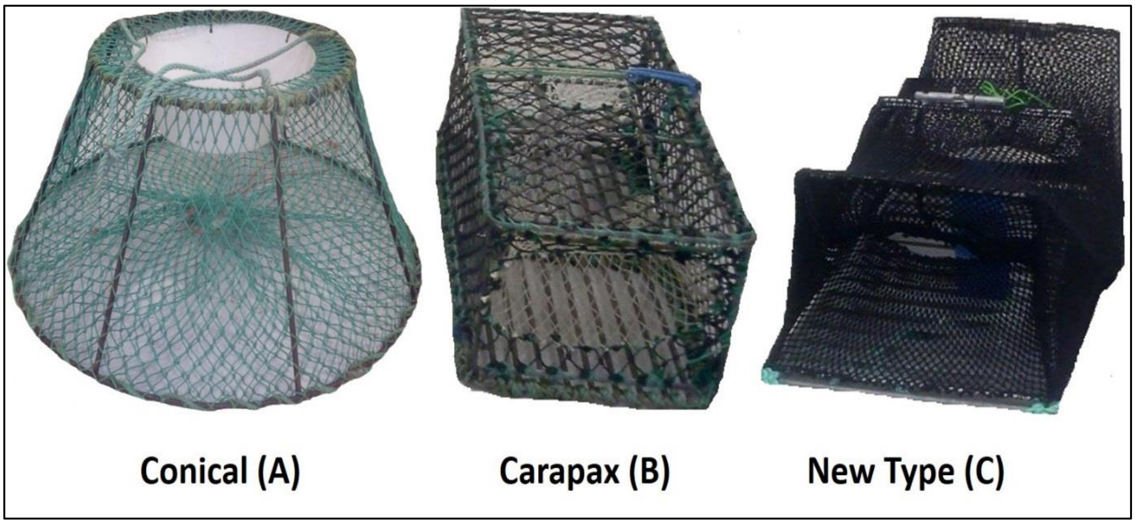

Figure 2. The three different pot used in the study (the size in figure is not in scale)

On each station, six pots where deployed in a line comprised of two each of the different designs. The pots were spaced 20 m apart which should inhibit the potential of bait from one pot leading crabs to the next. The stations were at various depths ranging from 3 to 28 metres. Pots were baited with approximately 300g of frozen bait comprised of blue whiting *(Micromesistius poutassou*) and great silver smelt (*Argentina silus*). Bait was stacked into the bait bags in the middle of the pots and rebaited after hauling with each set of pots arranged randomly and left on the water for a soak-time of 48 and 72 hrs. With each haul the pots were moved to a new location over a period of four fishing trips before collection. The escape window in one of the Carapax (B) pot by station was closed to compare the gear selectivity, marked as BO (escape window open) and BC (escape window closed). All samples caught were counted, weighed and measured (carapace length or width depending on species of crab), and standard length for fish recorded.

All data summaries and statistical analyses were conducted using the R statistical software program (Crawley, 2007). The mean weight, and crab number by pots were examined for significant difference using the variance analysis (One-Way-ANOVA) and Turkey HSD test to test for differences between pots. The means of the total catch rate and catch rate without by-catch by soak time were examined for differences using t-test analysis. Also the CPUE (Catch Per Unit Effort) between pots were compared using the variance analysis (One-Way-ANOVA) and Turkey HSD test to test for differences between pots.

The pot selectivity analysis was conducted according to the frequency retention rate by size group caught in Carapax pot type with escape window closed (BC) and with escape window open (BO) for spider and rock crab species. The green crab catch rates was too low to support a size group analysis.

Video observations were conducted during daylight hours with a HD-video camera in an underwater housing mounted above the bottom parallel to the bait bags in different pot types in each of the four trials to study the rate of ingress and behaviour of animals around the gears.

4 RESULTS

4.1 Pot catch efficiency

A total of 1447 crabs of three species (139 green crab, 302 rock crab and 1006 spider crab) were caught in 24 stations with 144 pots of three different types. The spider crab was the most represented species in the catch with an average catch between 5.4 crab per pot in Conical pot to 9.6 crab per pot in New type pot (Table 1).The rock crab was the second most abundant species with an average catch of 1.0 crab/pot in Conical pot to 3.6 crab/ pot in New type pot. The green crab had the lowest average catch of 0.2 crab/pot in conical pot to 1.5 crab/pot in new type pot.

Table 1. The average catches of crab species by different pot type (crab number/pot). The results of One-Way ANOVA test on averages catch number are also presented

	Conical (A) (g)	Carapax (B) (g)	New Type(C) (g)	F	p
	Mean(SD)	Mean(SD)	Mean(SD)		
Green	0.2(0.6)	1.3(2.4)	1.5(2.6)	5.5	0.004*
Rock	1.0(1.3)	1.7(2.2)	3.6(3.0)	16.8	< 0.001**
Spider	5.4(6.9)	5.8(5.7)	9.6(10)	4.2	0.01*
Total	6.5(7.4)	8.8(5.8)	14.8(9.80)	14.1	< 0.001**
N	48 (pots)	48 (pots)	48 (pots)		
** highly significant *significant					

There was a significant differences in average catch (crab number/pot) between pots for all species and Turkey HSD test revealed that New type pot caught significantly more crabs for all species than Conical pot (Figure 3). However in the comparison between Carapax and New type pots the averages catches were significantly larger in the latter, with respect to rock and spider crab species. The green crab average catch did not differ between the Carapax and New type pots.

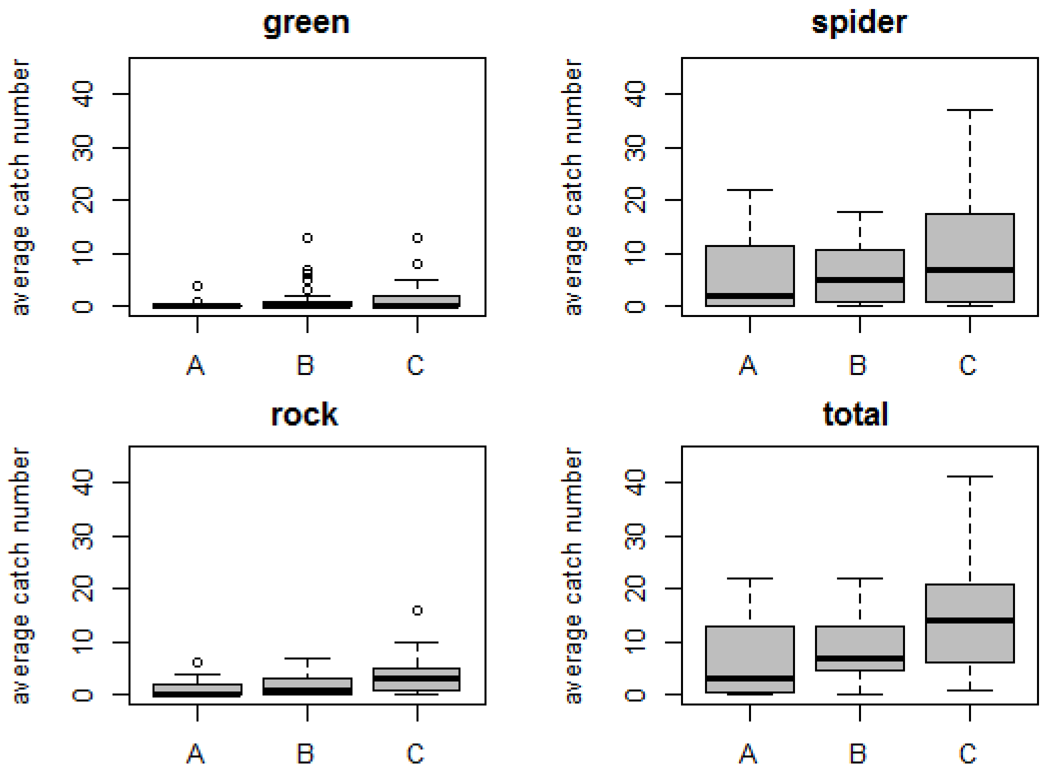

Figure 3. Boxplot chart of average catch number (crabs number/pot) by pots and species Where the grey box (50% of data distribution 25-75 percentiles), the median (black line inside the box), whiskers (95% of data distribution). With A (Conical), B (Carapax) and C (New type pot)

Similar results were with the average catch weight (crab weight/pot) by pots and species (Table 2). The spider crab had highest averages weight per pot or from 537 g/pot in Conical pot to 966 g/pot in New type pot; and green crab the lowest average weight per pot with the averages between 19 g/pot in Conical pot and 157 g/pot in New type pot. On the other hand the averages catch of rock crab (crab weight/pot) was between 180 g/pot in conical pot and 648 g/pot in New type.

Table 2. The average catch of crab species by different pot type (crab weight/pot). The results of One-Way ANOVA test on averages catch weight are also presented

	Conical (A) (g)	Carapax (B) (g)	New Type(C) (g)	F	p
	Mean(SD)	Mean(SD)	Mean(SD)		
Green	19(66)	124(231)	157(282)	5.44	0.01*
Rock	180(240)	307(387)	648(585)	15.4	< 0.001**
Spider	537(735)	568(514)	966(950)	4.8	0.01*
Total	736(846)	998(606)	1770(1055)	29.9	< 0.001**
N	48 (pots)	48 (pots)	48 (pots)		
** highly significant *significant					

The New type pot caught significantly more of all crab species with regards to weight than the Conical pot seen with Tukey HSD, p<0.001). The New type also caught more in comparison with Carapax pots, with respect to rock and spider crabs (Figure 4). The average catch in weigh crab for green crab was not statically different between pots.

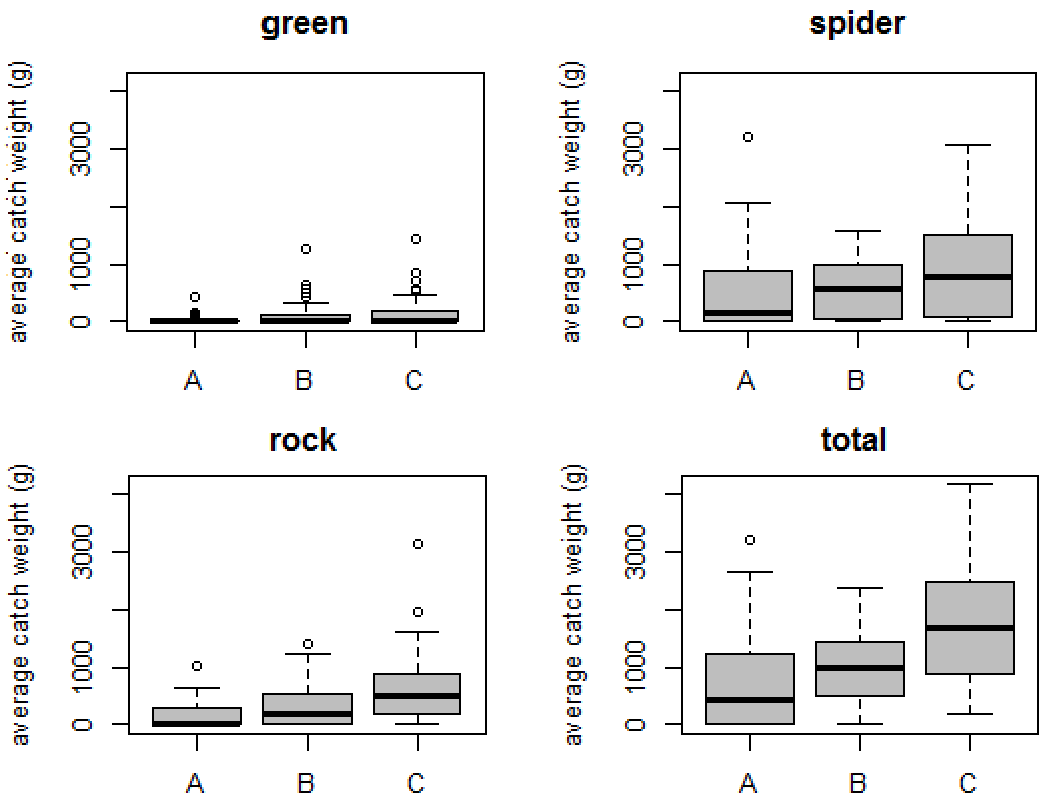

Figure 4: Boxplot chart of average catch weight (crabs weight/pot) by pots and species Where the grey box (50% of data distribution 25-75 percentiles), the median (black line inside the box), error lines (95% of data distribution), with A (Conical), B (Carapax) and C (New type) pots.

4.2 Species distribution by depth ranges

The spider crab was the crab species most represented in the average catch at deeper water (19-27 m) in the three sampled pots, where the New type pot (C) recorded the highest average catch (16.4 crab/pot) while the Carapax (B) and Conical (A) recorded (10.7 and 9.0 crab/pot) respectively (Figure 5).

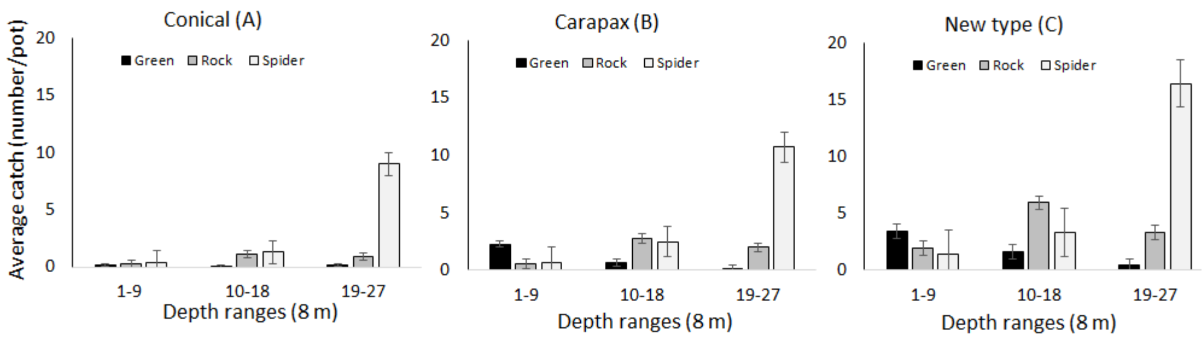

Figure 5: Average catch crab number by pots and by species at different depth ranges (6 station by depth range), where the line in the bar shown the Standard Error (SE).

The highest densities of spider crab were found at 20 and 24m depth stations. Also there was no catch of spider crab at the shallowest station and lower density of this species were caught at stations with less than 20 m depth (Figure 6).

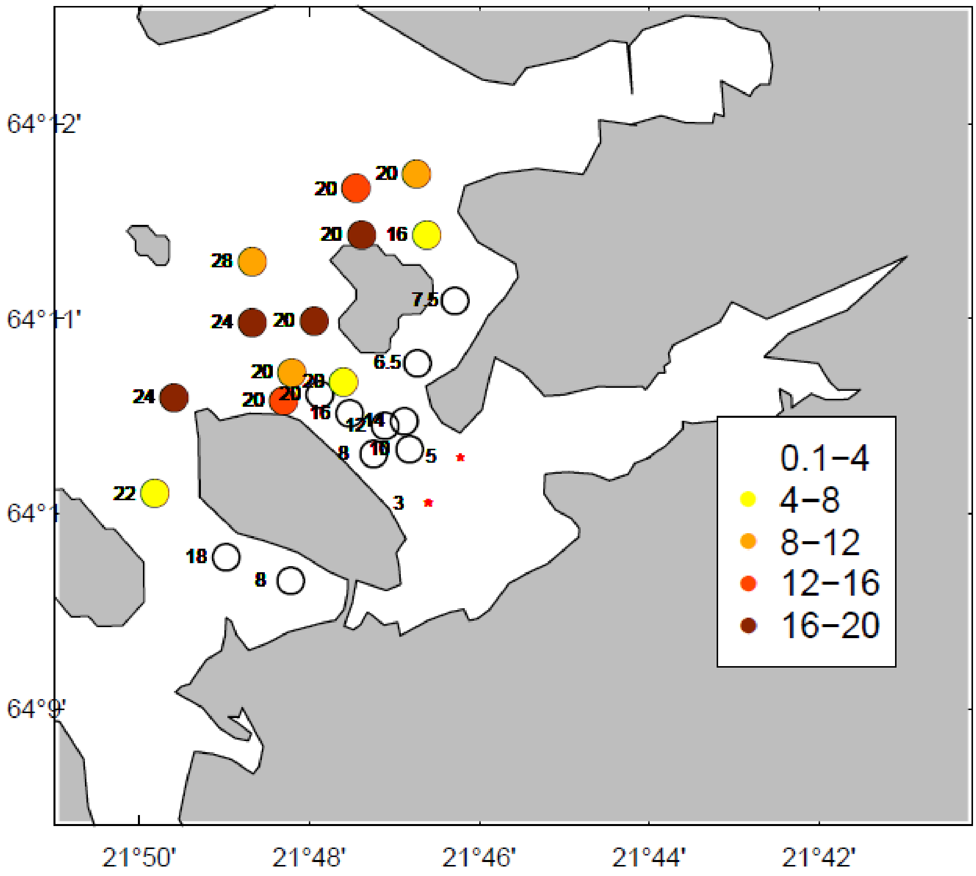

Figure 6. Average density of spider crab caught by station (colours) and depth (number on left side of the circle) and the red asterisk represents station with 0 catch

The rock crab was more representative at middle depth range (10-18 m) with average catch of (5.9 crab per pot) in the New type pot as compared with Carapax and Conical with 1.1 and 2.8 crab per pot (Figure 5). Also rock crab was represented in all station sampled with the highest densities at 14 and 18m depth stations (Figure 7).

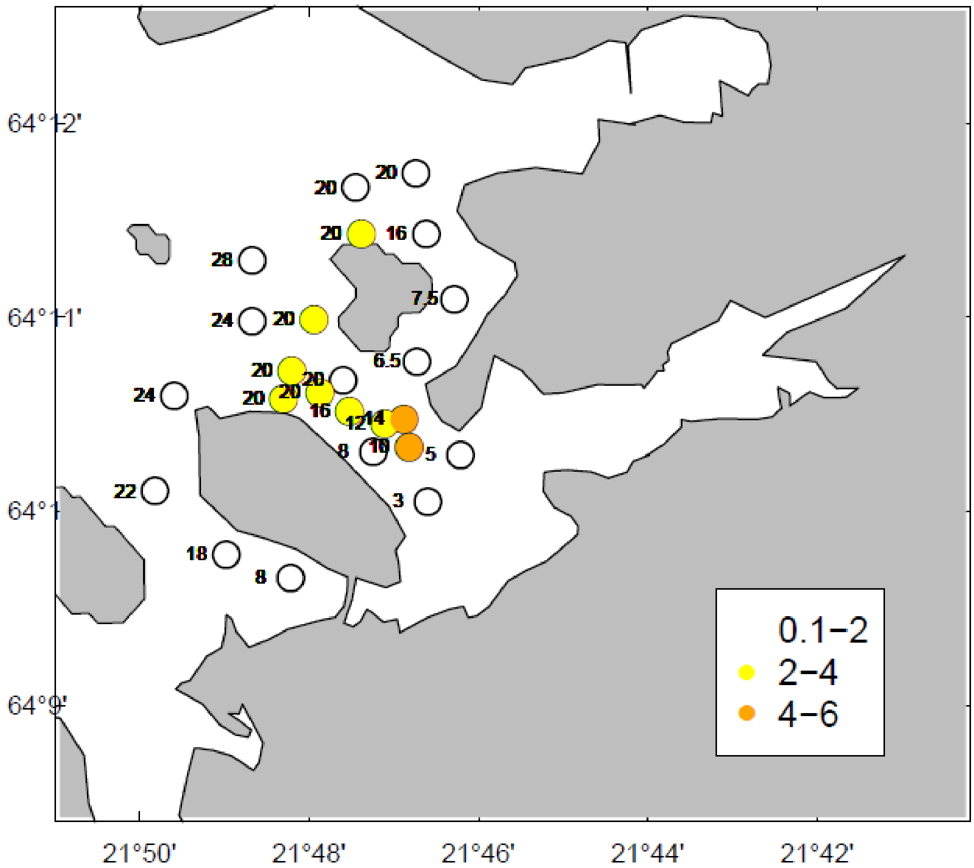

Figure 7.Average density of rock crab caught by station (colours) and depth (number on left side of the circle)

The green crab was the crab species least represented in the total catch. This species was mostly distributed at shallow water (1-9 m) (Figure 5) where the New type pot recorded the highest average catch (3.4 crab per pot) whereas Carapax and Conical recorded (2.3 and 0.2 crab per pot) respectively. However, the greatest density was found in 20m depth station, which is shown in Figure 8.

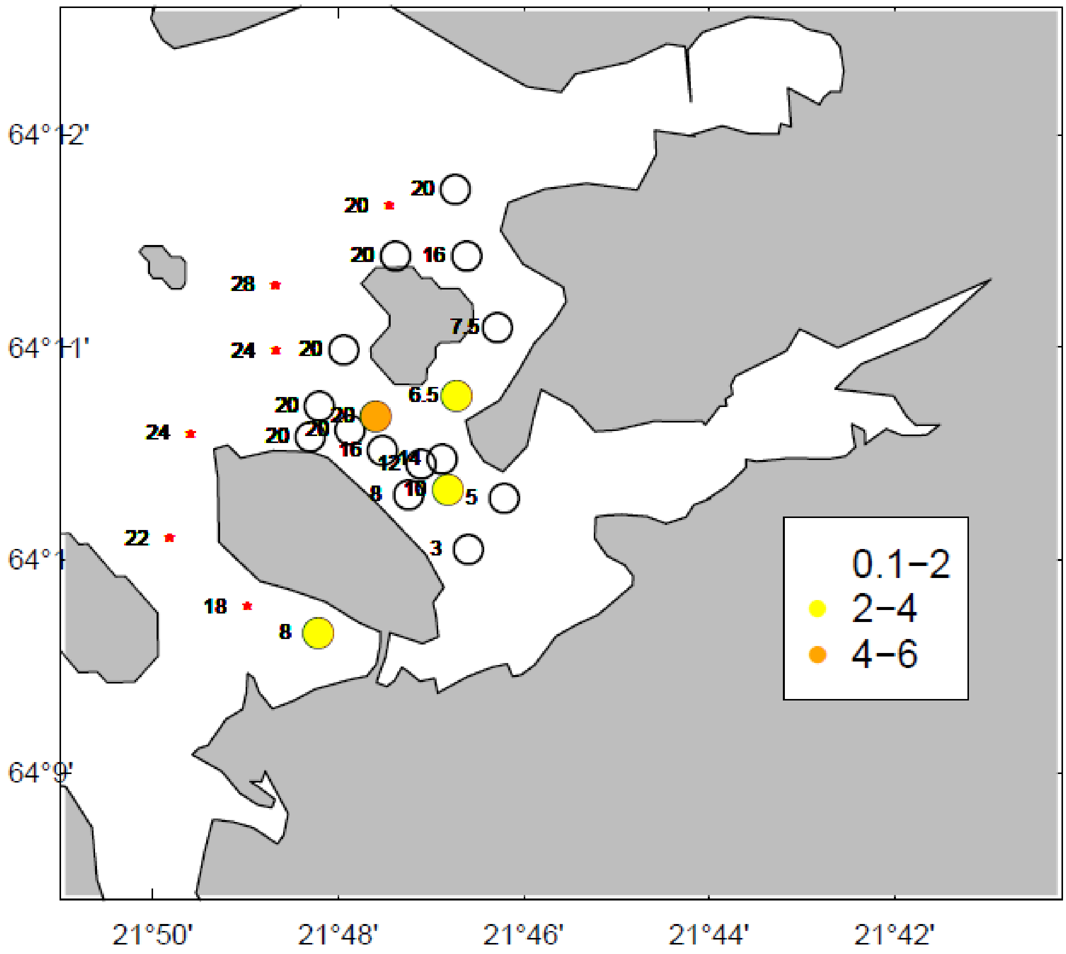

Figure 8: Average density of green crab caught by station (colours) and depth (number on left side of the circle) and the red asterisk represents stations with 0 catch.

4.3 Soak time analysis

Stations with 72hr soak time recorded a higher average crab catch both in total catch and catch without by-catch than 48hr soak time (Figure 9). However this was not statistically different for total catch (t= -1.78, p=0.09) and for crab catch (t= -0.42, p=0.68).

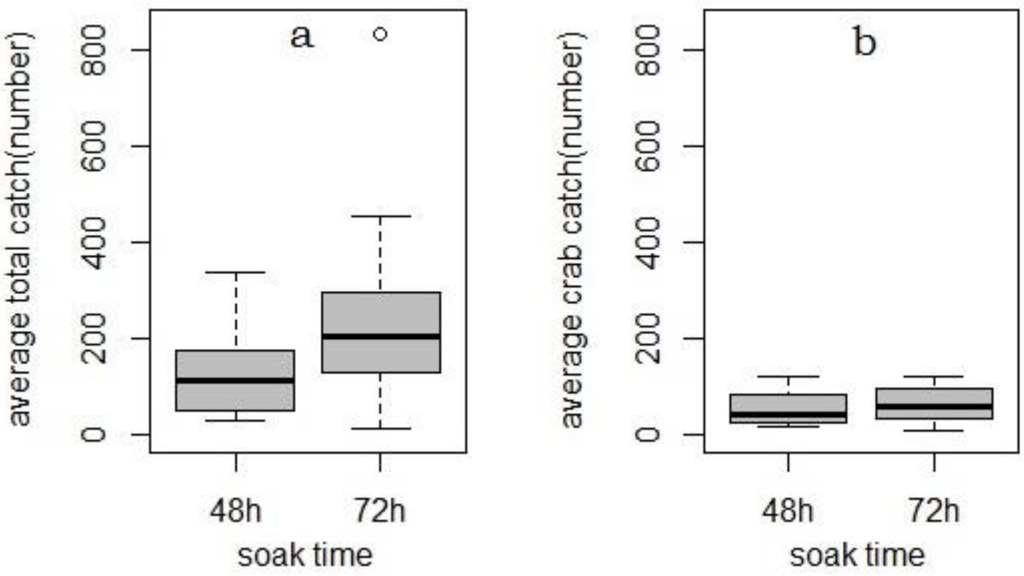

Figure 9: Boxplot chart of average total catch (a) and crab catch (b) (Catches without by-catch) by stations with the same soak time, where the grey box (50% of data distribution 25-75 percentiles), the median (black line inside the box), and error lines (95% of data distribution).

4.4 CPUE analysis by pots

Four zoological groups Echinoderm, Crustacean, Mollusca, and Fishes (Chordata) were represented in the catch of the three pot types. Although the fishing experiment was directed to Crustacean fisheries (Crab), the echinoderms was the most representative group with a total of 2572 starfish (Asterias rubens), followed by crustaceans with a total of 1454 crabs of four species (7 hermit crab *(Pagurus bernardus)*, 139 green crab, 302 rock crab and 1006 spider crab). The mollusca and fishes were the groups less representative in catch with a total of 52 whelk (*Buccinum undatum*) and 35 fishes of three species (15 Bull rout (*Myocephalus scorpius*), 19 Dab (*Limanda limanda*) and 1 Cod (*Gadus morhua*). The CPUE (Number of animal catch/hour) of three different pot types were not significantly different with respect to total catch (including by-catch). However without by-catch, there was a significant differences between pot types (Table 3).

Table 3. The average CPUE (Number of animal caught per hour) in total catch (with by-catch) and crab catch (without by-catch) by pots with One-Way ANOVA test on averages CPUE

	Conical (A)	Carapax (B)	New Type C)	F	p
	Mean(SD)	Mean(SD)	Mean(SD)		
CPUE with by-catch	0.5(0.4)	0.5(0.4)	0.5(0.3)	0.03	0.97
CPUE without by-catch	0.1(0.1)	0.2(0.1)	0.3(0.2)	8.07	0.001**
** highly significant					

Although the average catch per hour (median) in total catch are similar between pots (Figure 10a), when the by-catch is removed, average catch per hour median is higher than the 75th percentile of the catches in the New type (Figure 10b), suggesting a large difference and supported as well by Tukey HSD test ($p<0.001$). This analysis also shows that Conical and Carapax were not statistically different with respect to CPUE (Tukey HSD, $p>0.05$).

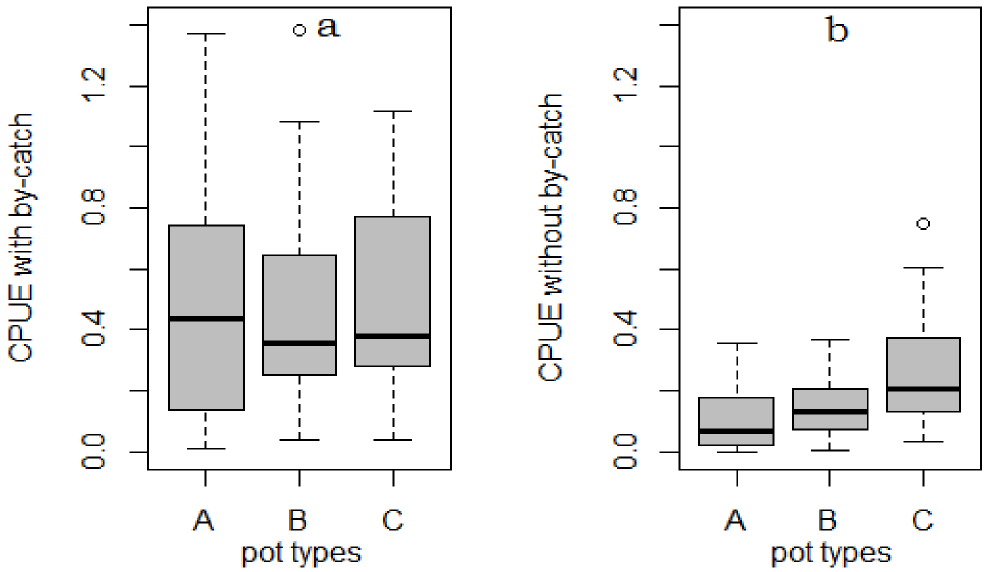

Figure 10: Boxplot chart of CPUE (number of animal catch per hour) with by-catch (a) and without by-catch (b) by pot types (A-Conical, B-Carapax, C-New type), where the grey box (50% of data distribution 25 -75 percentiles), the median (black line inside the box), and whiskers (95% of data distribution).

4.5 Selectivity analysis of escape window in Carapax pot type

A total of 278 spider crabs were caught in Carapax (B) pot type, 148 in the Carapax pot with escape window closed (BC) and 130 in Carapax pot with window open (BO). Although the Carapax catch rate of green and rock crabs were lower, the rock crab catches in Carapax pot type (12 rock crabs in BC and 43 rock crabs in BO) were used to test the escape window selectivity. The Carapax (BC) begins to retain size of spider crab from 30 mm of carapace length, whereas BO only begins to retain size after 54 mm of carapace length as shown in Figure 11. However this pattern changes when the retention size frequency for rock crab were analysed. The Carapax with escape window open (BO) begins to exploit the rock crab stock from 66 mm of carapace width whereas Carapax with escape window closed begins to retain size from 85 mm of carapace width, but due to the low number of rock crabs caught this pattern is not conclusive.

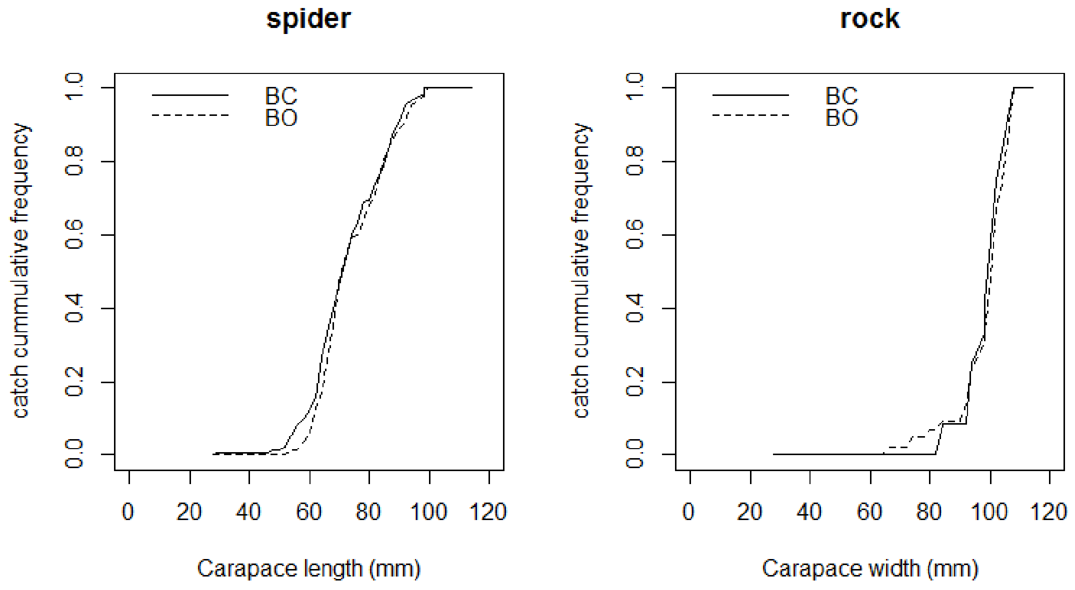

Figure 11. Accumulative frequency of catch by size group in Carapax window closed (BC) and Carapax window open (BO) for Spider and Rock crab species

4.6 Cumulative catch frequencies by pot types for spider and rock crab species

The cumulative length distribution seems to be almost identical from each pot, the results of these measurements are shown in Figure 12. Therefore no further tests were done.

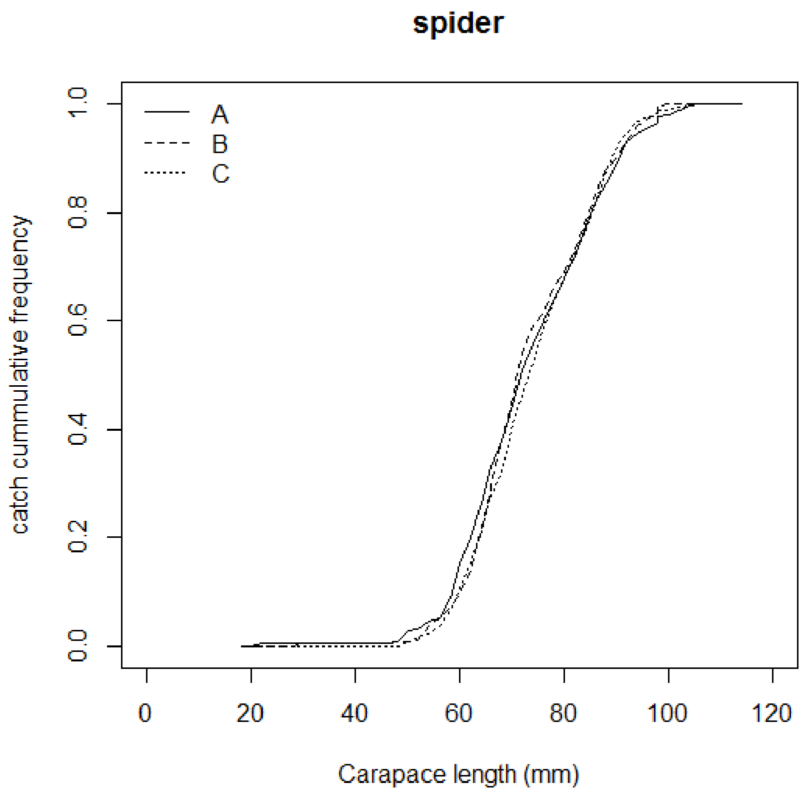

Figure 12. Accumulative frequency of catch by size group in Conical (C) Carapax (B) and New type (C) pots for spider crab species

For rock crab the pots shows similar cumulative catch frequencies, as found in the spider crab. However Carapax and New types pots retained smaller crabs than Conical pot, as Figure 13 illustrates.

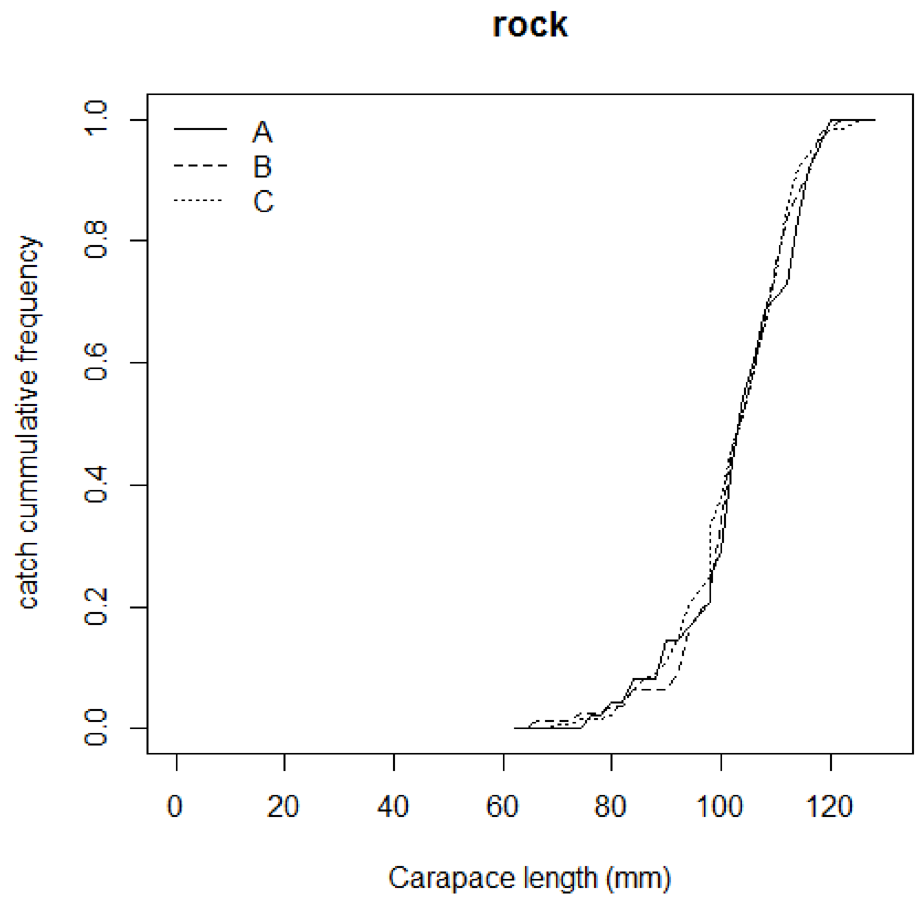

Figure 13. Accumulative frequency of catch by size group in Conical (C) Carapax (B) and New type (C) pots for rock crab species

5 DISCUSSION

The New type pot was more efficient than Conical and Carapax pots in terms of maximizing the catches and crab weight per pot of the three crab species. Although the spider crab was the species more represented in catches, from the economical point of view rock crab could be the most important crab species in Iceland due to its good commercial value in the seafood market. Also the catch rate and crab weight per pot in New type pot of this rock crab were slightly higher than those found by Gıslason *et al*., (2014) from April to June, the month of less abundance of this specie in Hvalfjorður and Faxafloi Bay using the Conical and Carapax pots.

Although Gislason *et al*., (2014) found that the number of green crabs increased with depth, this species was most representative in shallow water which could be supported by reproductive movements of both sexes (Klassen and Locke, 2007). The spider crab was more represented in 19-27 meters depth, as reported by Einarsson (1988) where the best catches of this species were between 26-27 meters deep. But contrarily, Gislason *et al*. (2014) found this species more distributed in 10 meters depth in July and October which can be probably explained as spawning movement. Most of the female catches observed were in the last stage of egg development during the fishing trials. Also Gislason *et al*. (2014) found that rock crab was the most abundant of the three species at all depths. However this species are commonly found in water less than 20 meter depth (Robichaud *et al*., 2000) as was found in this study.

The effects of soak-time on crustacean fishing studies results are contrasting. Some studies show that a short soak-time gives a higher catch (Whitelaw *et al*., 1991). Other studies show that the catch may become asymptotic with increasing soak-time (Robertson, 1989). While other studies indicate that catches are not affected with the increase in soak-time (Lokkeborg and Pina, 1997) which is consistent with this study where the catches in 48hr and 72hr soak time were not different. There were more by-catches in 72hr soak time period which account for the slightly higher catches. Studies have shown that longer soak-time of bait, more than a few hours, reduce the odour concentration from the bait leading to a decreasing attack rate (Sigler, 2000).

The results of this study clearly demonstrate that the New type pot outperformed the Conical and Carapax pots as evidenced by the number of crabs ingressing the pots per hour. The results from total catches of all the pots were masked by higher percentage of by-catches that were mostly starfishes of no commercial value. However when the by-catches were separated from the total catch a clear pattern was established with the new type pot having a higher catchability than both the Conical and Carapax pot. It is worthy to note that the new type pot is also the easiest in terms of operation, handling and in space on deck.

The effectiveness of the escape gap could not be established in this study as there was no clear pattern emerging from the result from the selectivity test, which could be probably due to the small size of the opening of the escape vent relative to the sizes of the crabs entering the Carapax pots. Comparison of pots to show larger size crabs preference for individual pot type also did not yield a clear pattern. Equal size representation for the spider and rock crab species were found in all pot types.

6 CONCLUSIONS

The new type pot in this study has proven to be the best of the three pot types investigated in term of catch performance as displayed by the number of crab per pot and number of ingression per hour.

Across all depth ranges the new type pot recorded the highest catch with the highest representation of the spider crab in depth of 19-27m, rock crab in 10-18m and green crab 1-9m.

There was no marked difference in the catch with increasing soak time from 48hr to 72hr.

The escape window in the Carapax pot was not selective.

7 RECOMMENDATION

The New type pot should be introduced to Iceland crab fisheries as it has proven to be the most efficient in terms of catch, handling and in space on deck.

The soak time of 48hr is suitable as to reduce ingress of by-catch (Starfish) but further investigation should be carried out to prove the catch efficiency between 24hr-48hr.

Escape gap should be included in all the pots in consonance with standard practice (legal size).

ACKNOWLEDGEMENTS

Our heartfelt thanks to Dr Tumi Tomasson, Director of the Fisheries Training Programme and Mr Thor Asgeirsson the Deputy Programme Director for the Privilege giving to us to undertake this project.

Many thanks also to our supervisors Jónas Páll Jónasson and Haraldur Einarsson who have been really supportive, and without whom this project would not have been possible, we also like to appreciate Halldor Halldorson the captain of our experimental vessel and Oskar Sindri Gislason for their support and assistance. Also to our course coordinator and lecturer Einar Hreinsson we say a big thank you.

We would like to appreciate the UNU/FTP staff Sigridur Ingvardottir and Mary Frances for their support and assistance as well. To all the 2013 fellows we say a big thank you and all the best in your various endeavours.

LIST OF REFERENCES

Arcement, G., & Gillory, V. (1993). Ghost fishing in vented and unvented blue crab traps. *Ghost fishing in vented and unvented blue crab traps* (pp. 1-7). Louisiana: Proc.Louisiana Acad. Sci.

Balik, I., Cubuk, H., & Uysal, R. (2003). Effect of bait on efficiency of fyke-nets for catching crayfish astacus leptodactylus. *Turkish Journal of Fisheries and Aquatic Sciences*, 1-4.

Bigford, T. E. (1979). *Synopsis of Biological Data on the Rock Crab, Cancer irroratus Say.* Roma: FAO.

Butler, J. N., Burnett-Herkes, J., Barnes, J. A., & Ward, J. (1993). The Bermuda Fisheries: A tragedy of the commons averted? *EVIRONMENT*, 7-33.

Campbell, M. J., & Sumpton, W. D. (2009). Ghost fishing in the pot fishery for blue swimmer crabs Portunus pelagicus in Queensland, Australia. *Fisheries Research*, 246-253.

Canadian Science Advisory Secretariat. (2013). *Assessment of the rockcrab (Cancer irroratus) fishery in the southern gulf of ST. LAWRENCE for2006 to 2011.* New Brunswick: Fisheries and Oceans Canada.

Crawley, M. J. (2007). *The R Book.* West Sussex: John Wiley and Sons Ltd.

DFO. (2002). *Southern Gulf of St. Lawrence rock crab (Lobster fishing areas 23. 24. 25, 26A and 26B).* Dartmounth, Nova Scotia: DFO Gulf Region Stock Status Report.

Einarsson, S. T. (1988). *The distribution and density of common spider crab Hyas araneus in Iceland water.* Reykjavik: Marine Research Institute.

Eno, N. C., MacDonald, D. S., Kinnear, J. A., & Amos, C. S. (2001). Effects of crustacean traps on benthic fauna. *ICES Journal of Marine Science*, 11-20.

FAO. (2012). World review of fisheries and aquaculture. In FAO, *The state of the world fisheries and aquaculture* (pp. 1-148). Rome: FAO.

Furevik, D. M. (1994). Behaviours of fish relation to pot. In A. Ferno, & S. Olsen, *Marine Fish Behaviour in Capture and Abundance Estimation* (pp. 28-44). Bergen, Norwey: Fishing New Book.

Furevik, D. M., & Løkkeborg, S. (1994). *Fishing trials in Norway for torsk (Brosme brosme) and cod (Gadusmorhua) using baited commercial pots.* Amstersdam: Fisheries research.

Gislason, O. S., Halldorsson, H. P., Palsson, M. F., Palsson, S., Davıðsdottir, B., & Svavarsson, J. (2014). Invasion of the Atlantic rock crab (Cancer irroratus) at high latitudes. *Biological Invasion*.

Guillory, V., McMillen-Jackson, A., Hartman, L., Perry, H., Floyd, T., Wagner, T., & Graham, G. (2001). *Blue Crab Derelict Traps and Trap Removal Programs.* Mississippi: Gulf States Marine Fisheries Commission.

Icelandic Ministry for Fisheries and Agriculture. (2014, January). *Icelandic Fisheries, Information Centre for the Icelandic Ministry for Fisheries and Agriculture*. Retrieved from Fishing Gear: http://www.fisheries.is/fisheries/fishing-gear/

Klassen, G., & Locke, A. (2007). *A biological synopsis of the european green crab, Carcinus maenas.* Moncton: Fisheries and Oceans Canada.

Lokkeborg, S., & Pina, T. (1997). Effects of setting time, setting direction and soak time on longline catch rates . *Fisheries Research*, 213-222.

López-Salgado, I., Gasca, R., & Suárez-Morales, E. (2000). La comunidad de copépodos (Crustacea) en los giros a mesoescala en el occidente del Golfo de México (julio, 1995). *Revista de Biología Tropical*, 169-179.

Moore, G., & Jennings , S. (2000). *Comercial fishing, the wider ecological impacts.* Great Bristain: Bristing Ecological Society.

Mustafa, C., Tarik, D., Basusta, N., & Cokce, M. A. (2005). Comparison of two different types of basket trap on fish catches in Iskenderun Bay. *Turk Journal Veterinary Animal Science*, 743-749.

Robertson, W. D. (1989). Factors affecting catches of the crab Scylla serrata forskal decapoda portunidae in baited traps: soak time, time of day and assessibility of the bait. . *Estuarine Coastal and Shelf Science*, 161-170.

Robichaud, D. A., Lawton, P., & Strong, M. B. (2000). *Exploratory fisheries for rock crab, Cancer irroratus, and Jonah crab Cancer borealis, in Canadian lobster fishing areas 34, 35, 36 and 38.* Dartmouth: DFO, Canadian Science Advisor Secretariat .

Sigler, M. F. (2000). Abundance estimation and capture of sable fish (Anoplopoma fimbria) by long line gear. *Canadian Journal of Fisheries and Aquatic Science*, 1270-1283.

Slack-Smith, R. J. (2001). *Fishing with trap and pots.* Rome: FAO.

Stoner.A.W. (2004). Effects of environmental variables on fish feeding ecology: implications for the performance of baited fishing gear and stock assessment. *Journal of fish biology*, 1445–1471.

Thomsen, B., Humborstad, O.-B., & Furevik, D. (2010). Fish Pots: Fish Behavior,Capture Processes, and Conservation Issues. In P. He, *Behavior of marine fishes* (pp. 143-154). Iowa: Wiley- Blackwell.

Valdimarsson, H., & Malmberg, S.-A. (1999). Near-surface circulation in Icelandic waters derived from satellite tracked drifters. *Rit Fiskideildar*, 23-39.

Watson, R., Revenga, C., & Kurab, Y. (2006). Fishing gear associated with global marine catches I. Database development. *Fisheries Research*, 97–102.

Whitelaw, A. S.-t.-3. (1991). Catching characteristics of four fish-trap types on the north west shelf of Australia. *Australian Journal of Marine and Freshwater Research*, 369-382.