Sudan University of Science and Technology

College of Graduate Studies

Illegal Fishing gears: Quantifying, Distributions and Its Impact on Fish population – Khartoum State

معدات الصيد غير القانونية : تقدير الكميات وتوزيعها و أثرها علي المجتمعات السمكية – ولاية الخرطوم

Thesis Summited in Partial Fulfilment of Requirements for the Degree of Master of Science in Fish Science and Technology

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(January, 2020)

الاية

بسم الله الرحمن الرحيم

وقال تعالى: (اللَّهُ الَّذِي سَخَّرَ لَكُمُ البَحْرَ لِتَجْرِيَ الفُلْكُ فِيهِ بِأَمْرِهِ وَلِتَبْتَغُوا مِن فَضْلِهِ وَلَعَلَّكُمْ تَشْكُرُونَ)، 12 "الجاثية

(وَإِذَا تَوَلَّىٰ سَعَىٰ فِي الْأَرْضِ لِيُفْسِدَ فِيهَا وَيُهْلِكَ الْحَرْثَ وَالنَّسْلَ ۗ وَاللَّهُ لَا يُحِبُّ الْفَسَادَ)
205، "**البقرة.**

صدق الله العظيم

Dedication

To my mother, who stayed the nights to light my way

To my father, who is I am walking, on his way

To my dear friend's soul, who I praying for her to be the heaven the end of her way

To the friends of my path who walked with me in science and his way

Acknowledgement

I would like to grateful to my supervisor for his patience and support in overcoming numerous obstacles I have been facing through my research

I am also thank the all fishermen for their participation in the survey who supported my work in this way and helped me get results of better quality.

I would like to thank my fellow master students for their feedback, cooperation and of course friendship. In addition, I would like to express my gratitude to the staff of Geshtala aquaculture and Jebel Aulia fisheries station the last minute favors.

Nevertheless, D. Hasen and D.Abubakr for sharing their knowledge for supporting me in writing this thesis.

I would like to thank my friends for accepting nothing less than excellence from me.

Last but not the least, I would like to thank my family: my parents and to my brother and sisters for supporting me spiritually throughout writing this thesis and my life in general

ABSTRACT

The study was conducted to report the types of illegal fishing gear used, to estimate the illegal fishing gears used by fishermen and to evaluate the impact of ghost gears on fish populations in Khartoum State. A mixed-method approach to evaluate the extent, character, and effects of using illegal fishing gears at Wad Alagaly, Jebel Aulia and Almorada. The three complementary methods used to describe these fisheries and evaluate its impacts, interviews with fishermen (N 50) in these regions to collect legal and illegal fishing gears information and to decide the location of the derelict fishing gears surveyed and gather the entangled organisms, derelict fishing gears` catch efficiency, and common population. The SPSS16 program was use to do the statistical analysis by Frequency, T-test and chi-square and one-way Anova. The interviews with fishermen showed that the total of gears found in the study were 280 gears, 82.5 % were illegal fishing gears while just 17.5% were legal fishing gears. All the fishermen in study sample fishing for income, 90% of fishermen noticed or found the ghost gears in the water body. In addition, 46% of fishermen leaved their old gears at beaches, while 22 % of fishermen leaved it in water bodies and 32% disposal it away. All the fishermen in the study have membership in union but 96% of them Saied that the Union does not have a role in implementing laws. The surveys for derelict fishing gears indicated that lifted ghost fishing net comprised 78.5% of the total ghost fishing gears observed during the survey at the Wad Alagaly and Jebel Aulia sites. While lifted ghost fishing line comprised 21.5% of the total fishing gears observed during the survey at Wad Alagaly site. Most of lifted ghost fishing nets were founded on the deep water 63.7%, while 18.7% were founded on the shore line and 17.6% founded on the small island . Most of lifted derelict fishing nets were founded as part net 89%, while 11% were found as a whole net. More than seventy five percent of lifted fishing nets were mono panel, while 24.4% were multi panel. Most of lifted fishing nets were White 34.1%, while 33% were gray. 62.6% of lifted fishing nets were made from Nylon. Proximately 35% of lifted ghost net entangled organisms. 45.8% of lines found with 20 – 40 hooks, while 29.2% were founded with less than 20 hooks and 25% were founded with 41- 60 hooks. 44% of lifted fishing lines were found with length 41 - 60 m. Overall, the illegal fishing gears were widely used by fishermen and this led to that fish become smaller and less in abundant than they used to be. The effect of ghost gears is relay in that gears continue catching live

organisms or causing injuries, ingestion of gear physical impact of gears on the benthic environment and ultimate fate of lost gear in the marine environment. All the interviewed fishermen agreed that we have to protect fish species and aquatic organisms to make it sustainable by using legal fishing gears and determine fishing seasons.

مستخلص الدراسة

تم إجراء الدراسة لتسجيل أنواع معدات صيد الأسماك غير القانونية المستخدمة من قبل الصيادين و تقدير كمياتها , و إخراج الشباك المتروكة في مياه النهر(معدات الصيد الشبح) و معرفة تأثيرها علي المجتمعات السمكية في ولاية الخرطوم.تم إستخدام منهج الطريقة المختلطة لتقييم مدي توسع ،خصائص و تأثير إستخدام معدات الصيد الغير قانونية في منطقة ود العقلي، جبل أولياء و الموردة. أستخدمت الطريقة الثلاثية المختلطة لوصف هذة المصائد و تقييم تأثيرها عن طريق إجراء المقابلات مع الصيادين (عدد 50) لجمع المعلومات عن معدات الصيد القانونية و غير القانونية و لتحديد مواقع المسح للشباك المهجورة و لأخذ العينات الأحياء المصطادة من هذة الشباك و معرفة قدرتها علي الصيد و الأنواع التي تصتادها. أستخدم البرنامج الإحصائي SPSS 16 لإجراء التحليل الإحصائي بإستخدام التحاليل التردد , إختبار T , one way anova و مربع كاي.من نتيجة مقابلة الصيادين كان العدد الكلي لمعدات الصيد المستخدمة 280 معدات صيد تمثل المعدات الغير قانونية فيها نسبة 82.5% بينما 17.5% فقط يستخدمون معدات صيد قانونية.كل الصيادين في الدراسة يصطادون من أجل الدخل .90% من الصيادين لاحظوا وجود معدات الصيد الشبح في المجري الرئسسي لمياة النهر.بالإضافة إلي أن 46% من الصيادين يتركون معدات الصيد القديمة علي الشواطئ,بينما 22% من الصيادين يتركونها داخل مجري المياه و 32% منهم يتخخلصون من معدات الصيد القديمة بعدا عن مياة الأنهار و الشواطئ.كل الصيادين الذين تمت مقابلتهم لديهم عضوية في إتحادات الصادين , لكن 96% منهم ولون ان الإتحاد ليس له دور في تنفيذ القانون. نتيجة المسح عن الشباك المتروكة كانت شباك الشبح التي تم إستخراجها مثلت نسبة 78.5% من مجمل معدات الصيد المتروكة في النهر التي تمت ملاحظتها أثناء عملية المسح في منطقة ود العقلي و منطقة جبل أولياء , بينما مثلت الخيوط و السنارات التي تم إستخراجها من النهر 21.5% من مجمل معدات الصيد المهجورة في النهر في منطقة ود العقلي. معظم الشباك الشبح الت تم إستخراجها من النهر وجدت في المياه العميقة بنسبة 63.7% بينما 18.7% منها وجدت علي خط الششاطئ و 17.6% وجدت في الجزر الصغيرة داخل النهر .معظم شباك الشبح المستخرجة وجدت كأجزاء من الشباك 89%, بينما 11% كانت شباك كاملة. أكثر من 75% من شباك الشبح المستخرجة كانت أحادية بينما 24.4% كانت متعددة.معظم شباك

الشبح المستخرجة من النهر كانت ذات لون أبيض 34.1% , بينما 33% باللون الرمادي.62.6% من شباك الشبح المستخرجة مصنوعة من النايلون. تقريبا 35% من شباك الشبح المهجورة هائمة في النهر كانت ممسكة للأحياء المائية .45.8% من خيوط الشبح كان بها من 20-40 خطاف , 29.2% كان بها أقل من 20 خطاف و 25% كان بها من 41-60 خطاف .44% من خيوط الصيد الشبح المستخرجة و جدت بأطوال من 41-60 متر. في المجمل معدات الصيد الغير قانونية تستخدم علي نطاق واسع من قبل صيادين الأسماك و هذا أدي إلي أن الأسماك أصبحت أصغر حجما و أقل وفرة مما كانت عليه من قبل. يتمثل تأثير معدات الصيد الشبح في أن هذة المعدات تستمر في صيد الأحياء المائية او تسبب لها الجروح , و يمكن لهذة الأحياء أن تبتلع هذة المعدات , كما أن لها تأثير فزيائي علي البيئة القاعية و يمكن أن تؤدي إلي تدمير البيئة المائية. كل صيادي الأسماك الذين تم إستطلاعهم يتفقون علي أنه من أجل حماية الأحياء المائية و جعله مستدام لا بد من إستخدام معدات صيد قانونية و تحديد مواسم للصيد .

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CHAPTER ONE

1. INTRODUCTION

1.1 Background

It is widely accepted that there is a severe problem with future Global food security. Driven by substantial world population growth, demand for fish protein continues to increase, but a large number of the world's fish stocks are currently depleted and therefore, not capable of producing their maximum sustainable yield (FAO, 2007) (the state of world fisheries and aquaculture, 2006). Illegal, unreported and unregulated (IUU) fishing is a significant global problem jeopardizing ecosystems, food security, and liveli- hood s around the world. The IUU fishing undermine efforts to sustainably manage fish stocks and threaten fish populations worldwide (Agnew et al, 2009). A sour protein-hungry planet faces an unprecedented crisis of overfishing – 85% of all commercial stocks are now fished up to their biological limits or beyond (Pitcher et al,2013).Fishing practices that violated national laws , evade reporting requirements, or simply escape manage mental together pose a major challenge to the sustainable use of ocean resources .Managers must know as much as possible about the extent, character (e.g., gear types, target by catch species, timing, location), and motivations of illegal fishing to effectively develop and implement regulations. However, quantifying illegal fishing is inherently difficult: it is generally covert and significant incentives exist for informants to withhold information (Renzetti 1993). budget and human resource constraints often restrict efforts to monitor illegal resource use, especially in developing countries (James, Gaston 1999). There is a need to develop inexpensive yet informative methods for quantifying illegal fishing and its impacts. Indirect observation, the use of signs of illegal activity as an indicator of non-compliance, has been commonly used to characterize illegal resource use in terrestrial systems (Gavin, Solomon 2010). Most successful quantifications of illegal fishing compare the amount of derelict fishing gear inside and outside reserve boundaries (Cinner,2005) and (Clanahan 2009).but such comparisons are of little use in places without reserves or where the areas

outside reserves are undesirable to fishers. The full capacity for indirect observation to reveal rich and quantitative information about illegal fishing remains unexplored. Repeated surveys can reveal spatial and temporal patterns of non-compliance (Chiappone 2004), (Cinner 2005) and (Williamson et al, 2014) that can be compared to changes in fish communities to examine the effects of illegal fishing (Jachmann2008).

1.2 Problems of the study

The use of illegal fishing gears has a significant impact on fish stocks and its sustainability. There is little studies recorded in Sudan to know its effect so it is necessary to estimate it and study how they affect fish population in Khartoum State.

1.3 Significant of the study

Fish contribute to meet the increasing demand for protein as the result of increase of population. Therefore, it is necessary to know what is the illegal fishing gears used because they affect fish stocks and their sustainability. This study will provide information in regard of illegal fishing gears used, open the door to other studies and authorities. The study will contribute to raise the issue to be consider in fisheries management in Khartoum, particular the affected areas.

1.4 Objectives

In general, this study aimed to provide knowledge regarding legality of the fishing gears and its impact on fish population and its dynamic. Whoever, the Specific objectives are:

1. To report the types of illegal fishing gear used in Khartoum state if any.
2. To estimate the illegal fishing gears using by fishermen in Khartoum state.
3. To record the impact of lifted ghost gears on fish populations and other organisms in Khartoum state.

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CHAPTER TWO

2. LITERATURE REVIEW

2.1 Khartoum state fisheries

Khartoum state is considered as the main fish consumption center in the Sudan (Fisheries Department, 2003). Khartoum state has limited natural fisheries scattered on the Blue and White Nile River: Fiteihab, Azozab, Al-Kalakla and Jebel Aulia Dam in the White Nile and Al-Gereif and Soba in the Blue Nile and Al-Mourada in the Main Nile (Mohammed, 2004). The White Nile River Fisheries contribute about more than half of total fish marketed in the state, which was estimated to be at around 12.5% (Fisheries Department, 2003).

2.2 Fishing gears in Khartoum State

Few studies conducted on fishing gear that used in the White Nile River, showed that gill-nets and seine nets are dominant, whereas, long lines are seasonal in use (Mohammed etal, 2011). Jebel Aulia Dam Reservoir suffered much from using fixed nets (nylon nets) with different mesh sizes especially along its northern part. For this reason, gill-nets selectivity has affected negatively fish population (Ali, 1977). Fishing operations used in the White Nile River include drift way, fixed, per-suit and luring type. Fixed method is utilized broadly by fisheries of the White Nile River (Mohammed, 2004). Fishing nets used in offshore areas in the White Nile River are floating gill-nets with mesh sizes ranging from 16 to 20 cm or more, while the seine nets are used around breeding grounds in the inlets and shallow beaches. Small-sized gill-nets (2 to 8 cm) made of fine twine are used only to catch *Alestes dentex* and *Hydrocynus forskalii* for preparing salted fish products (Mohammed etal, 2011).

Long-lines which known locally as Sareema and Jago gears are used in the White Nile River as non-selective fishing gear during flood (Kawai, 1994), Fisheries Department, 2003) and (Mohammed, 2006). It was recorded that gill-nets (fixed nets and drift nets) and seine nets (Bibi nets and Um Surra nets) were used widely with clear variation in use during all seasons of whole year in both Al-Kalakla Fishery (KF) and Jebel Aulia Dam Fishery (JADF). Luring gear was used in limited way in KF more than in JADF, while cast nets were used only in JADF Mesh sizes of gill-nets used commonly were 6, 8, 12 and 15 cm, while 2 and 4 cm mesh sizes of seine nets were dominant in use. Most of fishing nets extended one meter and half in depth and 100 m up to 150 m length Mesh sizes of gill-nets used commonly were 6, 8, 12 and 15 cm, while 2 and 4 cm mesh sizes of seine nets were dominant in use. Most of fishing nets extended one meter and half in depth and 100 m up to 150 m length Results showed that Rami nets were dominant in fishing in both fisheries, but they were used in JADF more than KF. In contrary, Um Kubuk net was dominant in KF more than in JADF. Use of drift nets followed fixed nets in both fisheries, but JADF showed the highest percentages. Fishermen in JADF used cast nets, while those in KF did not (Mohammed el 2011).

2.3 fish species in Khartoum State

Only 66 species are now available in the main Nile, 95 Blue Nile, 50 in White Nile, 66 in Lake Nubia. (Elagba and Asaad Ibrahim, 2017). the fish composition on the species level shows that *Synodontis* species (42.43%) as the dominant followed by *Latus Niloticus* (12.06%) and thirdly *Oreochromis Niloticus* (6. 51%).The Fisheries Department of Khartoum State (2003) surveyed al- Gereif fish landing at the Blue Nile within Khartoum city and recorded (22) fish species, Tilapia sp. was dominant and followed by *Labeo* sp., *Synodontis* sp. and *Bagrus sp* respectively, whereas

Distichodus Niloticus and *Protopterus aethiopicus* were of less occurrence (1EGBAL leal,2018)

1.4 Ghost gears in the world

Illegal, unreported and unregulated fishing distorts competition, harms honest fishermen, weakens coastal communities, promotes tax evasion. Moreover, the total extractions of living resources from marine ecosystems are needed in order to understand the sustainability of fisheries both in terms of ecology and economics since catches reported to national and international agencies (Pramod etal, 2014) exclude IUU, discards and often small-scale and recreational fishery catches (Pitcher et al, 2002). This illegal catch is valued at between $10 and $23.5 billion per year (Agnew et al, 2009) The 1995 FAO Code of Conduct for Responsible Fisheries (FAO.1992) initiated an international frame work for addressing this problem, recently termed 'fishery crime' (Österblom,2014) is reported to lead to a loss of many billions of dollars of annual economic benefits (Pauly and Christensen2002) and (MRAG, 2005), creates significant environmental damage through the use of unsustainable fishing practices (MRAG, 2005) and has wider consequences for food supply (Brashares,2004). Attempts at control have focused on fishery management through improving Monitoring ,Control, and Surveillance(MCS), through a UNP or testate agreement to restrict chandlers up port for suspect vessels (Flothmann, 2010) and by national and Interpol tracking of suspicious vessels including trans- shipment at free ports .These activities have substantially improved the prospects for addressing IUU fishing and associated crimes, but significant profits are still being made from illegal fishing. Fishery markets, increasingly global, and, despite increasing use of chain of custody documentations (Borit and Olsenv, 2012)

notoriously opaque at the distribution level, provide another opportunity to reduce profits from illegal fishing by isolating trade.

CHAPTER THREE

3. MATERIALS AND METHODS

3.1 Site of study

The study was carried out at Jebel Aulia, Wad Alagaly and Al-Morada Khartoum State, Sudan.

3.1.1 Jebel Aulia

Jebel Aulia is a village in the north-central part of Sudan, about 40 km south of Khartoum at 15°14'45.7"N 32°29'00.3"E.Nearby is the Jebel Aulia Dam, built in 1937 by the British for the Egyptian government and now there is a big fishing activity. R wikapidia

Image 1: Show the location of Jebel Aulia from Satellite Image

3.1.2 Wad Alagaly

It is located in the south of Khartoum State, the locality of Jebel Aulia bordered by the White Nile on the western side at 15°27'01.0"N 32°27'43.1"E and it has a fishing activity .

Image 2: Show the location of Wad Alagaly from Satellite Image

3.1.3 Al-Morada landing site

Al-Morada neighborhoods in the city of Omdurman at 15°37'38.2"N 32°29'23.0"E , which is an ancient and old neighborhood. Sailboats were carrying

wood, firewood and food from the north, east and south of the Omdurman retaliation at the shore of the Nile.

Image 3: show the location of Al-Morada landing site

Therefore, this anchor called **Al-Morada**, now this has turned and the beach has become a popular market by which fish are return to Omdurman.

3.2 Materials

Questionnaires. GPS (Global Positioning System). Fiberglass boat. Long stick end by hook to collect nets and line from the river (locally made). Digital balance to take organism weight and Meter.

3.3 Experimental design used

Three complementary methods used to describe these fisheries and evaluate its impacts as shown below.

3.3.1 Interviews

Interviews with fishermen,(N 50) in the three study regions were performed at Jebel Aulia (N 20) , Wad Alagaly (N 20) and Al-Morada (N 10). The purpose was to

collect legal and illegal fishing gears data and to find the location of the derelict fishing gears.

3.3.2 Derelict fishing gears survey

Surveys at May 2017 for period of 10 days, for derelict fishing gears and organisms which entangled in ghost gears, derelict fishing gears` catch efficiency, and common population, which carried out at September 2017 for period of 6 days. To know the characteristic of the study area like the depth and type of bed we used physical methods.

The forma bellow used to collect data about ghost gears

GPS:															
Fishing, gear Type: A. net categories Date:															
Site No	Fishing area	Type of bed	gear number	Type of net	Type of existing net	float line	lead line	Type of panel	Knot type	Net color	Number of strands	Filament no	Mish size/cm	Gears length/m	Fish species/number

Table 1: Illustrate information about the forma used to collect data of ghost nets gears

GPS:						
Fishing, gear Type: B. Line categories Date:						
Site No	Fishing area	Numbers of hooks	gear number	Gears length/m	Robe twisted to	Level of hooks

Table 2: Illustrate information about the forma used to collect data of ghost lines gears

3.4 Statistical analysis

The SPSS16 program was use to do the statistical analysis by Frequency, T-test, one-way Anova and chi-square.

CHAPTER FOUR

4. RESULTS

4.1 Interviews with Fishermen

The means of gears did the fisherman had was 5 gears, the total of gears in the study sample was 280 gears 82.5 % was illegal fishing gears (231 gears) , while only 17.5% are legal fishing gears (49 gears) .

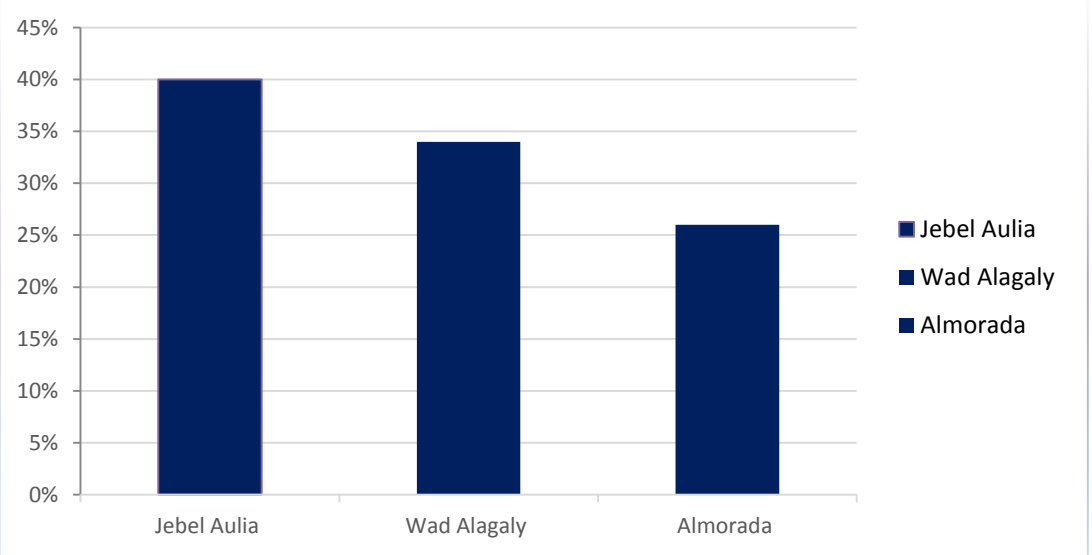

Figure1: Shows information about fishing area.

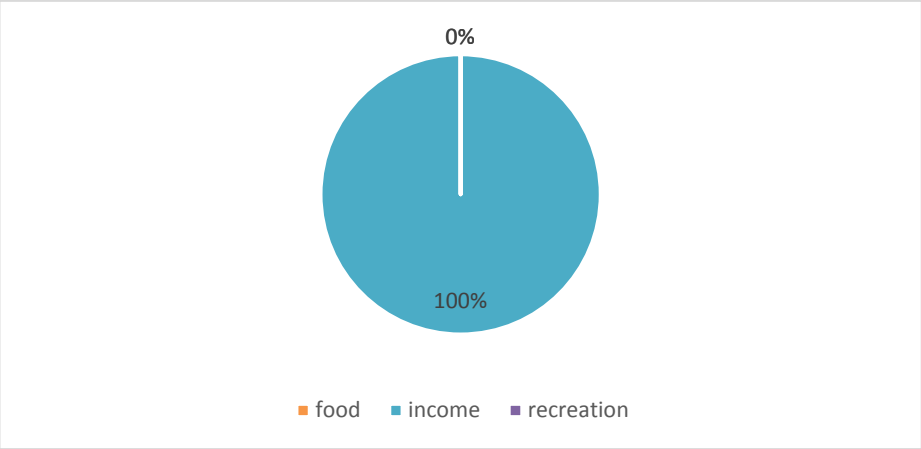

Figure 2 : Illustrate information about why fishermen fishing for.

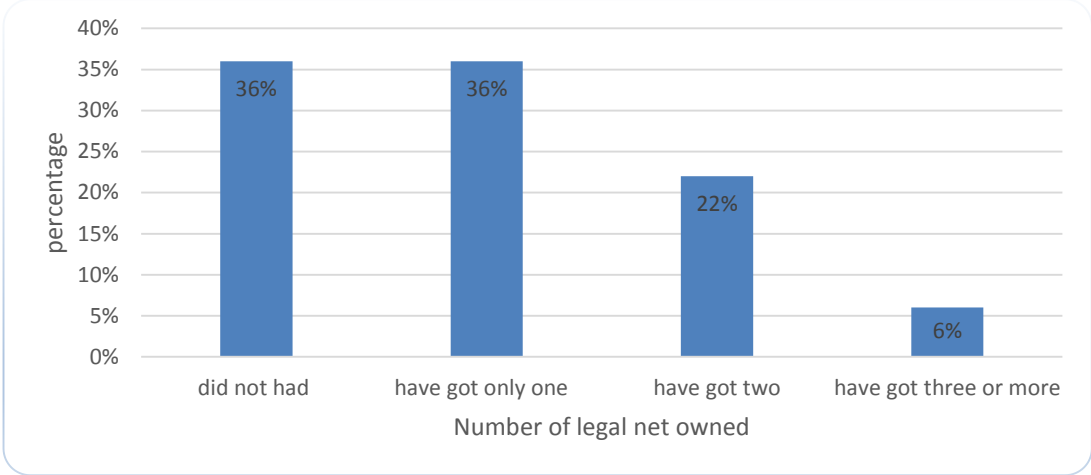

Figure 3: Illustrate information about the number of legal net which fisherman owned.

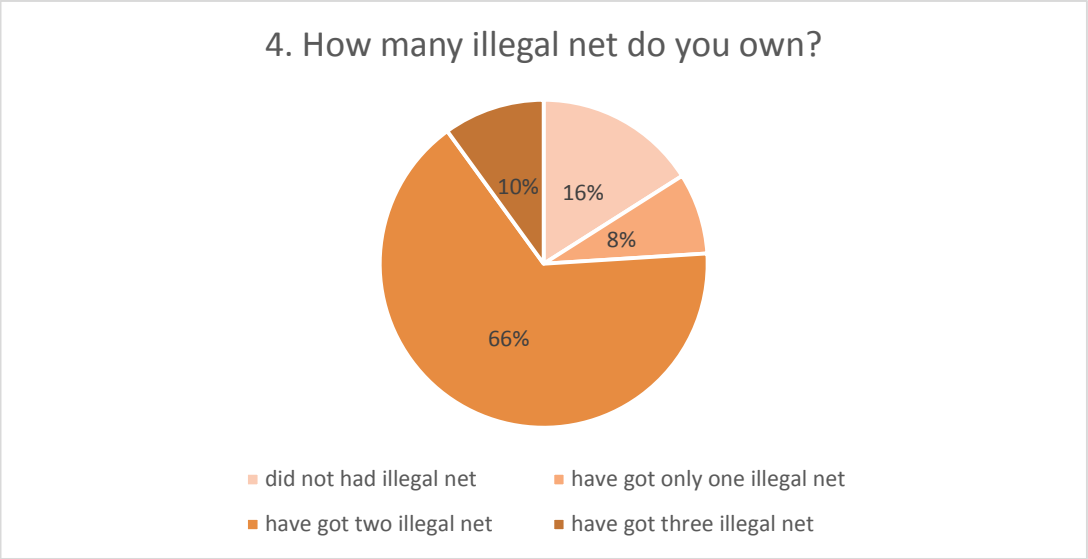

Figure 4: Illustrate information about the number of illegal net which fisherman owned.

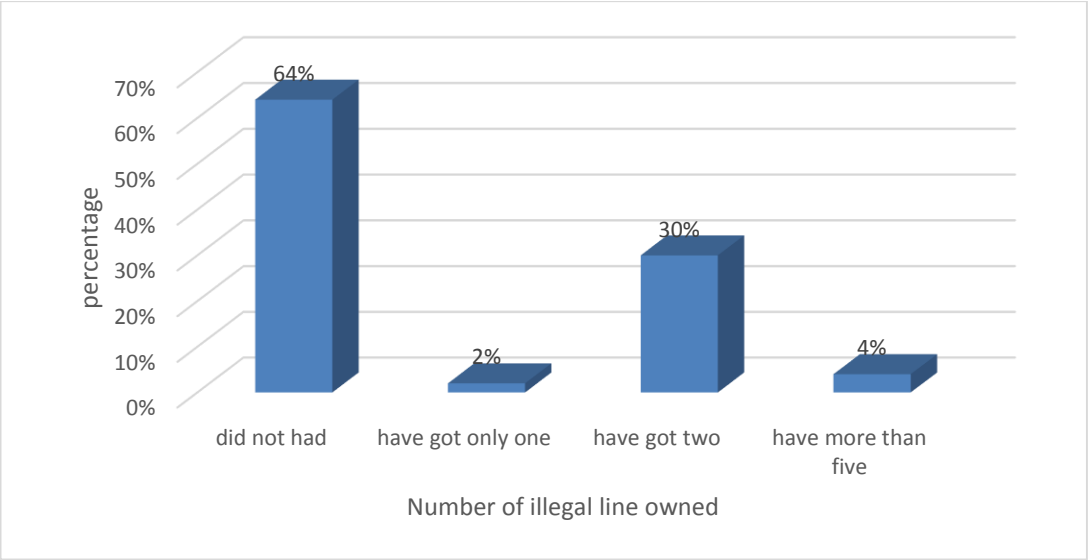

Figure 5: Introduce information about the number of illegal lines which fishermen owned

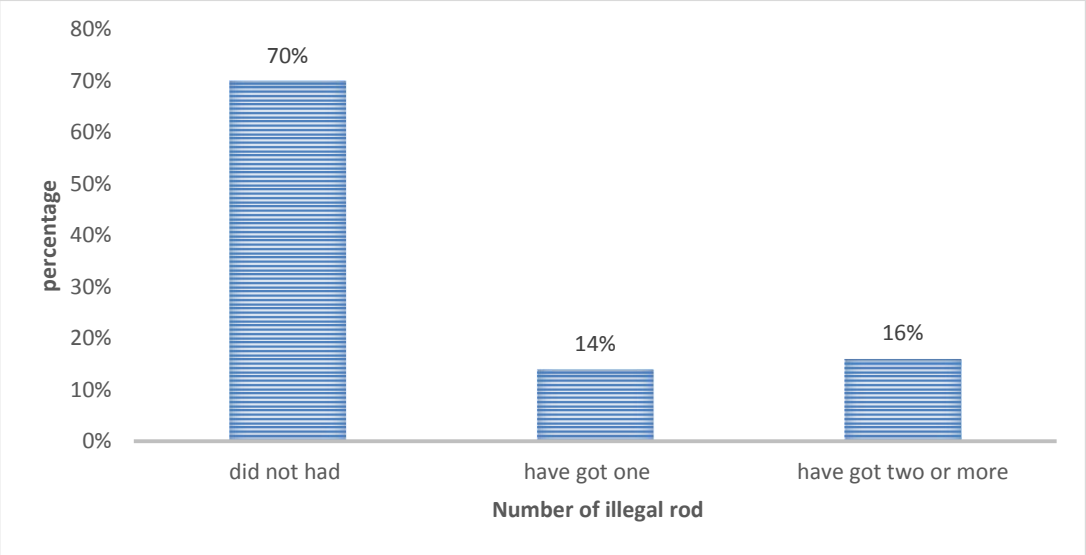

Figure 6: introduce information about the number of illegal rod which

fisherman owned

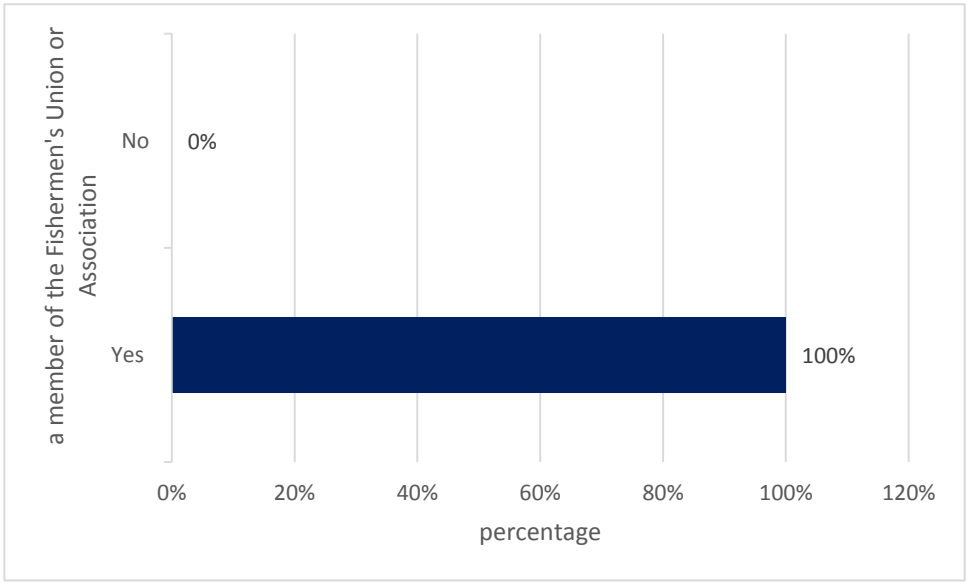

Figure 7: Introduce information about if a fisherman a member of the Fishermen's Union or Association

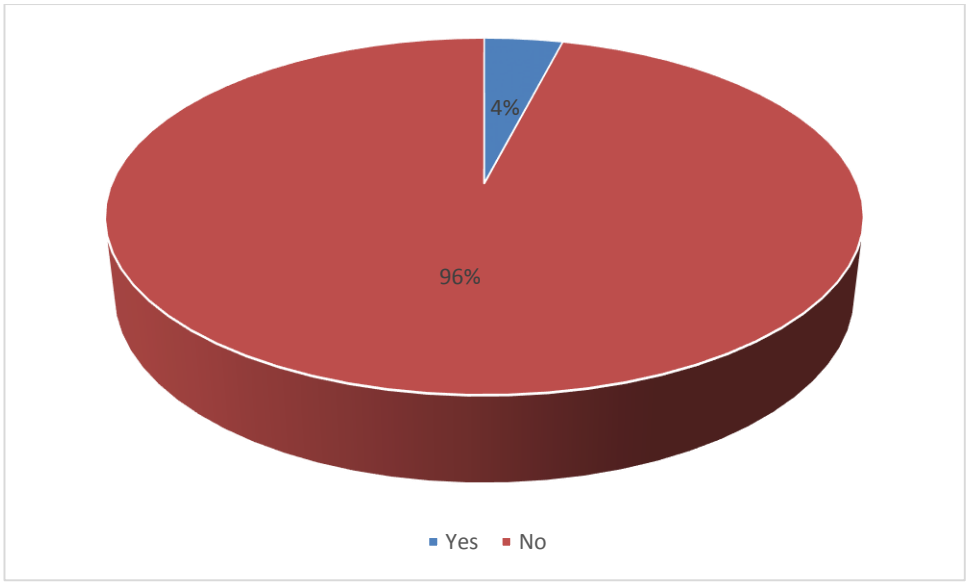

Figure 8: Introduce information about if the Union have a role in implementing law

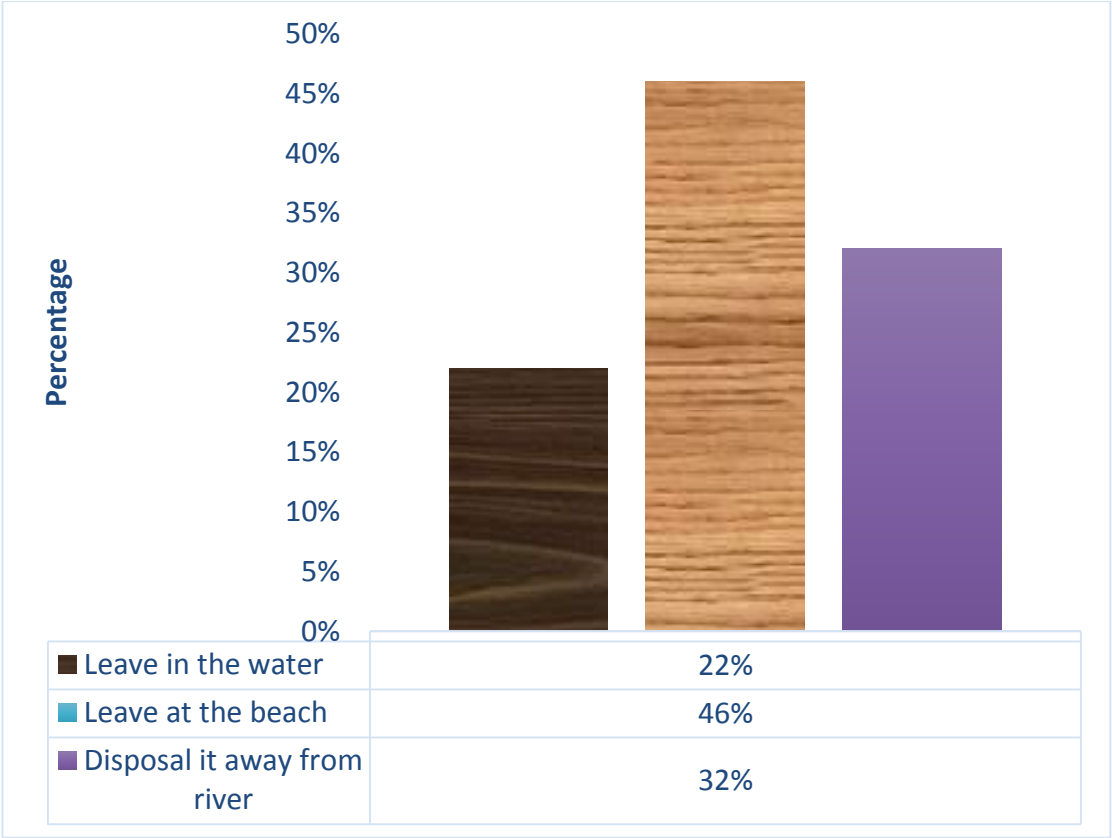

Figure 9: Shows information about what do the fishermen do by their old gears

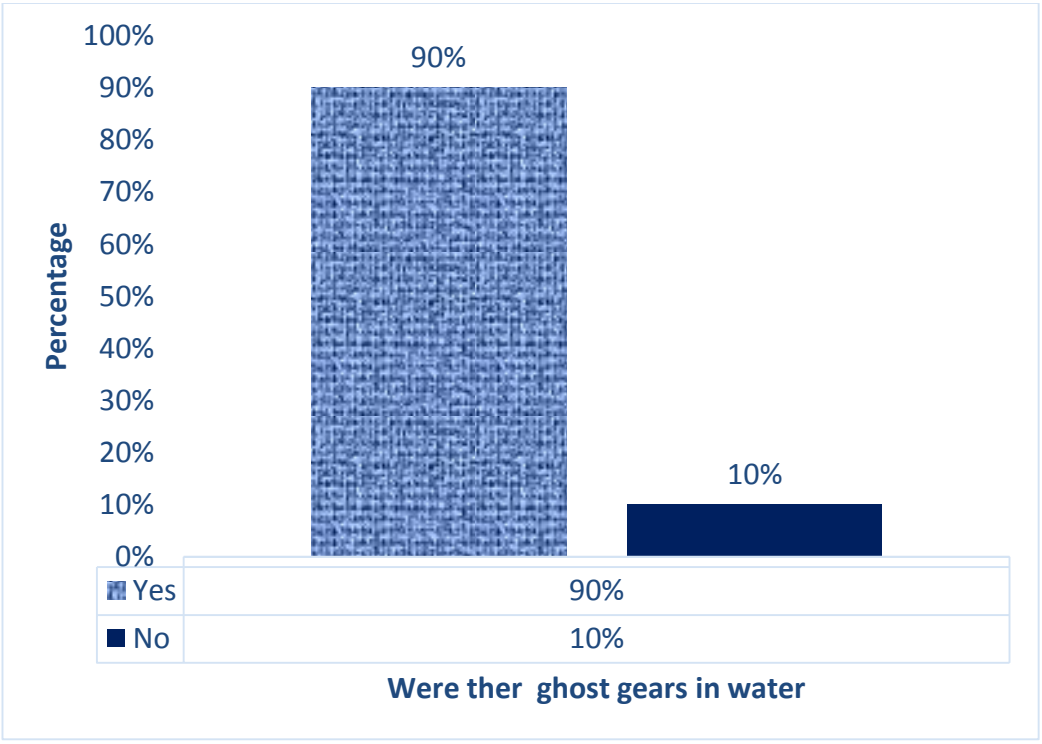

Figure 10: Shows if the fishermen see or found the ghost gears in the water body.

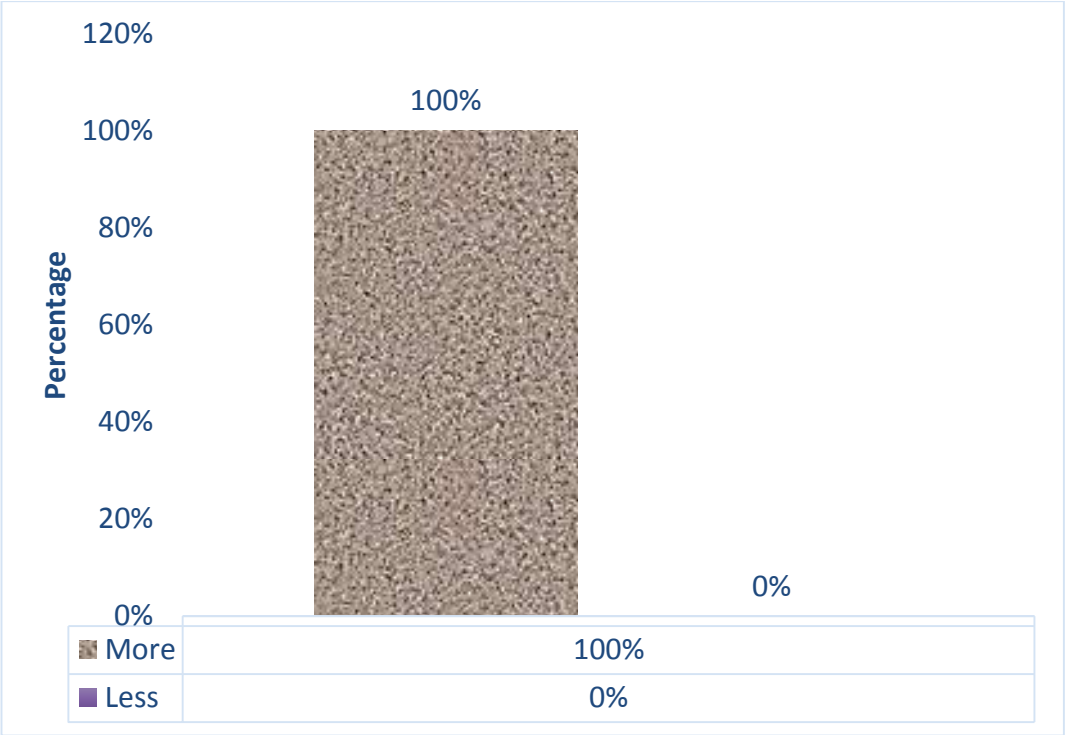

Figure 11: Shows are fish more or less abundant than they used to be

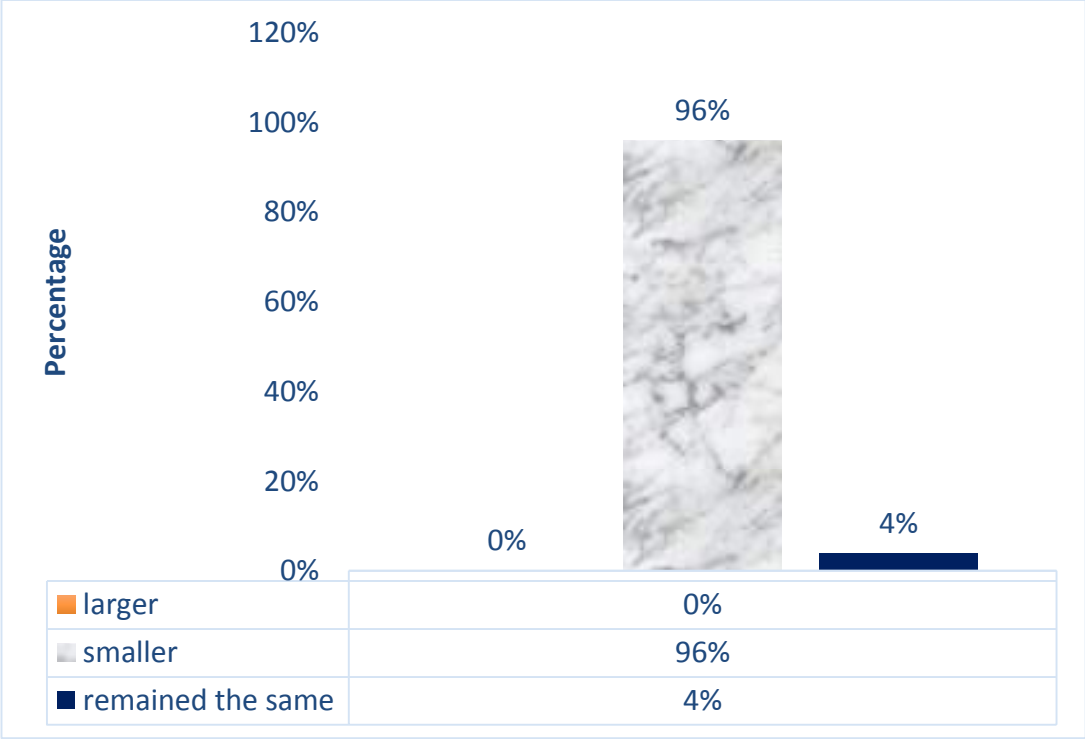

Figure12 : Shows information about are fish larger or smaller than they used to be

4.2 Surveys for derelict fishing gears

A total of 116 of derelict fishing gears were collected in the 2017 survey, ghost fishing net comprised 78.5% (91 ghost net) of the total fishing gears observed during the survey at the Wad Alagaly and Jebel Aulia sites

Questions	**Answers**	**Frequency**	**Percentage**	**Notes**
1.Fishing area	Shore line	17	18.7	Most of lifted fishing nets were founded on the deep water 63.7%,while 18.7% were founded on the shore line and 17.6% founded on the small island .
	Deep water	58	63.7	
	Small island	16	17.6	
2. Type of bed	Sandy	5	5.5	87.9% of lifted fishing nets were found on muddy bed , while 6.6% were found on rocky bed and 5.5% were found on sandy bed
	Muddy	80	87.9	
	Rocky	6	6.6	
3.Type of net	stationary bottom	0	0	All lifted fishing nets were floating water Colum
	floating water Colum	91	100	
4.Type of existing net	Whole net	10	11	Most of lifted fishing nets were founded as part net 89%, while 11% were found as whole net.
	Part net	81	89	

Table 3: Shows the characteristic of the founded ghost nets:

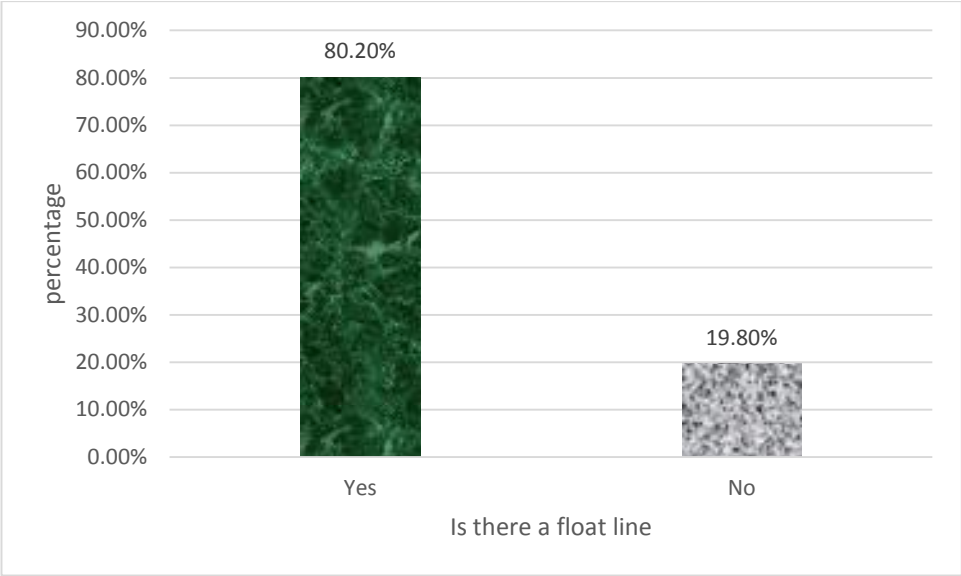

Figure 13: Shows information about is there a float line in lifted ghost net

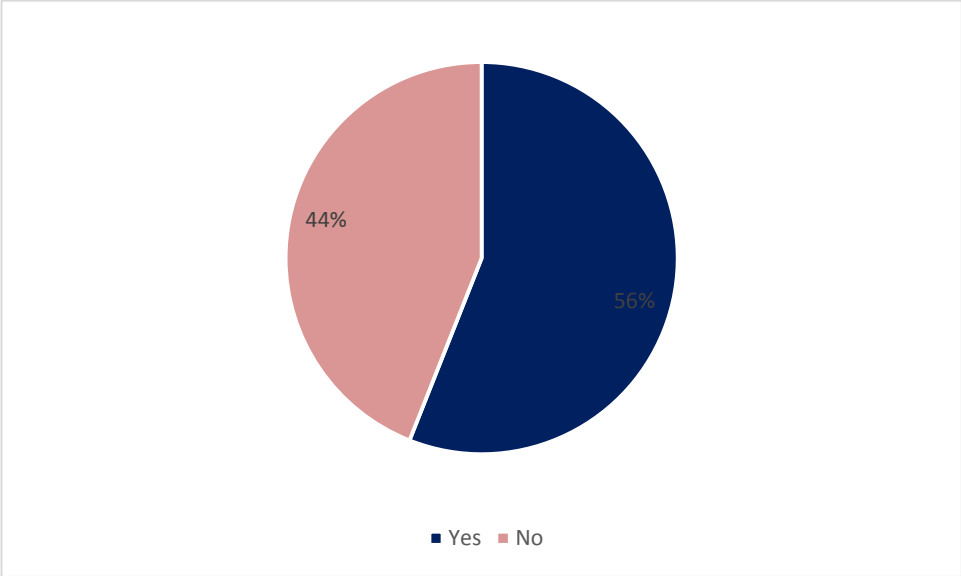

Figure14: Introduce information about is there a lead line in lifted ghost net

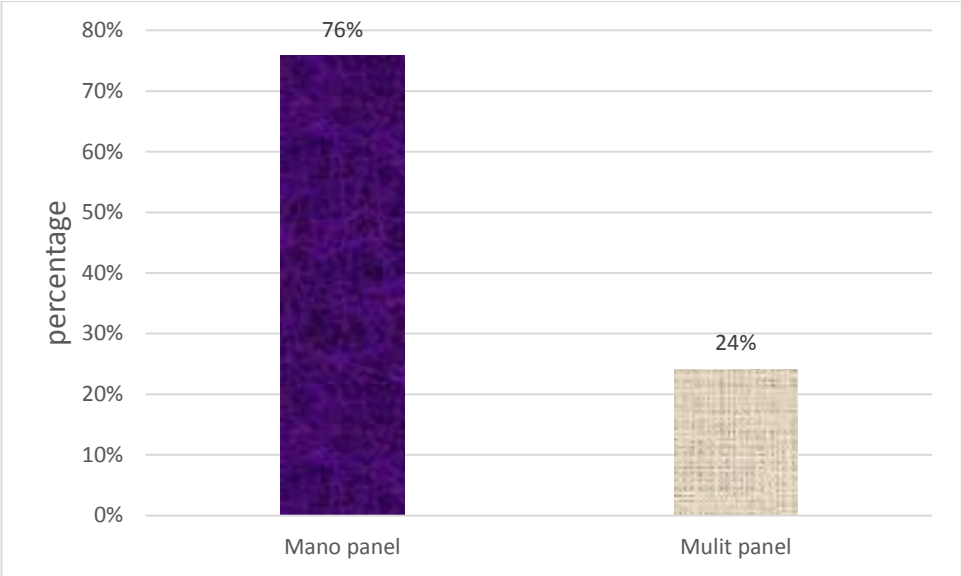

Figure 15: Illustrate information about type of panel in the lifted ghost net

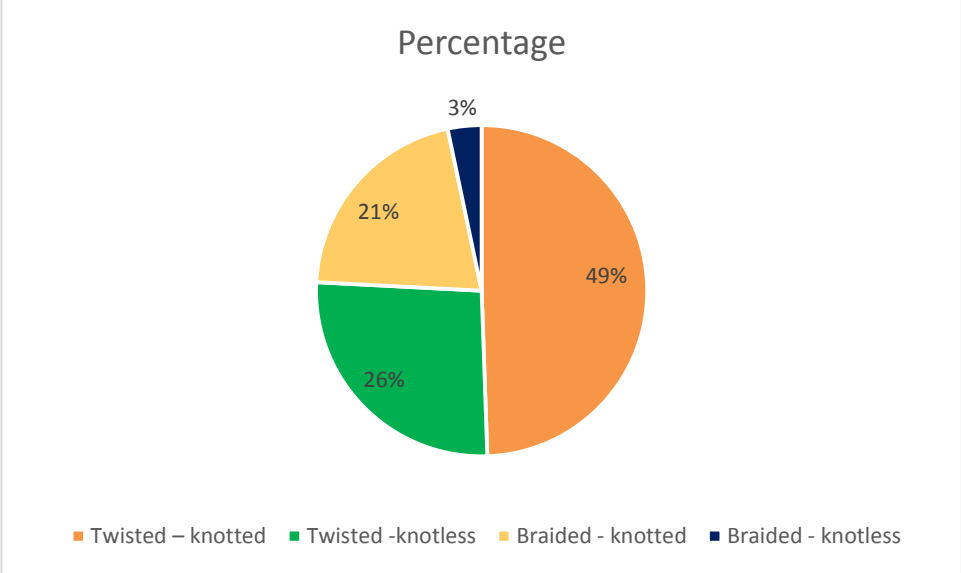

Figure 16: Shows information about knot type in the lifted ghost net

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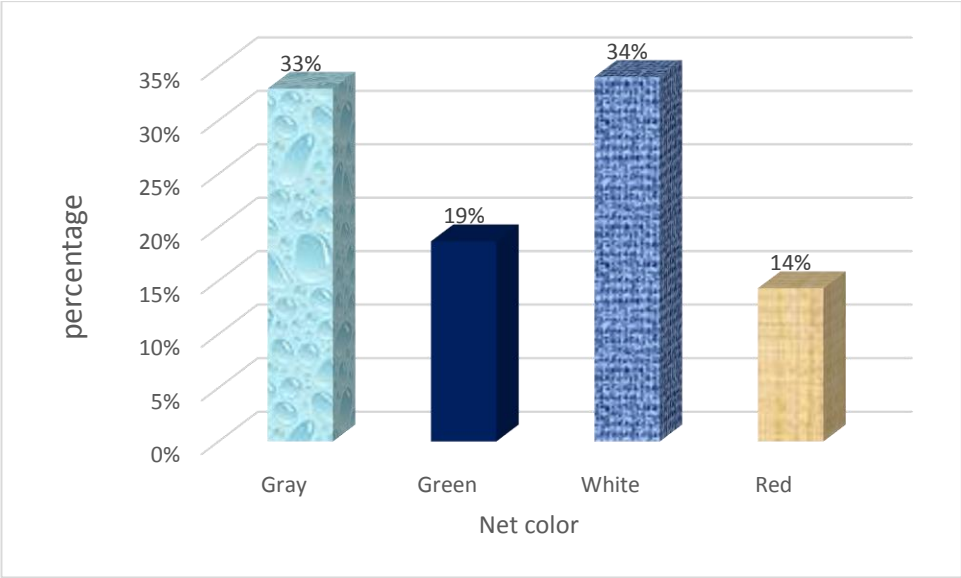

Figure 17: Shows information about net color in the lifted ghost net

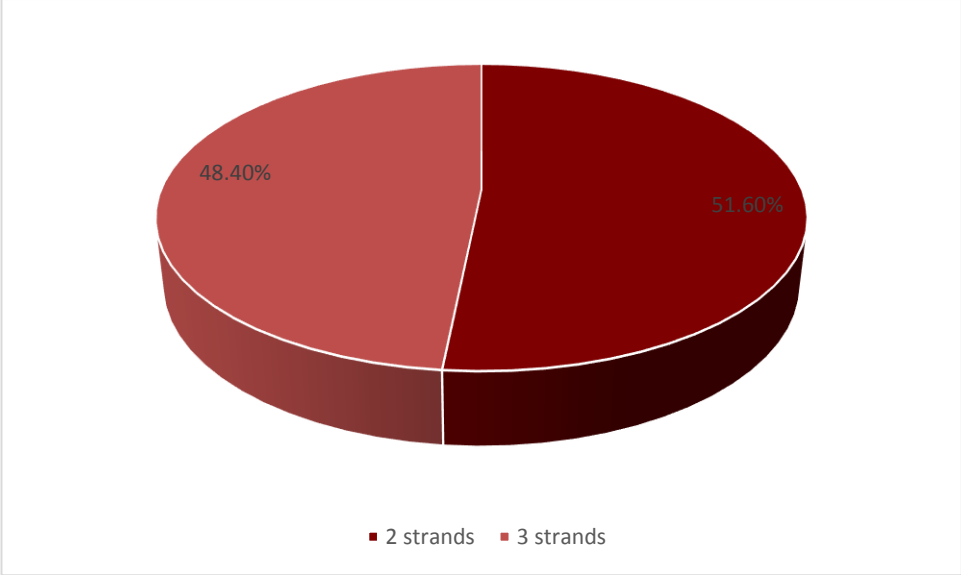

Figure 18: Shows information about number of strands in the lifted ghost net

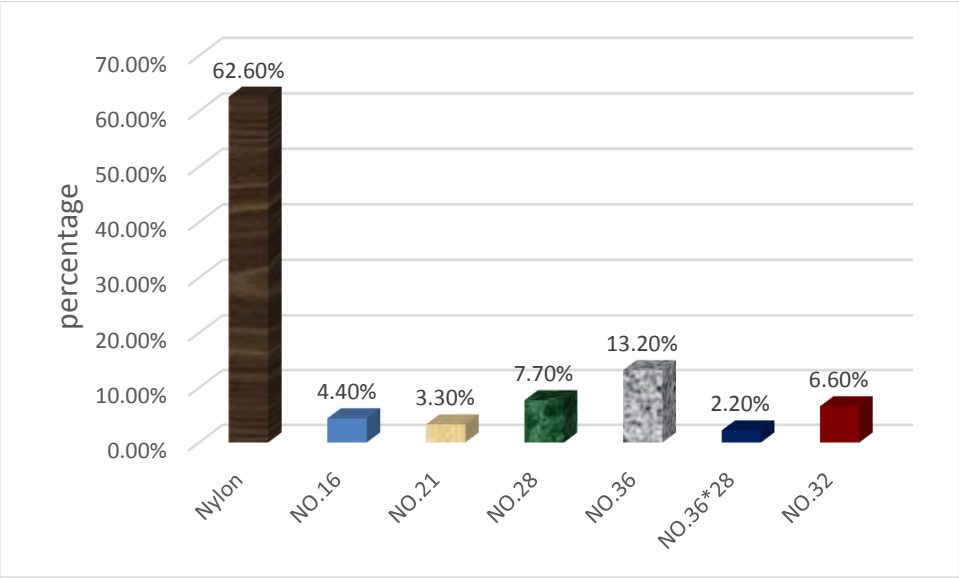

Figure 19: Shows information about filament no in the lifted ghost net.

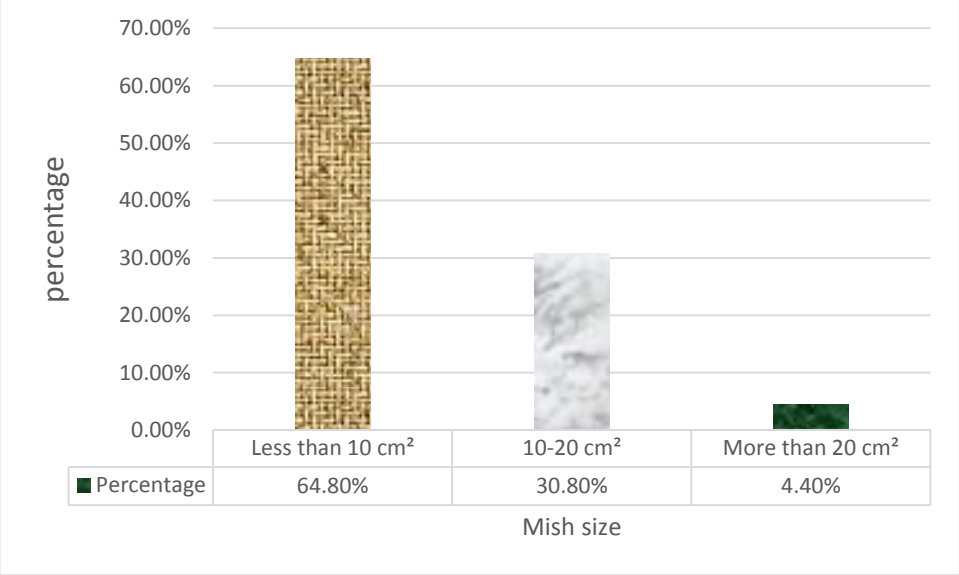

Figure 20: Illustrate information about mish size in the lifted ghost net.

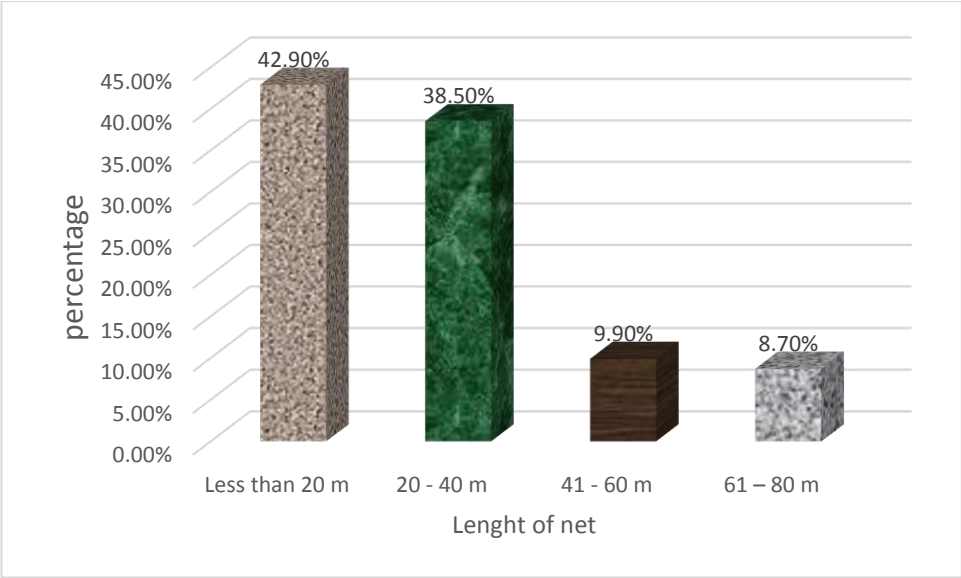

Figure 21: Illustrate information about lifted ghost net lengths.

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While lifted fishing line comprised 21.5% (25 lifted lines) of the total fishing gears observed during the survey at Wad Alagaly site, and there is no lifted line founded at Jebel Aulia site. There is no organisms founded or caught by the lines this is because all line Found as tangled lines, we just founded parts of fish's skin witch indicate that the hooks cause injuries for fish that cross the line's area

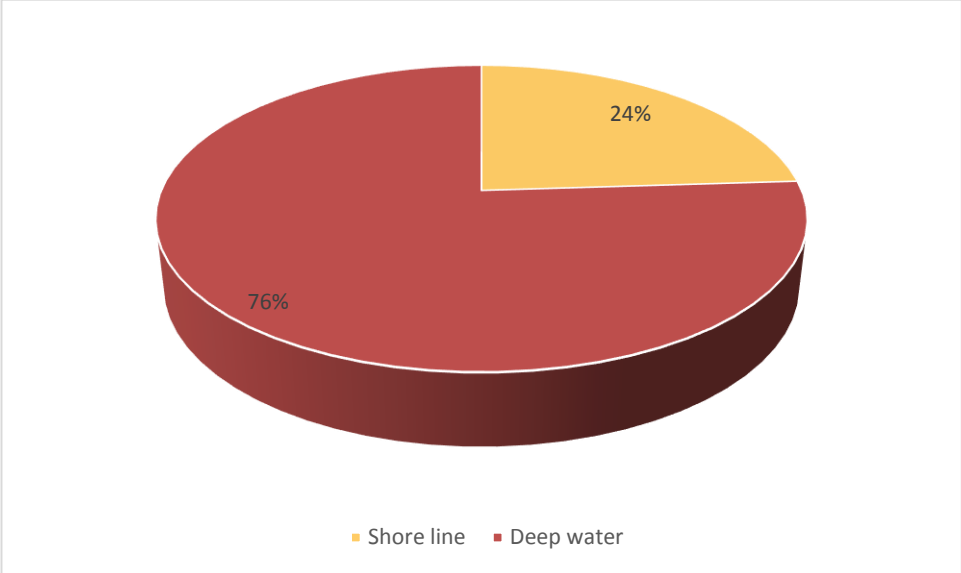

Figure 22: Illustrate information about the location where lifted ghost line found.

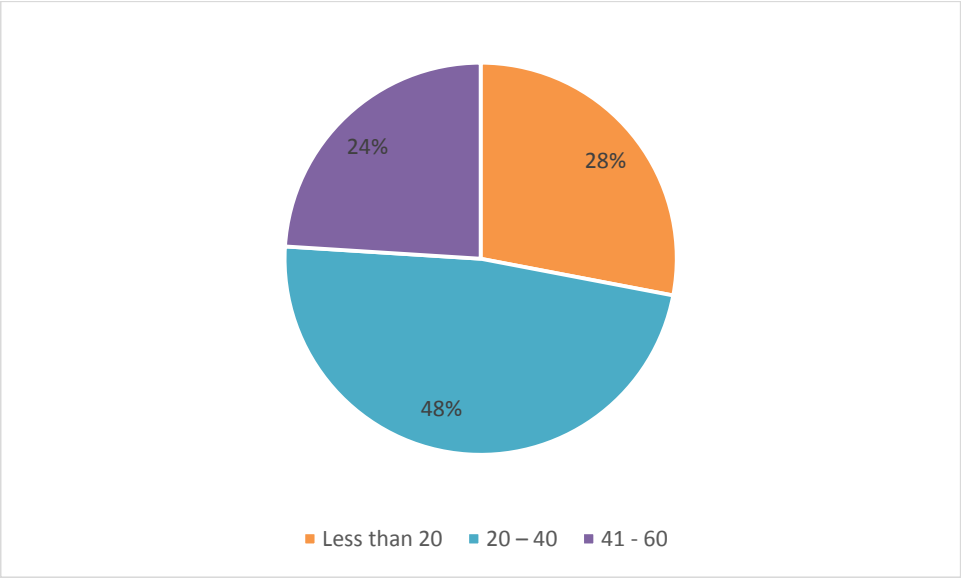

Figure 23: Illustrate information about the number of hooks in lifted ghost line found.

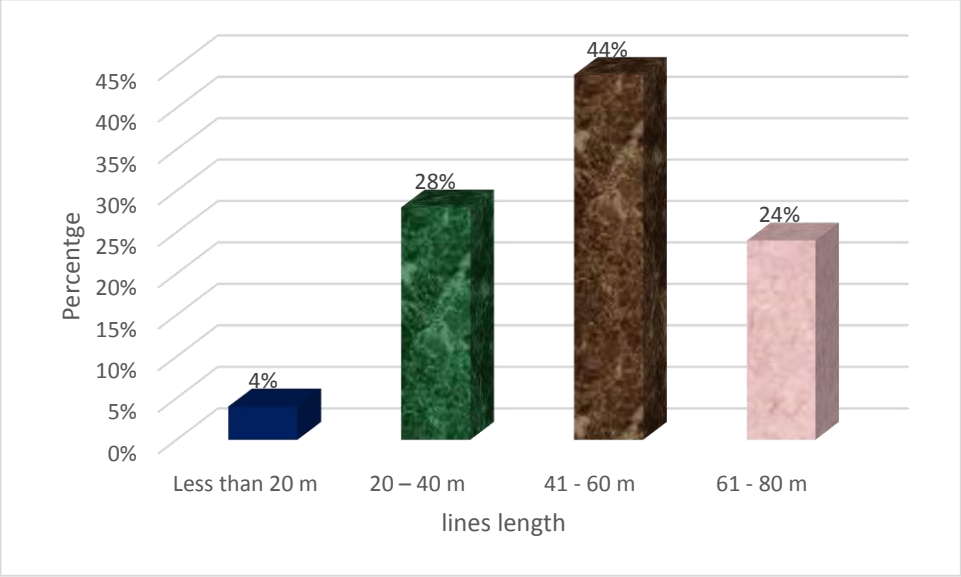

Figure24: Illustrate information about lifted ghost line length.

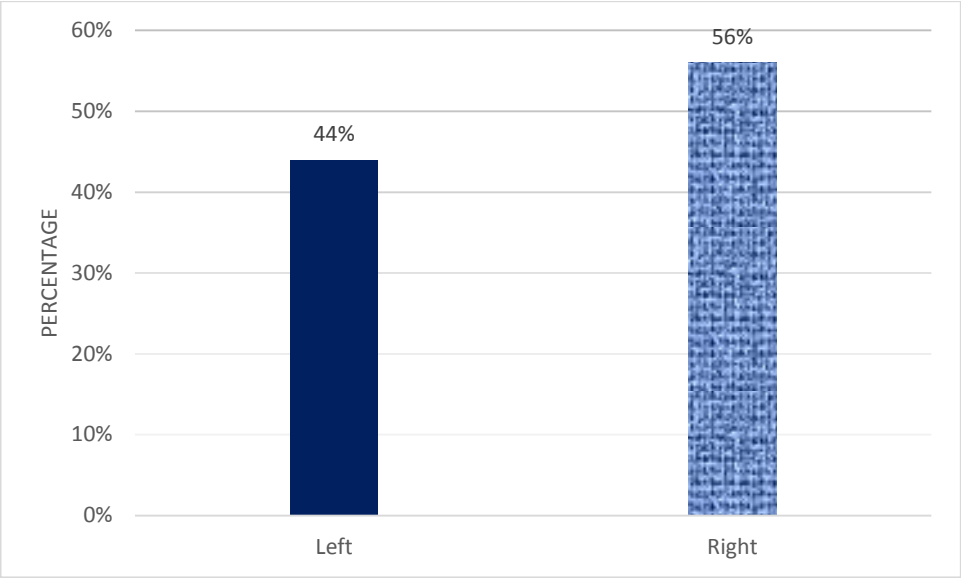

Figure 25: Illustrate information about where robe twisted to in lifted ghost line.

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Figure 26: Shows information about the level of hooks in lifted ghost line.

The number of lifted nets witch were caught fish was 32 net 35.2% of the lifted net (total number of lifted net was 91 net) all of caught fish are commercial type.

All Fish were founded entangled life , the fish species were *: Tilapia , Synodontis spp ,Tetraodon fahaka , Lates niloticus ,Barbus bynni , Auchenog occidentalis , Labeo spp , Hydrocyon , Mormyrus niloticus , Hyperopisus bebe , Bagrus Bagrus , Clarias spp , Bagrus docma , Alests , labeo* , River shells , *Brachyura.*

The means length of net which caught fish is 27.8 m, the means of number of caught fish by one net is 13 fish / net ,71% of caught fish entangled by net with mish size

less than 10 cm ,18.75 % of caught fish entangled by net with mish size 10-20 cm and 10.25 % of caught fish entangled by net with mish size more than 20 cm.

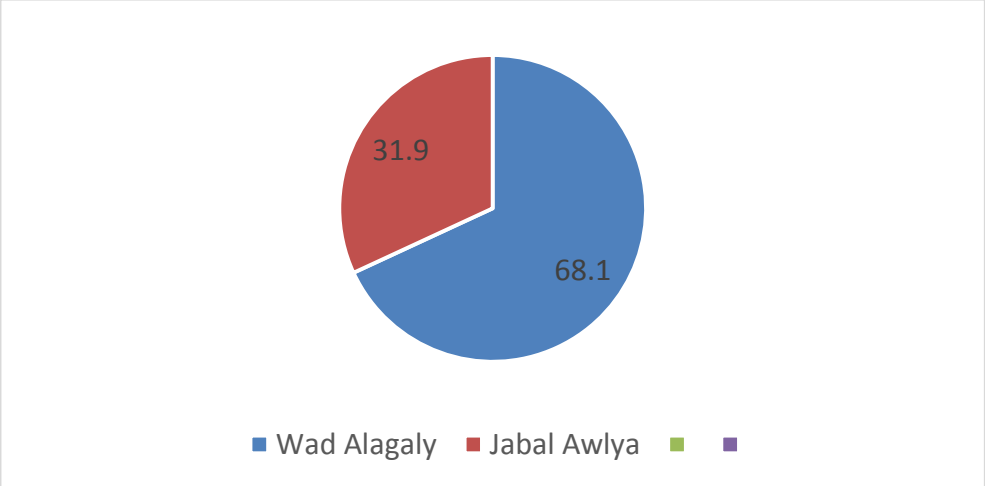

Figure 27 : Illustrates information about percentages of lifted gears in both sites

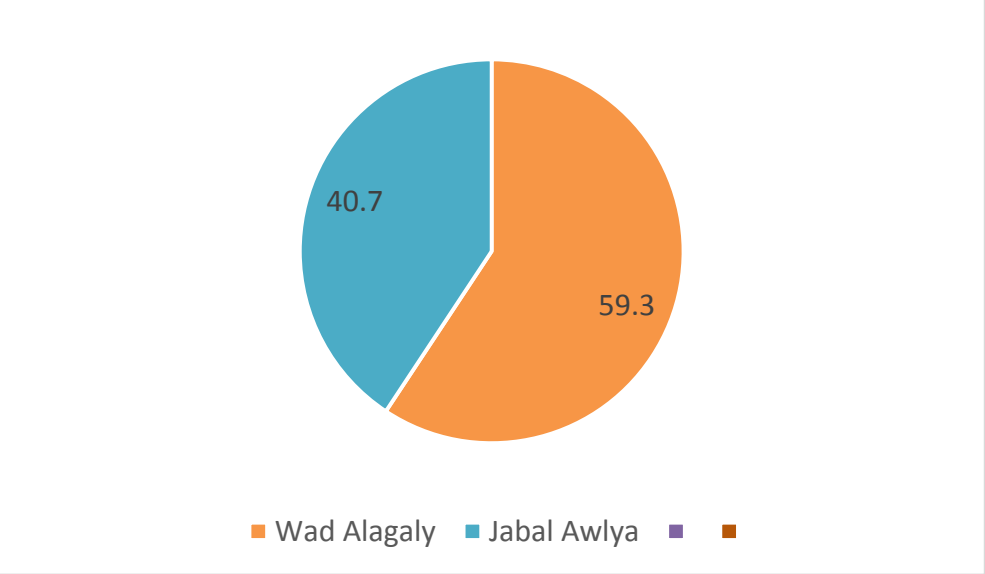

Figure 28: Shows information about percentages of lifted nets in both sites

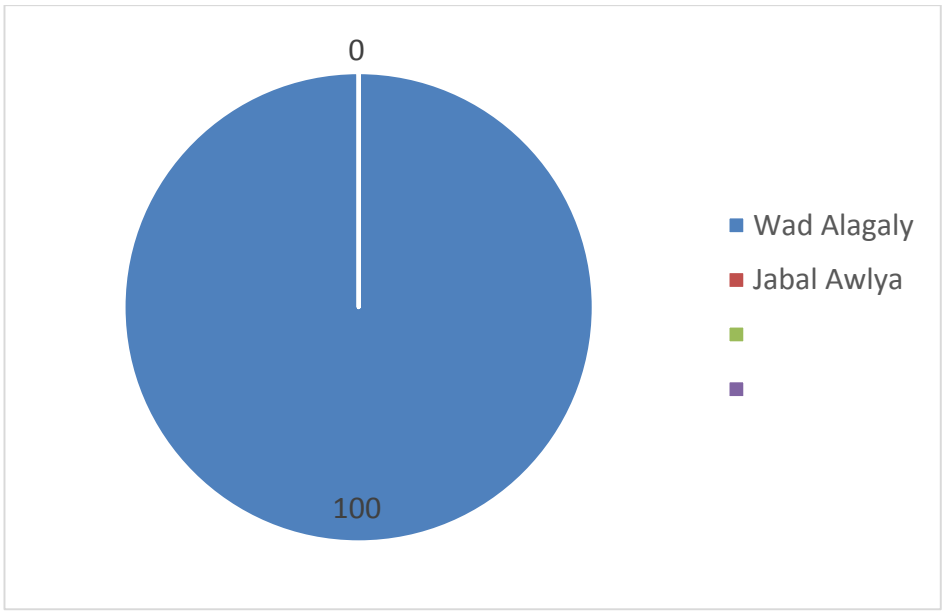

Figure 29: Illustrates information about percentages of lifted lines in both sites

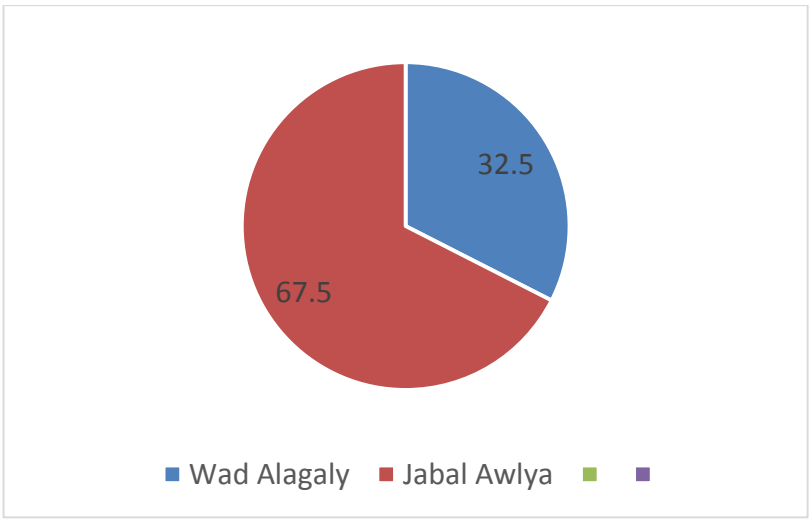

Figure 30: Illustrates information about percentages of caught fish in both sites

Site / Numbers	At both site	At Wad Alagaly	At Jebel Aulia
survived area	2010 m²	1100 m²	910 m²
Number of gears	116	79 (68.1%)	37(31.9%)
Number of nets	91	54 (59.3%)	37(40.7%)
Number of lines	25	25	0
Number of net caught fish	32	12 (37.5%)	20 (62.5%)
Number of caught fish	419	136 (32.5%)	283(67.5%)

Table 4: shows the characteristic of lifted gears at both sites

CHAPTER FIVE

5. DISCUSION

A total of 82.5 % of the gears were illegal fishing gears (231 gears); while only 17.5% are legal fishing gears (49 gears) , it is agree with the (Agnew etal, 2009) he said that the recent estimates of IUU extent by country and region have revealed substantial IUU worldwide between 13% and 31% of reported catches, and over 50% in some regions. From the interview we found that all the fishermen in the study sample were fish for income (100% of the fishermen), it is disagree with Christopher M. and others (2015) who reported that herding families fish primarily for food. Only one family sells fish when the rare opportunity arises. All the Fishermen agree on that the fish less in abundant than they used to be this is the same with Christopher M. and others (2015) Grayling spring spawning migrations are shorter and less intense. Lenok and burbot have become especially rare. Most of the Fishermen agree on that the fish become smaller than they used to be 96% while 4% of them said that the fish remained the same size.it is agree with Christopher M. and others (2015).

Nearly all of the interviewed fishermen stated that fish population sizes have decreased dramatically. 54% of the fishermen said that to protect the fish population it is important to use legal fishing gears , while 26 % they think the protection will be done by determine fishing seasons, and , 20% said that the both are important to protect fish population it is same with Christopher M. and others (2015) few concrete ideas were provided.

A total of 116 of derelict fishing gears were collected in the 2017 survey, lifted fishing net comprised 78.5% (91 lifted net) of the total fishing gears observed during the survey at Wad Alagaly and Jebel Aulia sites , it is coincides with Laura

Ballesteros and others (2018) who said that nets formed the dominant type of lost gear, followed by ropes, lines and cages, respectively. Also agree with a recent study from the 'Great Pacific Garbage Patch plastic accumulation zone in the North Pacific Ocean determined that abandoned, lost or discarded fishing nets alone represent 46% of the 79,000 tons of plastic observed within the 1.6 million km2 region surveyed (Massey, 2008) and it is disagree with (de Oliveira etal, 2013) in the state of Rio Grande do Sul said Among the plastic items found, 21% were related to fishing activities, of which lines were the most frequent type of gear, accounting for 11% of this total . Most of lifted fishing nets were found on the deep water 63.7%, while 18.7% were found on the shoreline and 17.6% founded on the small island its agree with Brown and Macfadyen (2007), they report that some fisheries operating in deep water appear to be a particular cause for concern because of a greater rate of net loss and a persistence to ghost fish also accord with Jéssica Link elal (2018) who reported that most recorded items were nets, ropes and fishing lines found on beaches, submerged in coastal areas and in oceanic islands and it is dissenting with Ballesteros (2018) who found that a majority were found on offshore pinnacles, where gear was recorded down to relatively greater depths: 27m at site 1 (Chumpon Pinnacle) and 23m at site 5 (Southwest Pinnacle),also it is at odds with Cefas (2006) who reported that gillnets were found in all strata and areas and were particularly abundant in the upper slope stratum southwest of Porcupine.

87.9% of lifted fishing nets were found on muddy bed., while 6.6% were found on rocky bed and 5.5% were found on sandy bed it is disagree with Angiolillo and others (2015) who they reported that the survey campaigns generally detected a larger number of fishing nets and gears abandoned in the rocky outcrops.

All lifted fishing nets were floating water column it is discordant with Bellebaum and others (2013) who they found that the static gear loss as a problem in the Baltic Sea is most notable in the bottom gillnet fishing fleet fishing in the open sea area well off the coast. Most of lifted fishing nets were found as part net 89%, while 11% were found as whole net it is accord with Ballesteros and others (2018) he reported that the size of the gear was predominantly small. Most of lifted fishing net were found with (head line) floating line 80.2% , 56% of lifted fishing nets were founded with lead line it is almost agree with Cefas (2006) gillnet fragments recovered included small parts of net a few square meters in area, short lengths of headline or lead line with some netting attached, or occasionally both headline and lead line with netting attached also it is harmonizes with Balasubramanian etal (2011) who were reported that some nets had pieces of rope attached . Most of lifted fishing net were nylon 62.6%, 13.2% with filament no 36, 24.2% with different filament numbers. It is agree with (Fortuna etal., 2012) he founded that the collected Abandoned, Lost or otherwise Discarded Fishing Gear (ALDFG) were composed of 60% synthetic polyamide monofilament polymers for gillnets, long lines, and rod and pole fishing.

Most of lifted fishing net founded with mesh size (stretched mesh) less than 10 cm 64.8%, while 30.8% founded with 10 -20 cm mish size and 4.4% founded with more than 20 cm mish size, it is the same with Balasubramanian etal (2011) who found that the stretch mesh size among all nets varied from 0.5 cm to 14.5 cm and it discordant with Santos etal (2012) who found all nets were multifilament, with meshes of 17–22 cm (stretched mesh) and it is dissenting with Cefas (2006) who they found that most of these (630) from the total 648 gillnet panels were recovered

from three fleets retrieved, two of which were classified as anglerfish nets (mesh size 280 mm) recovered in 400 –800 m from the Rock area.

42.9% of lifted fishing net with length less than 20 m, 38.5% with length 20 - 40 m and 18.6% with length more than 40 m it is nearly agree with Cefas (2006) some 648 gillnet panels were recovered, with an estimated total length of 35 –40 km.

Lifted fishing line comprised 21.5% (25 lifted lines) of the total fishing gears observed during the survey at Wad Alagaly site, and there is no lifted line founded at Jebel Aulia site. It is accord with Ballesteros etal (2018) who found that altogether, 143 pieces of derelict fishing gear were observed: 107nets (one of which was not accessible for measurements); 13 ropes; two cages, and 21 nylon lines.

there is no organisms founded or caught by the lines this was because all lines found as tangled lines, we just founded parts of fish's skin witch indicate that the hooks cause injuries for fish that cross the line's area

Most of lifted lines founded in the deep water 79.2% while 20.8 % founded in shoreline it is dissenting with Cefas (2006) who they reported that The greatest density of gear observed was for long lines in the upper slope stratum at southwest Porcupine. 45.8% of lines were founded with 20 – 40 hooks , while 29.2% were founded with less than 20 hooks and 25% were founded with 41- 60 hooks it is agree with Stopha 2017 who they found over 178,000 pieces of fishing line and more than 42,000 hooks and it is accord with Cefas (2006) who they reported that Most (exact number not recorded) long lines retrieved had hooks, but occasionally hooks were absent, suggesting that they had been stripped and discarded long lines were also relatively abundant in the deep stratum at west Porcupine .

The lifted fishing gears has affect the water life by continue catching it coincides with (NOAA Marine Debris Program, 2015) who said When fishing gear is lost,

abandoned or discarded in the marine environment, it can continue to ensnare and capture marine wildlife, earning the moniker ‘ghost gear and it is the same with (Gall *etal*., 2015) who reported that Marine wildlife are particularly at risk for ingestion of, or entanglement in, fishing gear, which can lead to injury and death. The number of lifted nets witch were caught fish was 32 net 35.2% of the lifted net (total number of lifted net was 91 net) all of caught fish are commercial it is at odds with Cefas (2006) who they reported that the total ghost catch of fish was 11 ton , of which 62% (5.5 t) was considered unfit for human consumption.

The number of lifted nets witch were caught fish was 32 net , which caught about 419 fish and crustaceans it is agree with (Richardson etal., 2019) who founded 870 ‘ghost nets’ recovered in the coastal waters of Washington, USA contained more than 32,000 individual marine animals, including more than 500 birds and 23 mammals

All entangled Fish were founded a live, it is not same with (Possatto etal, 2011) There was also a record of ghost fishing gears fish was caught still alive in the estuary, trapped in a fragment of nylon monofilament net. the fish species were Tilapia , *Synodontis* ,*Tetraodon fahaka* , *Lates niloticus* ,*Barbus bynni* , *Auchenog occidentalis* , *Labeo sp* , *Hydrocyon* , *Mormyrus niloticus* , *Hyperopisus bebe* , *Bagrus Bagrus* , *Clarias* , *Bagrus docma* , *Alests* , *labeo* , River shells , *Brachyura*. It is the same with (Adelir-Alves 2013) the ghost nets found presented 32 entangled individuals belonging to 12 species (eight teleosts and four crustaceans).

The means of number of caught fish by one net is 13 fish / net it discordant with Philip etal (2006) who said that Ghost catches were found at the time of retrieval in five of the12 gillnet fragments retrieved, but almost all were small numbers (,25 specimens per fragment, but one large catch of 2600 specimens).

71% of caught fish entangled by net with mish size less than 10 cm, 18.75 % of caught fish entangled by net with mish size 10-20 cm and 10.25 % of caught fish entangled by net with mish size more than 20 cm it is at odds with Cefas (2006) who found third fleet (8 km long) was taken at Porcupine Bank at a depth of 800 – 1300 m, and this was classified as a shark net. The average mesh size of this net was 155 mm, considerably smaller than the 220-mm legal minimum mesh size required at that time in the shark fishery (Large etal, 2009).

CHAPTER SIX

6. CONCLUSION AND RECOMMENDATIONS

6.1 CONCLUSION

The illegal fishing gears were widely used by fishermen 82.5 % and this lead to that fish become smaller and less in abundant than they used to be. Ghost fishing net comprised 78.5% observed during the survey at the Wad Alagaly and Jebel Aulia sites while lifted fishing line comprised 21.5% of the total fishing gears observed during the survey at Wad Alagaly site and the effect of ghost gears is relay in the gears continue catching or causing injuries.

6.2 RECOMMENDATIONS

- To make survey to cover all Khartoum state especially at fishermen camps
- To make further studies in the environmental effects of ghost gears further of its effects in fish species.
- The study recommends that to authorize to collect the ghost gears from the water body and around it.

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8. Appendices

Fishermen interview questionnaire.

Personal fishing habits

1. Where do you fish?
2. Do you fish for recreation, food, or money?
3. How many legal fishing net do you own??
4. How many illegal net do you own?
5. How many illegal line do you own?
6. How many illegal rod do you own?
7. What type of gear do the other Fishermen use?

Questions about Fishermen's Union?

8. Are you a member of the Fishermen's Union or Association?
9. Does the Union have a role in implementing the law?

Fishermen habits questions

10. What do you do by your old gears?
11. Do you see or found lifted gears in water?

Fish population questions

12. Are fish more or less abundant than they used to be?
13. Are fish larger or smaller than they used to be?
14. What do you think should be done to protect the fish population?

Appendix 1: Format of questions used to interview Fishermen.

Question	Responses (out of 50 respondents)	Response notes
1. Where do you fish?	no response (0) Jebel Aulia 20 Wad Alagaly 17 Almorada 13	Fishermen in Khartoum state mostly fish at Jebel Aulia 40% And the more often fish at Wad Alagaly 34% and only 26% fishing at Almorada.
2. Do you fish for recreation, food, or income?	no response (0) food (0) income (50) recreation (0)	All the fishermen fish for income 100%
3. How many legal net do you own?	no response (0) did not had legal net (18) have got only one legal net (18) have got tow legal net (11) have got three legal net (3)	28% of the fishermen have got more than 2 legal net ,36% of fishermen they own only one legal net ,36% of them did not have legal net
4. How many illegal net do you own?	no response (0) did not had illegal net (8) have got only one illegal net (4) have got tow illegal net (33) have got three illegal net (5)	Most of the fishermen have own more than one illegal net 76%, 8% own one illegal net and 16% did not have illegal net

5. How many illegal line do you own?	no response (0) did not had illegal line (32) have got only one illegal line (1) have got 2 illegal line (15) have more than 5 illegal line (2)	64% of fishermen does not use line ,36% of them used illegal line
6. How many illegal rod do you own?	no response (0) did not had rod (35) have got one illegal rod (7) have got tow illegal rod (8)	70% of the Fishermen did not own rod, 30% of them used illegal rods.
7. Are you a member of the Fishermen's Union or Association?	no response (0) yes (50) no (0)	All the fishermen have membership in union
8. Does the Union have a role in implementing the law?	no response (0) yes (2) no (48)	96% Saied that the Union do not have a role in implementing the law
9. What do you do by your old gears?	no response (0) Leave in the water (11) Leave at the beach (23 Disposal it away from river (16)	46.0 % leave the old gears on the beach , while 22% leave it on the river and just 32% Disposal it away from river.

10. Do you see or found lifted gears in water?	no response (0) yes (45) no (5)	90% of the Fishermen noted the old gears on the river while 10% of them did not see any lifted gears on the water.
11. Are fish more or less abundant than they used to be?	no response (0) more (0) less (50)	All the Fishermen agree on that the fish less in abundant than they used to be.
12. Are fish larger or smaller than they used to be?	no response (0) larger (0) smaller (48) remained the same (2)	Most of the Fishermen agree on that the fish become smaller than they used to be 96% while 4% of them said that the fish remained the same size.
13. What do you think should be done to protect the fish population?	No response (0) Determine fishing seasons (13) Use of legal fishing gears (27) All (10)	54% of them said that to protect the fish population it is important to use legal fishing gears , while 26 % they think the protection will done by Determine fishing seasons, and , 20% said that the both are important to protect fish population

Appendix 4: Shows the response of the Fishermen which appeared in figures 1 to 4

Questions	**Answers**	**Frequency**	**Percentage**	**Note**
1. Area	Shore line	6	24	Most of lifted lines founded in the deep water 79.2% while 20.8 % founded in shoreline.
	Deep water	19	76	
2. Numbers of hooks	Less than 20	7	29.2	45.8% of lines were founded with 20 – 40 hooks , while
	20 – 40	11	45.8	

	41 - 60	6	25	29.2% were founded with less than 20 hooks and 25% were founded with 41- 60 hooks
3. Lines length	Less than 20 m	1	4	44% of lifted fishing line with length 41 - 60 m, 28% with length 20 - 40 m , 24% with length 61 – 80 m and 4% with length Less than 20 m,.
	20 – 40 m	7	28	
	41 - 60 m	11	44	
	61 - 80 m	6	24	
4. Robe twisted to	Left	11	44	58.3% of lifted lines with robe twisted to right and 41.7% with robe twisted to left
	Right	14	56	
5. Level of hooks	In the same level	14	56	58.3% of lifted line were had hooks in the same level and 41.7% had hooks in different levels
	In different levels	11	44	

Appendix 5: Shows the characteristic of lifted line which appeared in figures 22 to 26.

Appendix 6: The picture shows the operation of collection of ghost net

Appendix 7: The picture shows the operation of collection of ghost net

Appendix 8: The picture shows the operation of collection of ghost net which couth life organisms.

Appendix 9: The picture shows the operation of collected of ghost net which couth life organisms

Appendix 10: The picture shows the operation of collected of ghost net which couth life organisms

Appendix 11: The picture shows the operation of collected of ghost net which couth life organisms

Appendix 12: The picture shows the operation of collected of ghost net which couth life organisms

Appendix 13: The picture shows the operation of collected of ghost net which couth life organisms

Appendix 14: The picture shows the operation of collected of ghost net which couth life organisms