Quantifying Sea Turtle Bycatch in Coastal Cambodia: An Analysis of Threats and Potential Conservation Interventions

A report by Fauna & Flora International

Based on Data Collected during 2016-2018

Kim Sour, Vong Rylida, Kieran Murray, and Marianne Teoh

2019

TABLE OF CONTENTS

List of Tables

List of Figures

List of Acronyms

CMCP	Coastal and Marine Conservation Programme of FFI
FAO	Food and Agriculture Organization
FFI	Fauna & Flora International
FiA	Fisheries Administration
MAFF	Ministry of Agriculture, Forestry and Fisheries
MoU	Memorandum of Understanding
NOAA	National Oceanographic and Atmospheric Administration
TED	Turtle Excluder Device
USFWS	United States Fish and Wildlife Service

Acknowledgements

These sea turtle bycatch surveys were developed and conducted by Fauna & Fauna International (FFI) from 2016 – 2018, alongside San Satya, a masters scholarship student from the Centre of Biodiversity Conservation at Royal University of Phnom Penh in 2016. The assistance from Sobuoy Lay, Sophat Teom, and Sovannareach Long was invaluable, and the willing participation of fishers from across Cambodia's coastline made this study possible. The survey and this report could not have been completed without support from the U.S. Fish and Wildlife Service (USFWS) and the guidance of Manjula Tiwari from the U.S National Oceanographic and Atmospheric Administration (NOAA). Photographs on the cover page of this document are attributed to Rylida Vong from FFI. In addition, FFI would like to thank Mr Ouk Vibol and Cambodia's Fisheries Administration (FiA) for their leadership, support and long-term partnership for the conservation of sea turtles across Cambodia.

Recommended citation:

Kim Sour, Vong Rylida, Kieran Murray, and Marianne Teoh (2019) Quantifying Sea Turtle Bycatch in Coastal Cambodia: An Analysis of Threats and Potential Conservation Interventions. Fauna and Flora International. Phnom Penh, Cambodia.

Executive Summary

Coastal-wide sea turtle bycatch surveys were conducted through interviews local fishers and communities at landing sites and fishing villages across the four coastal provinces of Cambodia.

Around half of fishers interviewed were unaware that killing turtles or catching a turtle accidently is illegal under Cambodian law. Sea turtle bycatch was found across the coastline, and bycatch hotspots were identified as Thmor Reang, Keo Phos, Koh Ses, Koh Sdach, Thmor Sor and Koh Kras. Direct targeting of sea turtles still occurs but is now extremely rare

Three main fishing gears were found to have a significant impact on sea turtles, namely; push nets, ray hooks, and trawling nets. Green and hawksbill turtles were mostly encountered as bycatch, and all turtle species known in Cambodia appear to be threatened by bycatch.

Proportionally, more fishers in Kep and Kampot regularly see turtles in comparison to other provinces, and they are the people who know the locations of the turtles well. Koh Tbal was the most commonly cited location of consistent turtle sightings. Three bycatch hotspots were noted within the Kampong Som Bay. Thmor Reang and Keo Phos, two neighbouring sites near a seagrass and mangrove area, had 23 reported bycatch incidents between them.

Reported actions of respondents towards sea turtles were shown to be a mixture of positive (52%) and negative or opportunistic (48%). Fisher interviews showed that there is a perceived reduction in the number of sea turtles over the last 10 years as well as declines in sea turtle bycatch.

Only 48% respondents noted that sea turtles are important, with the most common reason being the rarity of the species. Possession of traditions and beliefs towards sea turtles was found but was not universal, with only 28% saying they followed or knew of any such systems. A small number of respondents believed that catching a turtle brought bad luck.

Based on the findings above, the following general recommendations were proposed for reducing sea turtle bycatch:

- Greater enforcement of the Fisheries Law to reduce destructive fishing practices and gears associated with bycatch, as well as the Endangered Species Sub-decree to control sea turtle meat consumption and trading is also necessary.

- Focusing the regulation and monitoring of fishing activity near turtle sighting and bycatch hotspots, and key habitat areas.
- Implement fishing gear modification or replacement in order to reduce sea turtle bycatch by high risk gears.
- Conduct long-term monitoring of wider threats to sea turtles such as coastal development and plastic pollution.
- Increase fisher awareness raising of national laws protecting turtles, the importance of sea turtles to the environment, and bycatch mitigation approaches.

I. Introduction

The fisheries sector in Cambodia is vital in terms of food security and employment, providing approximately 80% of animal protein for Cambodia's population and representing 8-12% of the country's GDP (FiA, 2011). Despite its relatively small scale compared with inland fisheries, marine fisheries represent around 20% of the total fisheries production and are a vital source of income for people living in all coastal provinces of Cambodia (MAFF, 2016). Cambodia's coastal resources also support a wealth of biodiversity including globally threatened species such as sea turtles.

Sea turtles are a globally endangered group of large marine reptiles. Despite the critical role of sea turtles within coastal ecosystems (Ing, 1999), there is a paucity of standardized information on sea turtles in Cambodia, and sighting or reports are mostly anecdotal. It was reported that five species of sea turtles could be found along Cambodia's coastline regularly prior to 1979. These species included: 1) green (*Chelonia mydas*), 2) hawksbill (*Eretmochelys imbricata*), 3) olive ridley (*Lepidochelys olivacea*), 4) loggerhead (*Caretta caretta*), and 5) leatherback (*Dermochelys coriacea*) (Ing, 1999).

In 2010, Fauna & Flora International (FFI) and partners conducted surveys to document the status of sea turtles in Cambodia, collecting data from sixty-six fishers living in the coastal provinces. Sightings of all five species were still reported from Cambodia's coastline, but sightings of olive ridleys, loggerheads, and leatherbacks were thought to have decreased. Among the sixty-six fishers, 72% had reported sightings of green turtles, 74% hawksbill, 3% olive ridleys, 1% loggerheads, and 1% leatherbacks in the previous 5 years (FFI 2011). In 2015, participants of a provincial survey mapped sea turtle sightings that they had observed over past 10-year period. One hundred and twenty participants from all the coastal provinces of Cambodia reported 233 sea turtle sighting events in water, but not nesting (McNamara *et al.* 2016). Community perceptions indicated that hawksbill and green turtle populations are likely to have declined over the past 10 years (Figure 1) (McNamara *et al.* 2016).

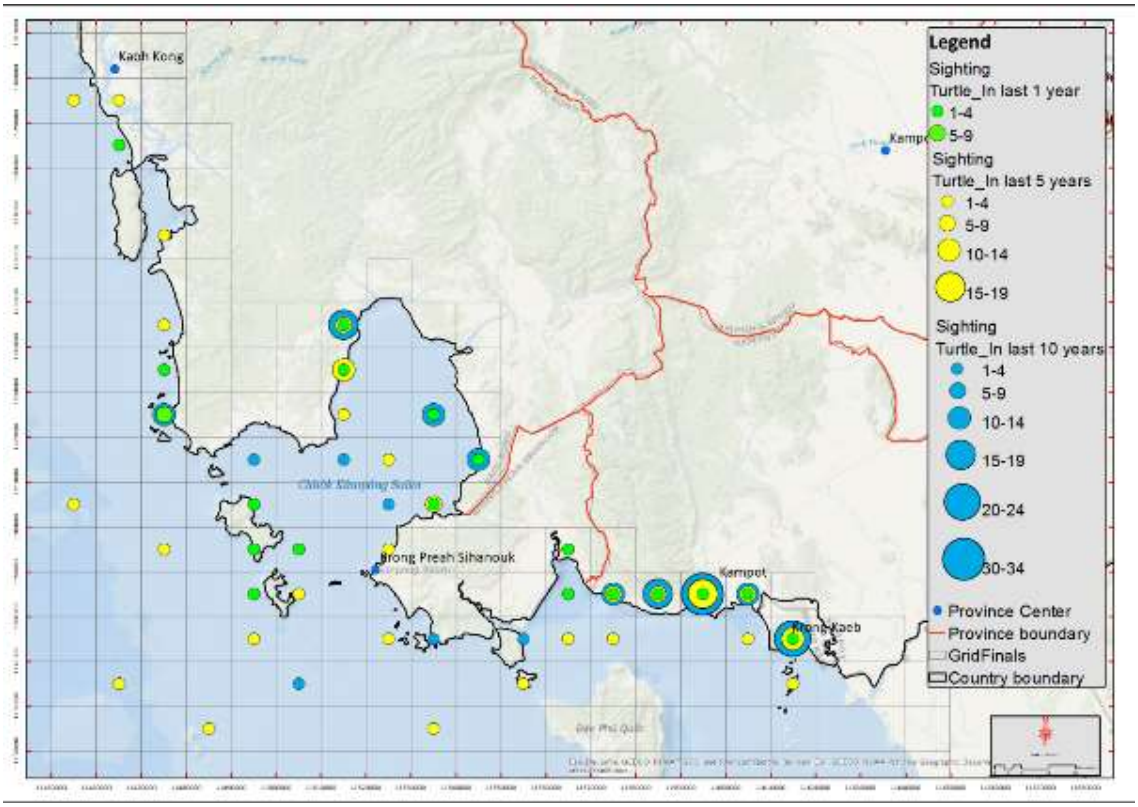


Figure 1. Sea turtle sightings over last year, five years and ten years from community consultation, by location (McNamara et al 2016)

Among these five species of sea turtles, green and hawksbill turtles (the most commonly sighted in Cambodia) are listed as *Endangered* (Seminoff, 2004) and *Critically Endangered* (Mortimer & Donnelly, 2008) on the IUCN Red List of Endangered Species, respectively. Sea turtles are also listed on Appendix I on CITES, which bans all international trade in these animals, and are also strictly protected under Cambodian law. Under the Law on Fisheries (Article 23 and 92), 2006, catching, selling, buying, transporting, collecting, processing and stocking turtles or their products within Cambodia is illegal. They were also listed as endangered species in Cambodia's Sub-decree No.123 on the 23rd of August 2009, putting them under additional protection. Through a collaboration between FFI and FiA (within the MAFF), the first Cambodia National Sea Turtle Action Plan was approved by the Director of General of FiA in October 2017. According to the Action Plan, key threats that have resulted in a decline in sea turtle sighting events include habitat degradation, coastal development, pollution, destructive fishing practices and associated bycatch. Despite being protected, opportunistic harvesting of eggs was acknowledged, in addition to consumption of meat from bycaught turtles (Vong, Teoh, & West, 2018). The increasing influence of anthropogenic

climate change adds more challenges to survival rates of sea turtles both regionally and globally (Mizrahi, West, & Ouk, 2017; FiA, 2017).

Sea turtles have been continually sighted in Cambodia during the past two decades, with bycatch and entanglement also reported anecdotally and inconsistently (Diamond, Blanco, and Duncan, 2012; Stuart, An & van Dijk, 2002; McNamara et al. 2016). Ongoing collation of turtle sighting reports indicate no more than around two dozen encounters annually, indicating sea turtles are rare (FFI, unpublished data). Some of these turtles were not safely released, and there is the potential for opportunistic meat harvesting to occur, although this has not yet been confirmed as an issue in Cambodia. Bycatch has not been reported properly, and so far there have been few studies evaluating this issue. Since sea turtles are classified as endangered species, their bycatch should be reduced as much as possible to support effective conservation. To achieve this, it is imperative that threats and the frequency of bycatch incidents are well understood. The Coastal and Marine Conservation Programme (CMCP) of FFI, with support from USFWS, have conducted a survey across coastal provinces in Cambodia in order to understand the sea turtle bycatch situation in Cambodia.

II. Research Objectives

This research aims to quantify and assess the drivers of sea turtle bycatch in Cambodia, with the ultimate goal of informing conservation interventions and fisheries management to reduce the frequency and mortality of sea turtle bycatch. To understand and quantify sea turtle bycatch, the following objectives need to be achieved:

1. Identify fishing gear that frequently result in sea turtle bycatch
2. Identify the species of sea turtles that are most frequently caught
3. Identify hotspots of sea turtle bycatch and sightings
4. Estimate the frequency of sea turtle bycatch and assess perceived trends in bycatch rates over time.
5. Understand the attitude of fishers towards sea turtle bycatch.
6. Determine if any targeted catch is occurring

III. Methodology

3.1 Site and Sample Selection

This survey was conducted in ports and fishing villages across the four coastal provinces in Cambodia – Kep, Kampot, Preah Sihanouk, and Koh Kong from 2016 to 2018 (Figure 2). A snowball sampling method was used to select the sites and samples for the survey, by asking interviewees to suggest additional people and sites considered appropriate for the study's purpose (Bryman, 2012). The sample site selection was made by asking government officials of FiA in each coastal province to recommend the places that are known for significant sea turtle bycatch. Additionally, fishers interviewed at fishing ports or villages were also asked to recommend fishing ports or villages where they have heard about sea turtle bycatch. Regarding sample size selection, the fishers who had experienced sea turtle bycatch were asked to refer others who may have also accidentally captured sea turtles. Totally, 221 samples were taken from 28 sites (landing sites) in the four coastal provinces. The names and locations of the survey sites (n = 28) and the number of samples from each site are shown in Appendix 1.

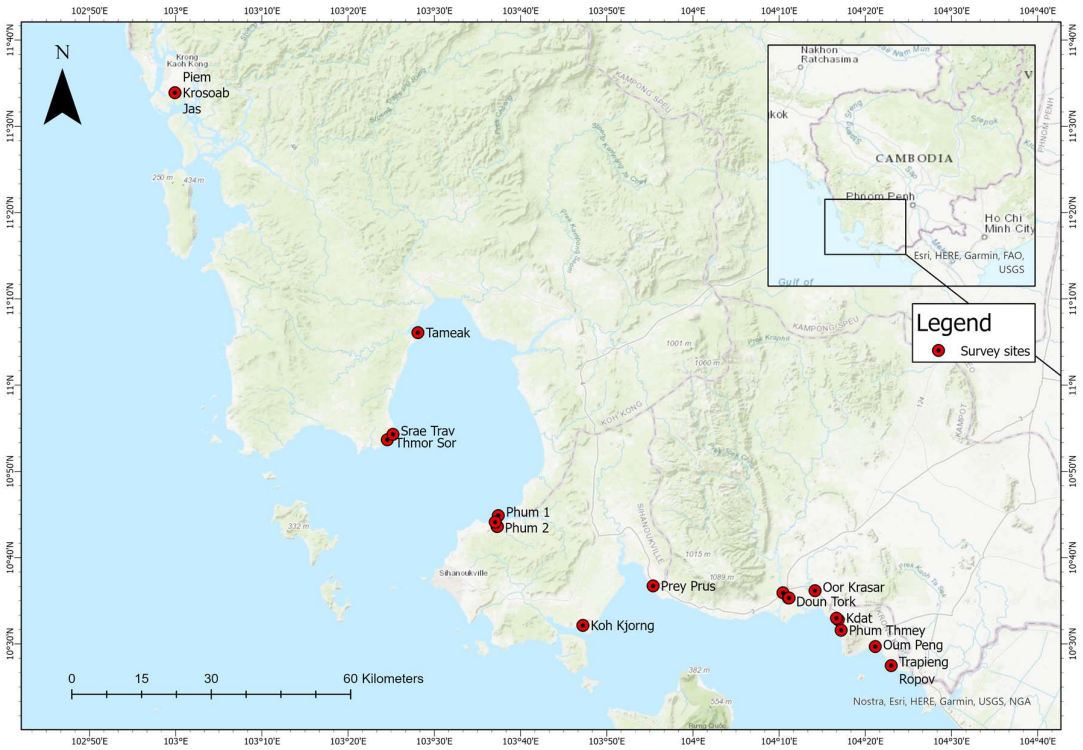


Figure 2. Locations where interviews were conducted

3.2 Data Collection and Analytical Tools

To collect the bycatch information on gear type and the number of sea turtles caught, a structured interview questionnaire modified from the Dugong MOU Standardised Catch and Bycatch Questionnaire (CMS, 2017) was used. There were three main parts to the structured interview questionnaire: 1) fishers' demographics 2) fishers' experience, i.e. fishing gear used, and fishing grounds, 3) sea turtle bycatch experience. To ensure validity of data, a set of criteria were used to evaluate the information from fishers after each interview. These criteria included how open and honest the fishers were, interest shown to answer the questions, and their certainty when answering numerical questions. See all questions used to collect the data in

Appendix 2. Due to the nature of the research objectives, frequency counts were used. Descriptive statistics in Microsoft Excel 2013 were used to analyse the data.

IV. Results and Discussion

4.1 Fishing Gear and Species of Sea Turtle Bycatch

4.1.1 Fishing Gear and Effort

There are 14 types of fishing gear used by fishers in this survey. These fishing gear include fish hooks, push nets, trawling nets, crab gillnets, shrimp gillnets, fish gillnets, crab traps, fish traps, fishing boat lights, squid traps, ray hooks, squid hooks, blood cockles' scrapers, and shrimp scrapers. Among these fishing gears, three main types of fishing gear most frequently resulted in sea turtle bycatch: (1) push nets, with 66.7% of fishers using it reporting sea turtle bycatch; (2) ray hooks with 66.1% of fishers using it reporting sea turtle bycatch; and (3) trawling nets with 45.7% of fishers using it reporting sea turtle bycatch. The other types of fishing gear that were also reported to catch sea turtles included crab gillnets (21.3%), crab traps (14.3%), and shrimp gillnets (8.55%). Figure 3 below summarizes the percentage of fishing gear causing sea turtle bycatch.

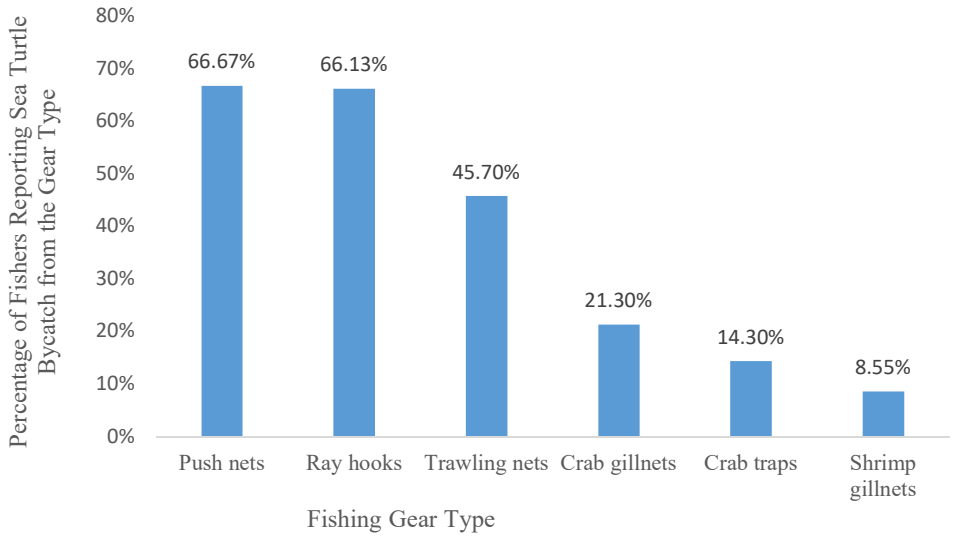


Figure 3. Percentage of fishing gears reported to result in sea turtle bycatch

According to the fishers, motorized push nets and trawling nets are classified as large-scale fishing, and these gear types are typically associated with high and indiscriminate bycatch, including sea turtles. Push nets and trawling nets are similar in terms of fishing locations and target catch, which is predominantly shrimp. Push nets are pushed along the bottom in shallow coastal waters (<20 m deep). It is pushed forward by either manpower or machine (FAOa, 2009). Trawling nets are a cone-shaped net, made from two, four or more panels. They are towed, by one or two boats, along the bottom or in midwater (pelagic) coastal waters (FAOb, 2009). Most of the time push nets and trawling nets were used in water of less than 20m depth (illegal under the Fisheries Law Articles 11 & 49) and around islands, areas that harbour vital habitats and foraging grounds for sea turtles. A study by Wallace et al. (2013) claims fishing gear anchored to the bottom of the sea (such as push nets) tended to have a greater probability of bycatch and higher mortality rates than gear set near the sea surface. Trawls are considered a major global threat to sea turtles, and consequently, they have become the focus of sea turtle bycatch reduction efforts since the 1980s, when it was recognized that the shrimp fisheries in

the Gulf of Mexico represented one of the largest causes of sea turtle mortality in the US (WWF, 2017).

Ray hooks have a special characteristic that attract sea turtles. Ray hooks are a longline fishing gear with J-hooks. Normally, the length of the line is up to 10km, and there are approximately 5000 to 6000 J-hooks on one longline. There is only 2 cm between each J-hook. They are normally used in shallow waters near islands for catching fish or rays, particularly in seagrass and mangrove areas. These areas are not only favourable for rays, but they are also favoured by sea turtles as foraging grounds, especially green turtles. Given the long line length, proximity of each J hook, and setting locations, ray hooks have become frequently associated with sea turtle bycatch. Wallace et al. (2013) also found that a large percentage of documented sea turtle bycatch around the world resulted from longlining gear.

Fishers were also asked to estimate their fishing effort per month. Only 33 of 221 fishers interviewed said they used trawling gear. The majority of those interviewed were in Preah Sihanouk and Kampot, with 17 and 10 trawlers, respectively. Most of the trawlers interviewed in Preah Sihanouk were based in Phum 1 village (11), and all trawlers in Koh Kong were in Thmor Sor commune (3), whereas trawlers were spread across different localities in Kampot and Kep. Overall, 81% of trawlers used their gear more than 20 days per month. 36% of these trawlers said they had caught turtles before. The sample size of trawlers is too small for overarching conclusions.

Various types of net gear were used by 140 of 221 fishers. As 23% of fishers used multiple net types, so all net types have been compiled (see Appendix 4 for details). Of these, 76% of fishers used nets more than 20 days per month. Only 28% of net fishers overall said they had caught turtles, with the highest proportion being in Kampot, where 52% of all fishers said they had

caught one. Most fishers in Preah Sihanouk were based in Thmor Sor (29) with 79% of these fishing more than 20 days per month, indicating a high fishing effort here. 57% of all net fishers in Kep said that they most often fished near seagrass.

Of the fishers interviewed, 98% said that fishing was their main source of income, and 77% said it was their only source of income. 63% were men and 37% were women.

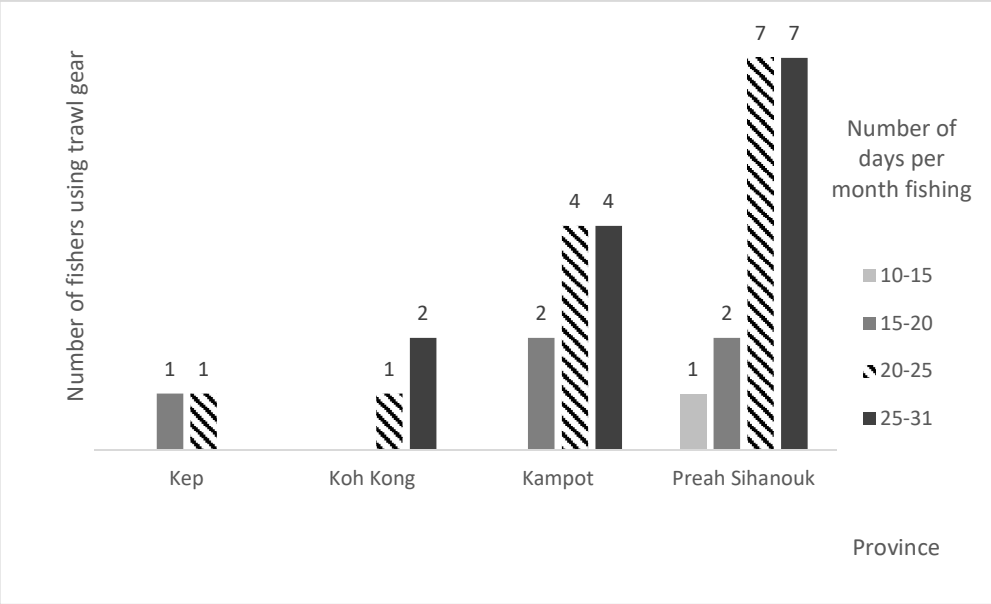


Figure 4. Average number of days fishing per month for trawl fishing gear by province

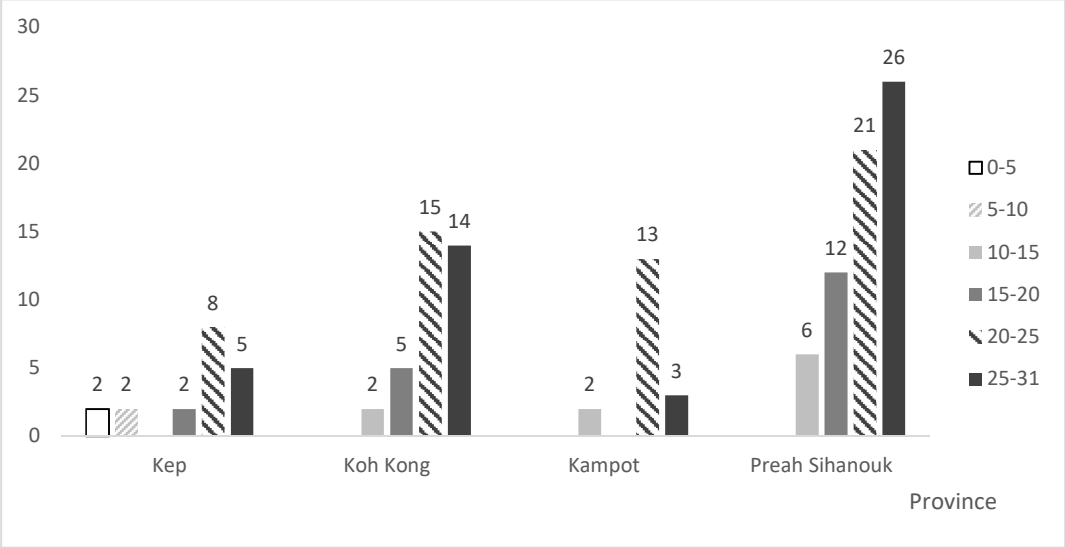


Figure 5. Average number of days fishing per month with all types of net gear by province

4.1.2 Sea Turtle Species Bycatch

The total number of sea turtle bycatch incidents reported in this survey was 244. The majority of bycatch consisted of green turtles (59.84%; n= 146) followed by hawksbills (27.46%; n= 67), olive ridleys (6.56%; n= 16), loggerheads (2.05%; n= 5), and leatherbacks (0.41%; n= 1). There were nine sea turtle bycatch incident reports where fishers did not recognize the species. Figure 6 shows the frequency of each species of sea turtle bycatch.

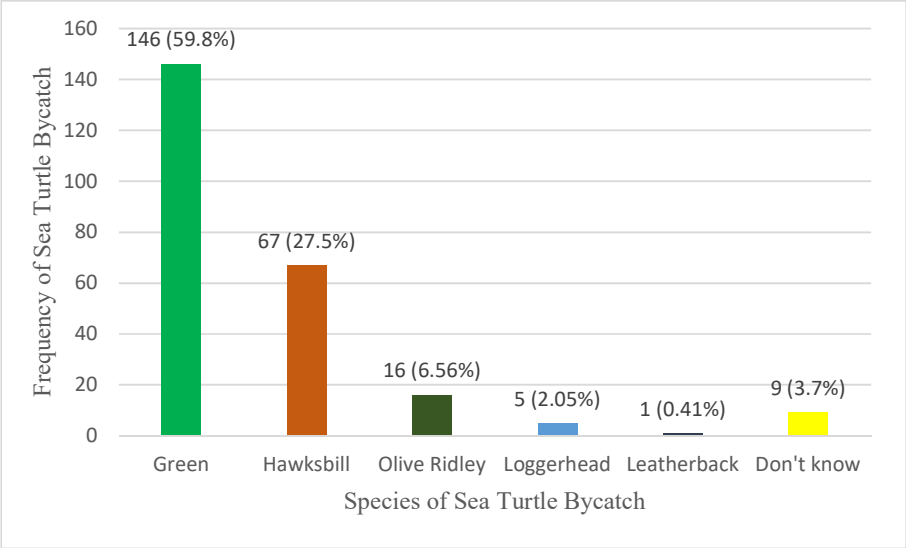


Figure 6. Frequency of each species of sea turtle reported as bycatch

These relative numbers of sea turtle species reported as bycatch corroborate findings from a provincial consultation workshop by FFI and partners in 2011. During this consultation, hawksbills and greens were reported as the most commonly sighted species, while olive ridleys, loggerheads, and leatherbacks were reported as the least commonly sighted species (FFI, 2011). Bycatch survey findings corroborates the provincial workshop in terms of the dominance of green and hawksbill species in Cambodia, which were reported as the most frequently sighted species and continue to be the most frequently landed bycatch species. The differing number of reports is likely to be reflective of the relative abundance of different species, and indicates that bycatch represents a major threat to all sea turtle species. High levels of bycatch for green and hawksbill turtles is clearly a major threat to these species, as is the lower incidence of reported bycatch incidents on the small remaining populations of leatherbacks, loggerheads and olive ridleys. Loggerheads and olive ridleys in Cambodia are only known from a handful of mostly unconfirmed reports (McNamara et al. 2016) and the only confirmed contemporary leatherback sighting in the country was in 2001 (Stuart, An & van Dijk, 2002).

Although respondents were shown a photo identification guide when asked species specific questions, it is worth noting that 63% of respondents said they did not know the difference between turtle species (Figure 7). However, in the researcher's view, 91% of respondents seemed "reasonably" or "very" comfortable with distinguishing turtle species during interviews. Inferences on these findings, particularly those indicating the presence of rare, seldom seen species, must still be interpreted with caution.

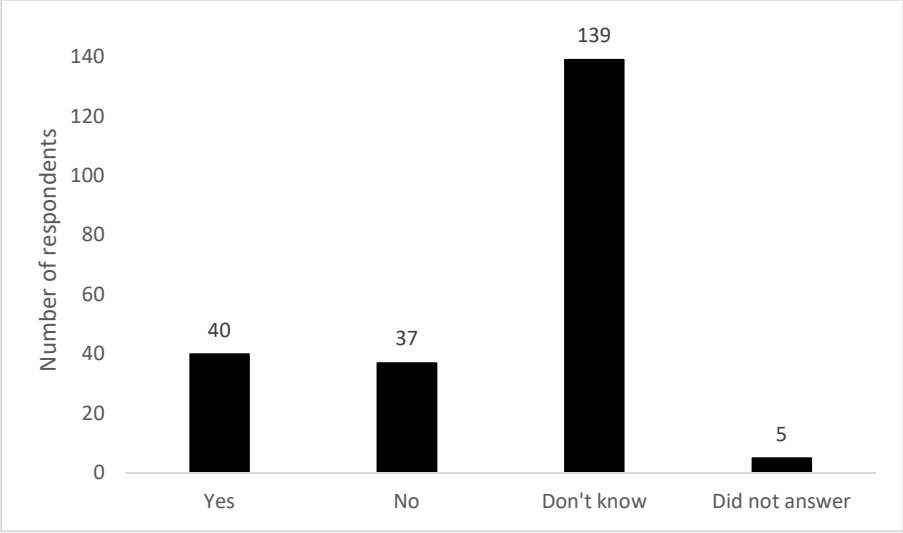


Figure 7. Responses to "do you know the difference between these turtle species?"

4.2 Location of Sea Turtle Sightings and Bycatch

Some fishers in each province noted that there were locations where they regularly see turtles. Across the coastline, 22% of all fishers knew of a place where turtles were regularly seen. The proportion was highest in Kampot and Kep, with 39% of fishers interviewed saying they knew of a place where turtles are regularly seen in each province. When asked if the location of sightings changed over time, most responded that they did not know (Figure 9). After filtering out this uncertainty, there were 16 fishers that knew of place where turtles are seen, and believed that the location of these sightings did not change. Twelve out of 16 of these were in Kep and Kampot. Four people mentioned Koh Tbal in Kep, making this the most likely candidate for consistent turtle sightings based on these data. The islands of Koh Ses, Koh K'tias and Koh Pring were all cited by two fishers each.

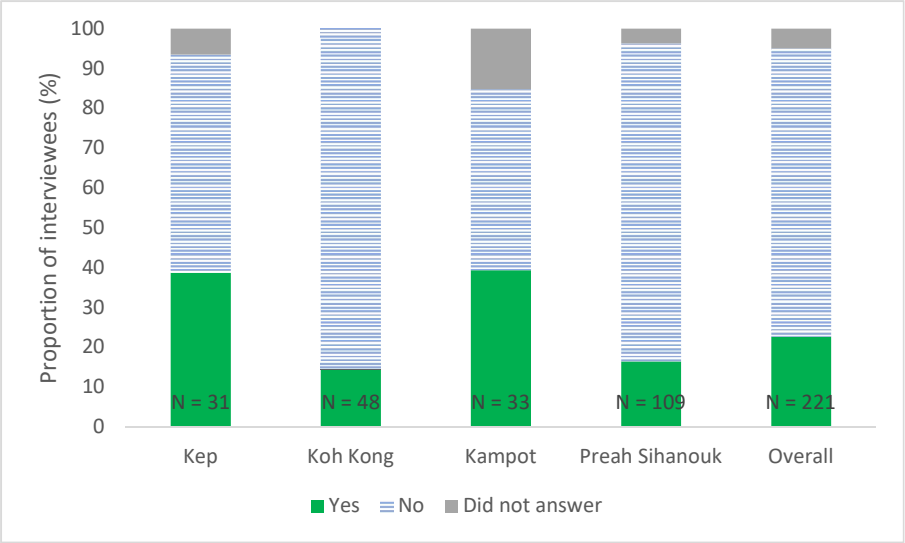


Figure 8. Responses to "are there locations where you regularly see turtles?"

Table 1. Locations cited by 3 or more respondents as places where turtles are regularly seen

Province	Most commonly cited location of regular sea turtle sightings	Number of participants who mentioned this site
Kep/Kampot	Koh Tbal	6

Preah Sihanouk	Thmor Ondaet	4
Preah Sihanouk	Koh Dong	3
Kep/Kampot	Koh Ses	3

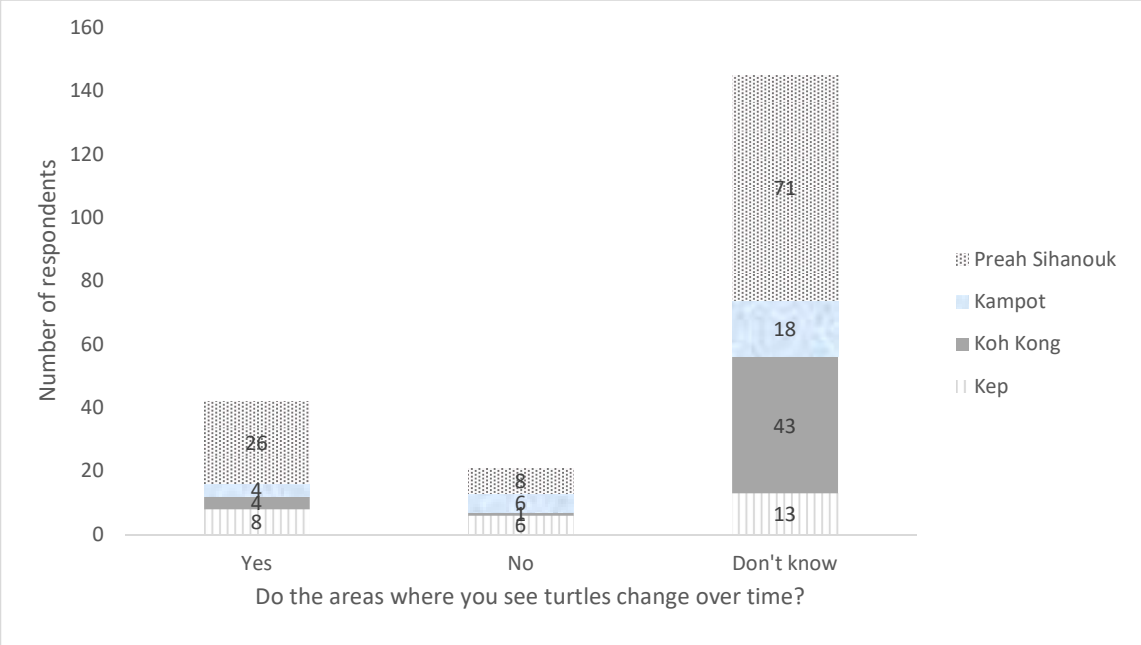


Figure 9. Responses to "do the areas where you see turtles change over time?"

Fishers did not have a clear answer for the season when turtles are sighted. Across the country, 36% said they saw them year-round, 33% in the dry season and 26% in the wet season. Within provinces, there was also not consensus (Figure 10).

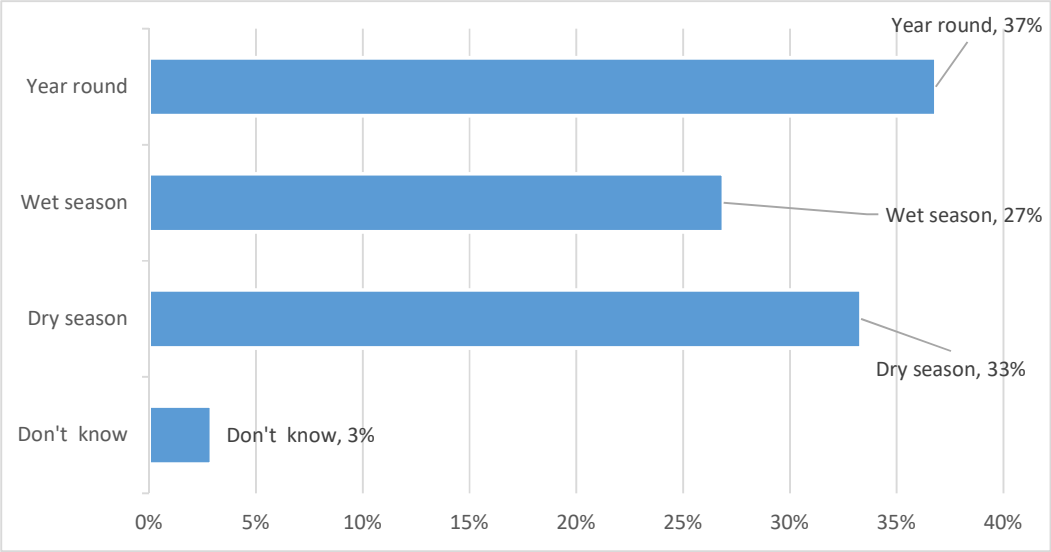


Figure 10. Respondents reported having seen sea turtle based on season

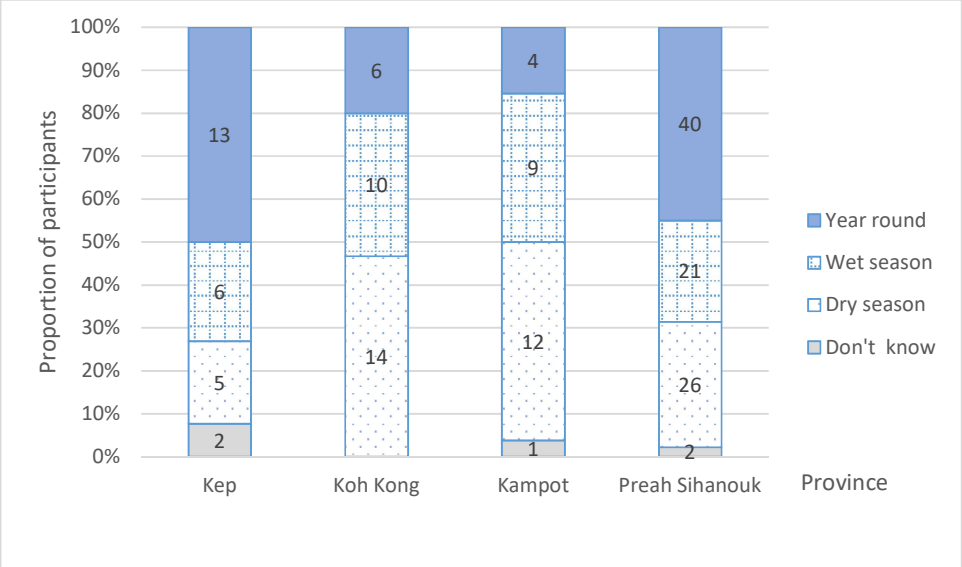


Figure 11. Answers to "when are turtles usually seen?" by province

Fishers in all coastal provinces reported some turtle bycatch. Out of 221 interviewees, only two knew of targeted hunting of turtles in their local area, and two knew of targeted hunting in other areas, confirming that almost all turtle catch is accidental bycatch. Both interviewees aware of any targeted hunting in their area were in Kdart Village, Prek Pampel, Kampot, one of which

said that targeted hunting still occurred. All other interviewees were not aware of any targeted hunting in their commune or elsewhere in Cambodia.

Thmor Reang, Koh Ses and Koh Sdach were the most cited location for sea turtle bycatch among those respondents who could remember bycatch locations (Table 2). Thmor Sor, Keo Phos and Koh Kras were also frequently mentioned locations.

Table 2. Locations of bycatch incident reports

Location	Province	Number of Bycatch Incidents Reported (N= 206)
Thmor Reang	Preah Sihanouk	13
Koh Ses	Kampot	12
Koh Sdach	Koh Kong	11
Thmor Sor	Koh Kong	10
Keo Phos	Preah Sihanouk	10
Koh Kras	Koh Kong	10

Since there were many locations where fishers reported sea turtle bycatch, for convenience, only the most cited locations are shown in Table 2, and displayed on the map in Figure 12. See Appendix 3 for all the names of all the locations that fishers reported for sea turtle bycatch.

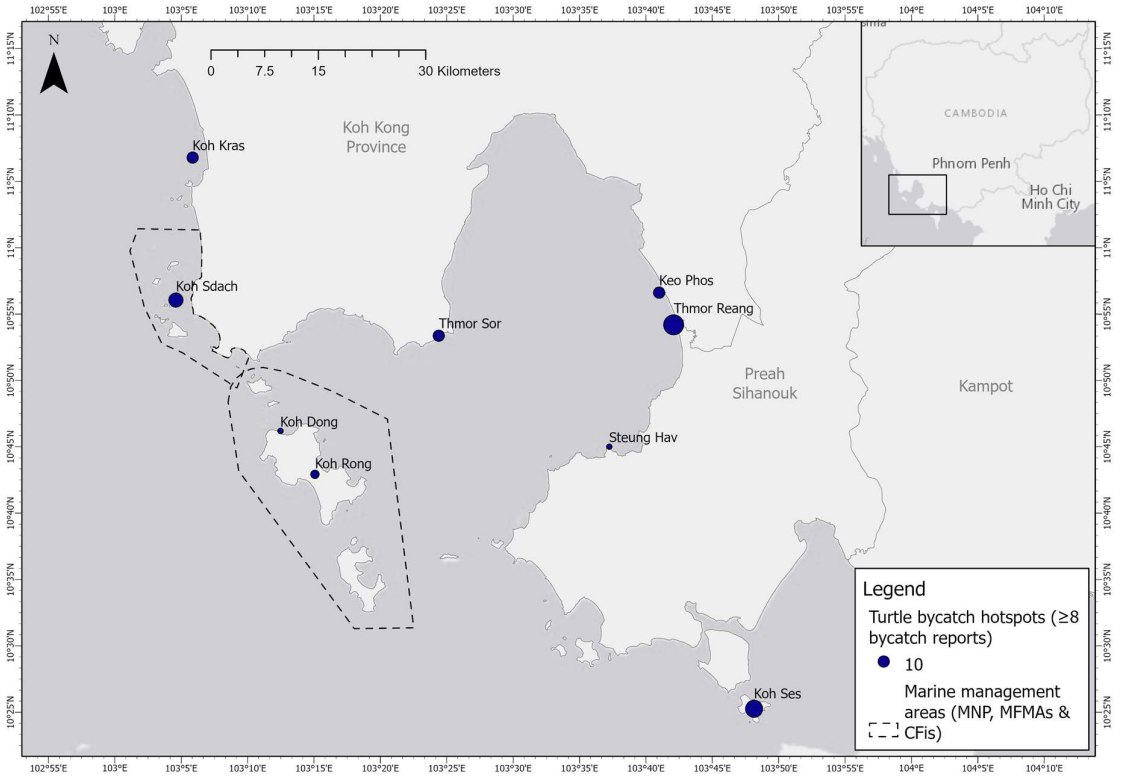


Figure 12. Approximate sea turtle bycatch hotspots (sites with 8 or more bycatch reports) Notes: This is based on respondents who recalled bycatch locations. Point size on the map is proportional to the number of reports.

Thmor Reang and Keo Phos are located near each other in Preah Sihanouk, where there are 13,500 ha of mangrove forests and 164 ha of seagrass beds (Ministry of Environment, 2007). Mangrove forests and seagrass beds are key habitats for turtles, particularly for green turtle foraging, making bycatch incidents more likely.

Koh Ses is located in Preah Sihanouk near Ream National Park, which contains rocky shores and coral reefs. These are also important habitats and foraging grounds for sea turtles including green and hawksbill turtles. The proximity to Kampot province makes it a frequently visited

island for fishers from the neighbouring province. This may be why Koh Ses hosts higher levels of sea turtle bycatch. It is also worth noting that Koh Ses is situated only a few kilometres from the Vietnamese island of Phu Quoc and the edge of the Cambodian EEZ, making illegal cross-border fishing and bycatch by non-local fishers a possibility not captured in these data.

Similarly, Koh Sdach and its surrounding archipelago is also high in biodiversity and provides favourable habitats for sea turtles (West, 2015). Although Thmor Sor is not considered a major habitat for sea turtles, (FiA, Preah Sihanouk pers. comm.) sea turtle bycatch is reported in Thmor Sor. This is most likely due to the high fishing effort in the area, as well as its location near the mouth of the bay, making it a possible route of sea turtle migration to Thmor Reang and Keo Phos where there are significant seagrass beds and mangrove forests (FiA, personal communication, May 02, 2019).

4.3 Sea Turtle Bycatch Frequency and Trends

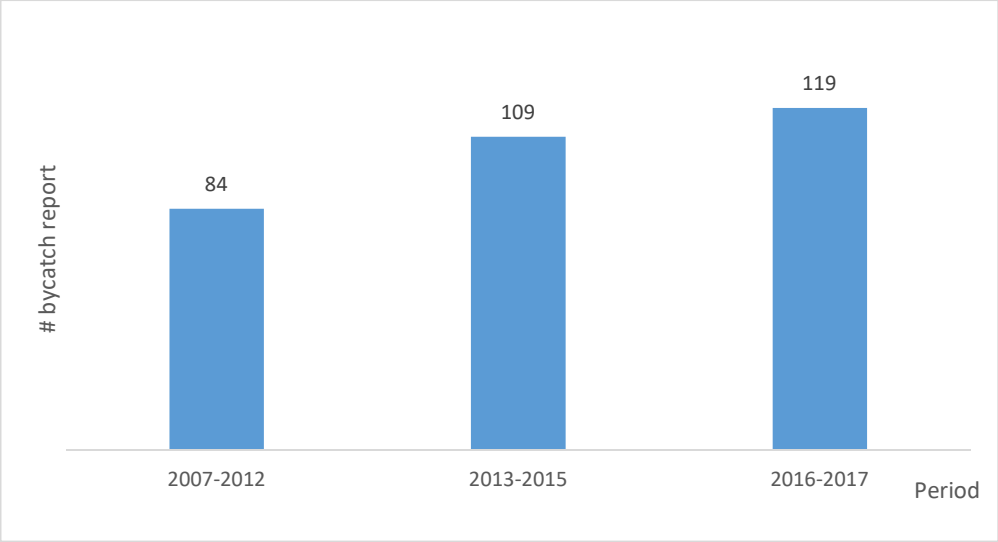
4.3.1 Frequency of Sea Turtle Bycatch Incidents

Out of 221 fishers interviewed, 75 fishers[1] confirmed that they have accidentally caught sea turtles. Below is the Figure 13 showing comparison of sea turtle bycatch incidents over time, reported by these fishers.

[1] Fishers frequently used more than one fishing gear; therefore, the number of frequencies in sea turtle bycatch in Figure 13 may be over the number of actual fishers.

Figure 13. Number of sea turtle bycatch incidents reported over time Note: Number in parenthesis represents the number of sea turtle bycatch each time

According to Figure 13, there are three inferences that can be drawn for sea turtle bycatch in Cambodia. First, number of reports for sea turtle bycatch has increased over these ten years (from 2007 to 2017). This may be attributed to the fact that fishers are using more fishing gear (the increase of fishing effort) with a high bycatch risk, such as push nets and trawling nets



based, on the results of the first research objective. Another attribution maybe fishers are more likely to remember bycatch in 2017 than 2007. Second, the number of bycatch incidents involving multiple turtles at the same time (three turtles or higher) has decreased, while bycatch involving one or two turtles has increased. This could indicate that the number of sea turtles in Cambodia waters may have declined over these years.

6.3.1 Trend in Sea Turtle Bycatch Over time

The finding here reflects that shown in the frequency of sea turtle bycatch incidents in **Error! Reference source not found.**.

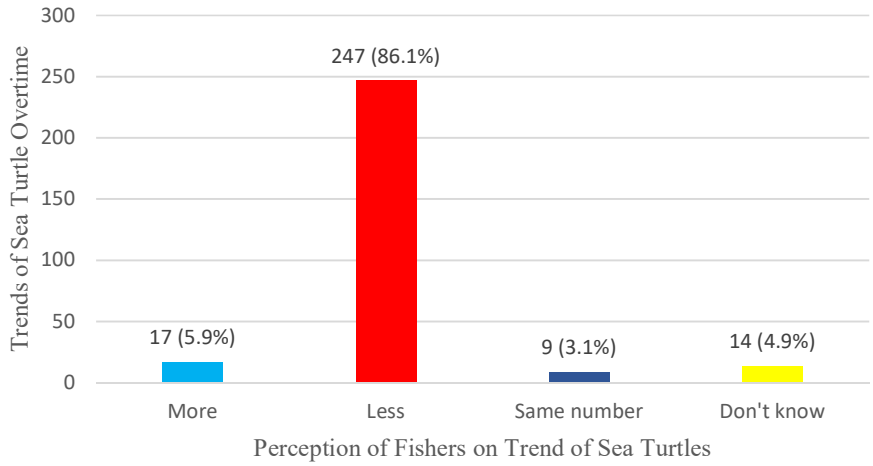


Figure 14. Perceptions of changes in levels of sea turtle bycatch over time

The majority of fishers, 86.1%, (n=247) reported that compared to when they started fishing, there are fewer sea turtles caught in their fishing gear although the minority of fishers, 5.9% (n=17), claimed that there are more sea turtles caught in their fishing gear. Fishers claimed during the interview that there are fewer sea turtles caught now compared to when they started fishing could be due to the fact that there are now more fishers and more destructive fishing gear, in particular trawling nets, which has driven a decline in turtle populations.

When fishers claimed that their turtle bycatch had increased, this could be explained by changes to gear type (from non-destructive to destructive) and/or increases to their fishing effort. For those fishers claiming that there has been no change in the number of sea turtle caught (3.1%; n=9) and those fishers claiming that they do not know if there has been any change in the number of sea turtles caught (4.9%; n=14) it is likely that they have only just started fishing, and this makes it difficult for them to make any comparison.

4.4 Attitude of Fishers towards Sea Turtle Bycatch

Table 3. Attitudes of fishers towards sea turtle bycatch

Type of attitude	Attitude toward bycatch	Frequency (N=317)	Percentage
Positive	Discard[1)]	6	1.9
	Release[3)]	142	44.8
	Discard & release	16	5.04
	Total	***164***	***51.74***
Negative or Opportunistic	Eat	19	6
	Sell	15	4.73
	Use as bait	2	0.63
	Other uses	0	0
	Eat &sell	75	23.7
	Eat & release[4)]	8	2.52
	Eat & discard[2)]	3	0.94
	Eat & other uses	1	0.31
	Eat & use as bait	1	0.31
	Eat, sell & release	17	5.36
	Eat, discard, & release	3	0.94
	Sell & release	6	1.9
	Sell & discard	0	0
	Use as bait & release	1	0.31
	Other uses & discard	1	0.31
	Other uses & release	1	0.31
	Total	***153***	***48.27***

Notes:

1) *"Discard" in positive attitude refers to when a fisher caught a sea turtle accidently but discard it to the sea when it is dead.*
2) *"Discard" in negative or opportunistic refers to when sea turtle bycatch is dead and a fisher discards it to the sea because its meat has decomposed, which cannot be eaten.*
3) *"Release" in positive attitude refers to when a fisher releases a bycatch sea turtle alive to the sea.*
4) *"Release" in negative or opportunistic refers to when a fisher releases a bycatch sea turtle alive to the sea when it is too small to eat or sell.*

Two types of fishers' action towards sea turtle bycatch were recorded: positive, and negative or opportunistic. Positive action refers to action that is or shows intent to be compliant with Cambodian laws protecting sea turtles. Positive actions included releasing sea turtles when caught alive or discarding them when caught dead. Negative or opportunistic actions refer to those which show intent to breach Cambodian laws protecting sea turtles. This includes selling

or eating sea turtles when caught, using their meat as bait or for other purposes even when dead.

According to Table 3, there are very slightly more fishers showing positive actions toward sea turtle bycatch (51.74%; n=164) than those having negative or opportunistic actions (48.27%; n=153). Releasing sea turtles caught alive is common positive action of fishers, representing 44.8%; n=142. Eating and selling caught sea turtles are the most prominent negative or opportunistic action of fishers, representing 23.7%; n=75.

Most respondents knew that killing sea turtles is illegal (62%), whilst a substantial proportion incorrectly believed that it was legal (33%). However, respondents were less aware that killing a turtle is also illegal if by accident, with 11% saying it was illegal, 38% saying it was legal, and 45% saying they didn't know either way.

Table 4. Awareness of legality of killing turtles, both deliberate and by accident

		Yes	No	Don't know	Did not answer	**Total**	
Is killing a turtle illegal?		**139 (62.9%)**	73 (33.0%)	0	9 (4.1%)	221	
Is killing a turtle illegal if by accident?	24 (10.9%)	86 (38.9%)			**101 (45.7%)**	10 (4.5%)	221

Interviewees were divided on whether they thought turtles are important, with 48% saying they were and 44% saying they were not. When asked for their reasoning, 50 of the 106 respondents who thought turtles were important said it was because they were rare species, making it by far the most common answer. A small number of respondents said they thought turtles are important as they are natural resources (7), mentioned ecological reasons for their importance (6) or that they should be known to future generations (6). Most respondents who said they did not think turtles are important did not give a reason (59).

Table 5. Perception on importance of having sea turtles in marine habitats

Do you think having turtles around is important?	**Frequency**	**%**
Yes	106	48.0
No	98	44.3
Don't know	17	7.7

Although 66% interviewees did not possess them, 28% of respondents said they knew of or followed local customs, beliefs or rituals related to sea turtles and their bycatch. By province, proportionally more fishers interviewed in Kampot had beliefs related to turtles, with 60% saying they knew of or followed a custom or belief about turtles. Given that fishers in Kampot and Kep also appear to have persistent turtle sightings (see 4.2), it is possible that traditional beliefs have persisted with them. Whether the presence of traditional beliefs have declined with the population of sea turtles in Cambodia, as has occurred with tiger beliefs (Ishibashi, Inoue & Tanaka, 2015) requires further investigation.

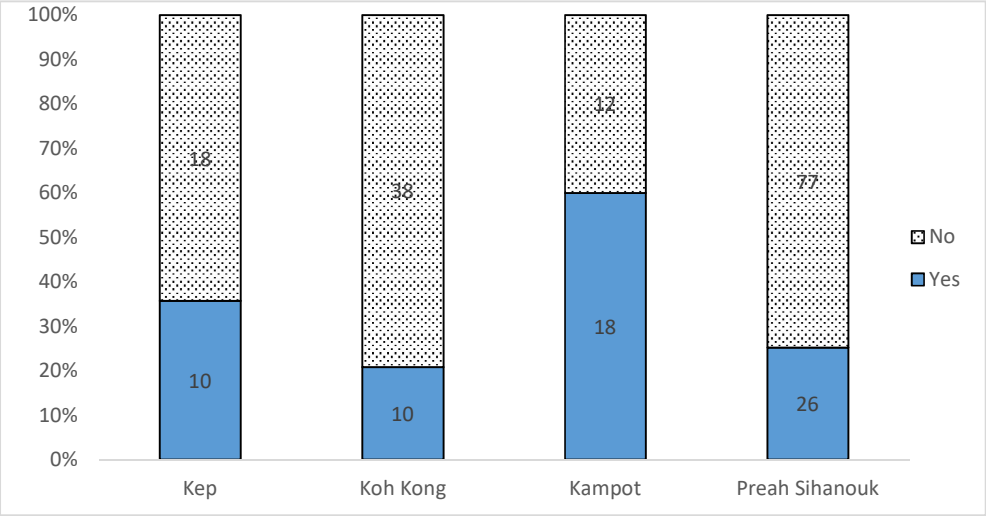


Figure 15. Proportional responses to "do you know of or adhere to customs, traditions or beliefs related to sea turtles?" by province

The most commonly held belief was that it is bad luck to catch turtles (17 respondents). A smaller number believed that it was bad luck to even see one (10). Others said they held a tradition of not eating turtles (7 respondents) or that turtles are spiritual, festive or lucrative animals (5 respondents).

Some respondents also held traditions specifically for releasing bycaught turtles. The most common was spraying a turtle with perfume when releasing, which some clarified was a way to avoid the bad luck they believe is brought by catching a turtle. Another tradition was carving their name into a turtle's shell before release (4 respondents) or tying a thread onto the turtle (2 respondents).

Table 6. Summary of stated beliefs related to sea turtles

Belief/custom related to turtles	**Number of participants**	**Percentage of people who claimed to have related beliefs**
Bad luck to catch	17	34
Perfume	12	24
Bad luck	10	20
Do not eat it	7	14
Festive/lucrative/spiritually important animal	6	12

Carve name of releaser	4	8
Good luck or brings happiness	2	4
Tie thread	2	4

V. Conclusions and Recommendations

The survey of sea turtle bycatch was conducted with 221 samples from 28 landing sites and fishing villages across the four coastal provinces. Key findings from the study include:

- Targeted sea turtle fishing in the communities is rare, with only two respondents from Kdart Village in Kampot reporting any knowledge of this occurring.
- About half of fishers did not know that killing turtles is illegal, and an even higher proportion did not know that it was still illegal if by accident.
- Bycatch was reported across the coastline, and therefore represents a substantial threat to sea turtles nationwide. Locations with more than 5 reported bycatch incidents were found in all coastal provinces. Bycatch hotspots, with more than 10 reported incidents, were identified as Thmor Reang, Keo Phos, Koh Ses, Koh Sdach, Thmor Sor and Koh Kras.
- The main fishing gear impacting sea turtles in Cambodia were found to be: 1) push nets, 2) ray hooks, and 3) trawling nets. The majority of fishers used their gear more than 20 days per month, suggesting high fishing effort.
- Green and hawksbill turtles were most regularly encountered as bycatch, but there were also reported bycatch incidents of much rarer loggerheads, leatherbacks and olive ridleys. The differences are most likely reflective of their relative abundance in Cambodian waters. All species appear to be threatened by bycatch.
- Proportionally, more fishers in Kep and Kampot regularly see turtles, and these provinces are where most fishers knew of locations where the turtles are consistently

seen to reside. Koh Tbal was the most commonly cited location of consistent turtle sightings. There is no clear evidence of any seasonality.

- Three bycatch hotspots were noted within the Kampong Som Bay. Thmor Reang and Keo Phos, both neighbouring each other near a seagrass and mangrove area, had 23 reported bycatch incidents between them. In addition, Thmor Sor, where turtles are thought to migrate past to reach the aforementioned seagrass and mangrove areas, are particular priority locations for conservation intervention.
- Actions of respondents towards sea turtles were shown to be a mixture of positive (52%) and negative or opportunistic (48%). Although many fishers said that they released turtles when accidentally caught, others consume or sell them opportunistically.
- Fisher interviews showed that there is a perceived reduction in the number of sea turtles in Cambodian waters over the last 10 years. Fishers also perceived the reduction of sea turtle bycatch compared to when they started fishing.
- Fishers were divided on to whether turtles are important, with only 48% thinking they are. Possession of traditions and beliefs towards sea turtles was found but was not universal, with only 28% saying they followed or knew of any. The nature of any beliefs also varied widely between different participants and locations. The most common of these was the belief that catching a turtle brings bad luck, and the practice of spraying turtles with perfume when releasing them is common.

Below are the recommendations to reduce sea turtle bycatch, based on the findings of the study.

1) Although trawling in water of less than 20 meters in depth is banned under the Cambodian Fisheries Law, some fishers still violate it. Therefore, there should be greater **law enforcement towards destructive fishing practices and gears**. According to the Fisheries Law, trawl gear is forbidden from fishing in the water column of less

than 20 meters deep. As long as there is no law enforcement on those fishing gears, key habitats such as seagrass and coral reef will be destroyed and incidents of bycatch will continue to occur. Additionally, enforcement of the Endangered Species Sub-decree should commence **to control opportunistic sea turtle meat consumption and trading**. This can be done successfully by collaborating with local authorities such as commune or village chiefs who can report to FiA at the provincial level.

2) Given that there is no clear seasonality in turtle sightings, focus should be placed on **regulating and monitoring fishing activity near sighting and bycatch hotspots and key areas of habitats** such as coral reefs, seagrass and certain islands.
3) There should be measures of fishing **gear modification or replacement in order to reduce sea turtle bycatch**. Ray hooks with J-hooks could be replaced by circle hooks, although this would require pilot trials in Cambodia to assess impacts. Turtle Excluder Devices (TED) should also be trialled and introduced to trawling nets.
4) **Long-term monitoring of threats** to sea turtles should be conducted not only for bycatch, but also for other types of threats including construction of ports and coastal urbanization, marine debris and plastic, and chemical discharge. For effective long-term monitoring, cumulative impacts that threaten sea turtles should be taken into consideration.
5) Finally, the results of the survey provide some insight on key areas to focus on for awareness raising activities. Many fishers **were not aware that turtle bycatch was illegal, particularly if by accident**. Some fishers also reported negative or opportunistic actions toward sea turtle bycatch. Therefore, to ensure that fishers can help release sea turtles after bycatch, **more awareness raising of national laws protecting turtles, the importance of sea turtles to the environment and how to minimize bycatch and handle them safely for release are required**, in particular in identified hotspots including Thmor Reang, Keo Phos, Koh Ses, Koh Sdach, and Thmor

Sor. Training of trainers, particularly for government authorities and community fishing groups, will improve the sustainability of these practices.

References

Australian Fisheries Management Authority. (2018). *Australian Fisheries Management Authority - Handling Practices Guide*.

Bryman, A. (2012). *Social Research Methods*. Oxford University Press.

Diamond, J., Blanco, V., and Duncan, R. (2012). Knowing sea turtles: local communities informing conservation in Koh Rong Archipelago, Cambodia. *Cambodian Journal of Natural History,* (2), 141-144.

Duc, L. D., Broad, & Steven. (1995). Exploitation of Hawksbill Turtles in Vietnam. TRAFFIC Bulletin, 15(2), 77–82.

CMS. (2017). Standardised Dugong Catch/Bycatch Questionnaire. *Dugong MOU Secretariat*. Retrieved from https://www.cms.int/en/project/cms-dugong-mou-standardised-catch-and-bycatch-questionnaire

FAO. (2019). Fishing Gear Types-Push nets- Technology Fact Sheets. In *Fisheries and Aquaculture Technology.* Retrieved from http://www.fao.org/fishery/geartype/253/en

FAO. (2019). Fishing Gear Types-Trawls- Technology Fact Sheets. In *Fisheries and Aquaculture Technology.* Retrieved from http://www.fao.org/fishery/geartype/103/en

FAO. (2009). *Guidelines to Reduce Sea Turtle Mortality in Fishing Operations*. Retrieved from http://www.fao.org/3/i0725e/i0725e.pdf

FFI. (2011). *Rapid Assessment to Determine the Status of Sea turtle Nesting in Cambodia.* Unpublished final report to USFWS Sea turtle Conservation Fund. Phnom Penh, Cambodia: FFI Cambodia Programme.

FiA. (2011). *The Strategic Planning Framework for Fisheries: 2010 - 2019 Cambodia.* Phnom Penh, Cambodia.

Garnier, J., Hill, N., Guissamulo, A., Silva, I., Witt, M., & Godley, B. (2012). Status and community-based conservation of sea turtles in the northern Querimbas Islands (Mozambique). *Oryx*, *46*(3), 359–367. https://doi.org/10.1017/S0030605311001566

Gerosa, G., & Aureggi, M. (2001). *United Nations Environment Programme Mediterranean Action Plan-UNEP Regional Activity Centre For Specially Protected Areas: Sea Turtle Handling Guidebook for Fishermen*. Tunis.

Gomez, L., & Krishnasamy, K. (2019). *A rapid assessment on the trade in sea turtles in Indonesia, Malaysia and Viet Nam*. Petaling Jaya.

Humber, F., Godley, B. J., Nicolas, T., Raynaud, O., Pichon, F., & Broderick, A. (2017). Placing Madagascar's sea turtle populations in a regional context using community-based monitoring. *Oryx*, *51*(3), 542–553. https://doi.org/10.1017/S0030605315001398

Ing, T. (1999). *Status of sea turtles in Cambodia.* Report of the SEAFDEC-ASEAN Regional Workshop on Sea Turtles Conservation and Management. pp: 72-74.

Ishibashi, H., Inoue, M., & Tanaka, M. (2015). Historical change in the traditional use of forests and its association with belief in tiger spirits in the Cardamom Mountains, Cambodia: The impact of war and wildlife trade on the relationship between humans and tigers. *Tropics*, *24*(3), 119–138. https://doi.org/10.3759/tropics.24.119

MAFF. (2016). *MAFF Annual Report 2015-2016*. Phnom Penh, Cambodia.

McNamara, A, Mizrahi, M., Vibol, O., & West, K. (2016). *Sea turtle Status Report for Cambodia 2015. Phnom Penh, Cambodia: FFI Cambodia Programme.*

Mizrahi, M., West, K., & Vibol, O. (2017). *Sea Turtle National Plan for Cambodia (2016-2026)*. Phnom Penh, Cambodia: FFI Cambodia Programme.

Ministry of Environment. (2007). *Coastal Environmental Management Action Plan 2007-2011*. National Coastal Steering Committee.

Mortimer, J. ., & Donnelly, M. (2008). *Eretmochelys imbricata* (Hawksbill Turtle). Retrieved November 17, 2020, from The IUCN Red List of Threatened Species website: https://www.iucnredlist.org/species/8005/12881238

Nahill, B., von Weller, P., & Barrios-Garrido, H. (2020). *The Global Tortoiseshell Trade*.

NOAA Fisheries. (2010). Sea Turtle Handling/Release Guidelines: Quick Reference for Hook and Line Fisheries. Retrieved from http://sero.nmfs.noaa.gov/

Phelps, J., Biggs, D., & Webb, E. L. (2016). Tools and terms for understanding illegal wildlife trade. *Frontiers in Ecology and the Environment*, *14*(9), 479–489. https://doi.org/10.1002/fee.1325

Pilcher, N., & Chaloupka, M. (2013). Using community-based monitoring to estimate demographic parameters for a remote nesting population of the Critically Endangered leatherback turtle. *Endangered Species Research*, *20*(1), 49–57. https://doi.org/10.3354/esr00480

Risien, J. M., & Tilt, B. (2008). A Comparative Study of Community-based Sea Turtle Management in Palau: Key Factors for Successful Implementation. *Conservation and Society*, *6*(3), 225–237.

Seminoff, J. (2004). *Chelonia mydas* (Green Turtle). Retrieved November 17, 2020, from The IUCN Red List of Threatened Species website: https://www.iucnredlist.org/species/4615/11037468

Sovinda Po, & Kimkong Heng. (2019). *Assessing the Impacts of Chinese Investments in Cambodia: The Case of Preah Sihanoukville Province. A Working Paper on China-Cambodia Relations* (No. 19). Retrieved from www.pacforum.org

Stuart, B. L., An, D., & van Dijk, P. P. (2002). A Record of the Leatherback Sea Turtle *(Dermochelys coriacea)* from Cambodia. *Sea turtle Newsletter*, *96*(22).

Vong, R., Teoh, M., & West, K. (2018). An action plan for sea turtle conservation in the Kingdom of Cambodia. *Oryx*, *52*(2), 213–213. https://doi.org/10.1017/s0030605318000212

Wallace, B. P., Kot, C. Y., DiMatteo, A. D., Lee, T., Crowder, L. B., & Lewison, R. L. (2013). Impacts of Fisheries Bycatch on Sea turtle Populations Worldwide: Toward Conservation and Research Priorities. *Ecosphere*, *4*(3), 1–49. https://doi.org/10.1890/ES12-00388.1

West, K. (2015). *A Preliminary Survey of Potential Marine Protected Areas and Existing Marine Conservation Initiatives in Cambodia*. Fauna & Flora International Cambodia Programme, Phnom Penh, Cambodia.

Wong, R. W. Y. (2020). Shadow operations in wildlife trade under China's Belt and Road Initiative. *China Information*, 1–18. https://doi.org/10.1177/0920203X20948680

WWF (2017). *Sea Turtle Bycatch-A Global Issue.* Retrieved from https://d2ouvy59p0dg6k.cloudfront.net/downloads/sea_turtle_bycatch_factsheet_032917_online.pdf

Appendices

Appendix 1. Names and locations of survey sites and number of samples from each of the 28 sites

No.	Name of survey site (Fishing port or village)	Locations (N= 4)	Number of samples (N= 221)
1	Damnak Chambok	Kep	31
2	Angkaol		
3	Oumpeng		
4	Phum Thmey		
5	Prek Tanan		
6	Kdart	Kampot	33
7	Doun Touk		
8	Kdart		
9	Manub		
10	Ou Krasar		
11	Prek Thnoat		
12	Trapeang Ropov		
13	Phum 1	Preah Sihanouk	109
14	Phum 2		
15	Phum 3		
16	Ou Tress		
17	Koang Kang		
18	Koh Kjorng		
19	Keo Phos		
20	Peam Krasop Jas	Koh Kong	48
21	Sre Trav		
22	Tameak		
23	Phum Dong		
24	Koh Kjorng		
25	Koh Sdach		
26	Chroy Svay		
27	Kampong Sdam		
28	Phum Sralao		

Source: Author (2019)

Appendix 2. Bycatch questionnaire

Interviewer Name:_____Date:_____Data Sheet Serial Number:___

Village:_____Commune:_____District:_____Province:_____

GPS Coordinate:_____

Introduction statement

Note: Reading this statement to the interviewee is compulsory. It ensures all interviews are treated equally.

My name is_____. I would like to study about marine resources in Cambodia including sea turtle bycatch.

Information from our research could be used to help reduce the accidental bycatch of sea turtles maybe through community support for our goals, or possibly through more effective regulations and enforcement. Your participation in this survey is voluntary and confidential. We will not record your name or any personal information you share with us unless this is ok with you. Individual answers will be collated and reported on as a group to provide a general idea of current status, and we will absolutely not share your individual answers to anyone outside of the research team. You do not have to answer questions you do not want to.

Interviewee Background

Note: Please tick the boxes to the left of any questions not asked. Provide appropriate ID charts and maps for interviewee to point to during the interview.

1. Name:_____
2. Age:_____
3. Gender: Male ☐ Female ☐
4. For how many years has fishing been your occupation?_____
5. Were your parents fishers? Yes ☐ No ☐ Grandparents? Yes ☐ No ☐
6. Is fishing the main way you earn a living? Yes ☐ No ☐
7. Is fishing the only way you earn a living? Yes ☐ No ☐

   If No, what is (or are) your other occupation(s)?_____

8. Which months do you normally fish (out of the last 12)?_____

(*if seasonal, indicate season start and end*)

9. How many days each week do you fish?____days (low season)_____days (peak season)

10. Is the boat motorized? Yes ☐ No ☐ (if yes) Inboard ☐ Outboard ☐

11. Have you ever seen sea turtles? Yes ☐ No ☐ Do you have another name for them?____

12. What species of turtles do you see? Green ☐ Hawksbill ☐ Olive Ridley ☐ Loggerhead ☐

Flatback ☐ Leatherback ☐ Don't know ☐

Do you know the difference between these turtle species? Yes ☐ No ☐ Don't know ☐

(*Note to Interviewer; Show ID chart or graphics*)

Please describe:_____

Do they have different names? If yes, please list:_____(*determine for each species*)

13. How do you see turtles? Seen while fishing ☐ Seen while travelling to fishing areas ☐

Coming ashore to lay eggs ☐ Accidentally caught in nets ☐ Hunted ☐

Stranded on the beach ☐

(*Note to interviewer: Refer to and complete attached table and mark all locations on maps*)

14. In what places do you normally fish?_____

(*Use prepared road maps, charts, Google maps and have interviewee point out areas*)

Do you use different gear in different areas? Yes ☐ No ☐ If yes, please describe:

_____

Fishery Information

Note to interviewer: Respondent should answer these questions to describe his/her individual experience, not that of their community. Use illustrations to assist where necessary.

Habitat Codes:(D) Deep Water; (C) Coral; (S) Seagrass; (F) Fine Sediments; (M) Mangroves; (R) Rocks; (E) Estuaries; (U) Unknown

Gear Type	**Gear description**	**Which months**	**How many day per month?**	**Habitat**	**catch sea turtles**	**Seen sea turtle**	**Last year**	**Last 2 to 5 years**	**5-10 year**	**Location**	**Other**
Observed only (not interacting with any gear)											
Hook	Type: Length: Depth: N Hook: Target:		0-5, 5-10,10-15,15-20,20-25, 25-31		Yes No	Yes No	0, 1-2, 2-3, 3-4, 4-5	0, 1-3 , 4-6 , 7-10, >10	0, 1-3 , 4-6 , 7-10, >10	Last Y 2-5 years: 5-10 years:	
Trawl	Type: Length: Depth: Mesh size: Target		0-5, 5-10,10-15,15-20,20-25, 25-31		Yes No	Yes No	0, 1-2, 2-3, 3-4, 4-5	0, 1-3 , 4-6 , 7-10, >10	0, 1-3 , 4-6 , 7-10, >10		

Net	Type: Length: Depth: Mesh size: Target		0-5, 5-10,10-15,15-20,20-25, 25-31		Yes No	Yes No	0, 1-2, 2-3, 3-4, 4-5	0, 1-3 , 4-6 , 7-10, >10	0, 1-3 , 4-6 , 7-10, >10		
Traps	Type: Length: Depth: Mesh size: Target:		0-5, 5-10,10-15,15-20,20-25, 25-31		Yes No	Yes No	0, 1-2, 2-3, 3-4, 4-5	0, 1-3 , 4-6 , 7-10, >10	0, 1-3 , 4-6 , 7-10, >10		
Other	Type: Length: Depth: Mesh size: Target:		0-5, 5-10,10-15,15-20,20-25, 25-31		Yes No	Yes No	0, 1-2, 2-3, 3-4, 4-5	0, 1-3, 4-6, 7-10, >10	0, 1-3, 4-6 , 7-10, >10		

Sea turtle catch / bycatch

15. How long do you think a turtle lives?_____Don't know ☐

16. Do you have any turtle experts in your village? Yes ☐ No ☐ Who?_____

17. What about in other villages? Yes ☐ No ☐ Who?_____What village?_____

18. Have people in your community ever hunted turtles? Yes ☐ No ☐ Don't Know ☐

    If yes, how many?_____For how long?_____

19. Do they do so now? Yes ☐ No ☐ Don't Know ☐

20. Do people from other villagers / communities hunt turtles? Yes ☐ No ☐ Don't Know ☐

    Who?_____What village?_____Any other details?_____

21. Compared to when you started fishing, are there more ☐, less ☐, or the same number of turtles captured in fishing gear? ☐Don't Know ☐ (*Note to interviewer: based on <u>actual</u> numbers, not perception*)

    If higher or lower, why do you think this?_____

22. Do you know of any areas where turtles <u>regularly</u> occur? Yes ☐ No ☐

    Where are these turtle areas?_____

23. Do these turtle areas change over time? Yes ☐ No ☐ Don't Know ☐

24. Do you see mating turtles? Yes ☐ No ☐ When?_____Where _____☐

25. When do you see turtles? (*indicate months or seasons*):_____

26. What do you do (or would you do) with a turtle if you caught one?

    Eat ☐ Sell ☐ Use as Bait ☐ Other Use ☐ Discard (*dead*) ☐ Release (*alive*) ☐

    (*do not lead interviewee*)

    (*Note differences by species where possible and if available*)

    What happened to the animal?_____

27. What would you do or did you do if you found a stranded turtle?_____

28. Do you think there will always be turtles in the sea? Yes ☐ No ☐ Don't Know ☐

If yes or no, why?_____

29. Do you think having turtles around is important? Yes ☐ No ☐ Why?_____

_____

30. It is illegal to (intentionally) kill a turtle? Yes ☐ No ☐ Don't know ☐

What about by accident (maybe caught in a net unintentionally)? Yes ☐ No ☐ Don't know ☐

31. Are there any local customs, beliefs, legends or rituals or stories related to turtles?

Yes ☐ No ☐

If yes, please describe:_____

Where / from whom did you hear this?_____

Confidential interviewer comments

32. How open and honest did the fisher seem about answering bycatch questions?

Very open/honest ☐ Somewhat open/honest ☐ Not honest ☐

33. How interested and engaged did the fisher seem with interview?

Very interested ☐ Moderately interested ☐ Bothered/ Not interested ☐

34. How certain did the fisher seem about answers to numerical questions?

Very sure ☐ Reasonable sure ☐ Unsure ☐

35. How comfortable were you about the respondents' ability to discriminate between the species? Very comfortable ☐ Reasonable ☐ Not comfortable ☐

36. Why do you think this?_____

37. Please indicate why (if any) questions were not asked _____

Appendix 3. Locations of bycatch incident reports

Name of Location	Province	Total	Percent
Thmor Reang	Preah Sihanouk	13	6.31068
Koh Ses	Kampot	12	5.825243
Koh Sdach	Koh Kong	11	5.339806
Keo Phos	Preah Sihanouk	10	4.854369
Thmor Sor	Preah Sihanouk	10	4.854369
Koh Kras	Koh Kong	10	3.398058
Koh Rong	Preah Sihanouk	9	4.368932
Stung Hav	Preah Sihanouk	8	3.883495
Koh Dong	Preah Sihanouk	8	3.883495
Koh Smach	Koh Kong	6	2.912621
Koh Ampil	Koh Kong	6	2.912621
Koh Kong Krao	Koh Kong	5	2.427184
Koh Tbal	Kep	5	2.427184
Koh Tonsai	Kep	5	2.427184
Thmor Kondal	N/A	5	2.427184
Koh Mnois	Koh Kong	5	2.427184
Koh Por	Kampot	5	2.427184
Sre Trav	Koh Kong	4	1.941748
Thmor Ondaet	N/A	3	1.456311
Koh Thmey	Preah Sihanouk	3	1.456311
Chamkar Daungpreing	Preah Sihanouk	3	1.456311
Koh Ondaet	Koh Kong	3	1.456311
Koh Damlong	Preah Sihanouk	3	1.456311
Koh Toteung	Preah Sihanouk	3	1.456311
Koh Ankrong	Kep	2	0.970874
Koh Kjorng	Preah Sihanouk	2	0.970874
Koh Nhor (Koh Touch)	Preah Sihanouk	2	0.970874
In front of Kep	Kep	1	0.485437
Kampeng Port	Preah Sihanouk	1	0.485437
Koh Russey	Preah Sihanouk	1	0.485437
Jong Poy (Koh Rong Sanloem)	Preah Sihanouk	1	0.485437
Koh Rek	N/A	1	0.485437
Thmor Reap	N/A	1	0.485437
Koh Kok	Preah Sihanouk	1	0.485437
Thmor Runtiashbagn	Preah Sihanouk	1	0.485437
Phum Thmey	Koh Kong	1	0.485437
Sa Ouy (Tanoon)	Koh Kong	1	0.485437
Koh Pring	Preah Sihanouk	1	0.485437
Koh Takeav	Preah Sihanouk	1	0.485437
Koh Tang	Koh Kong	1	0.485437
Koh Yor	Koh Kong	1	0.485437

China Port	Koh Kong	1	0.485437
Koh Krasar	Koh Kong	1	0.485437
Koh Aichses	Kep	1	0.485437
Poy Sgav	N/A	1	0.485437
Keo Phos & Thmor Runtiashbagn	Preah Sihanouk	1	0.485437
Koh Kteh & Koh Rong	Kampot & Preah Sihanouk	1	0.485437
Koh Ses & Koh Thmey	Kampot & Preah Sihanouk	1	0.485437
Near Koh Kong & Thmor Sor	Koh Kong	1	0.485437
Thmor Reav & Keo Phos	Preah Sihanouk	1	0.485437
Koh Thah & Koh Rong	Preah Sihanouk	1	0.485437
Thmor Sor & Koh Rong	Koh Kong & Preah Sihanouk	1	0.485437
Koh Tang & Koh Snerhar	Preah Sihanouk	1	0.485437
Koh Tang & Koh Dong	Preah Sihanouk	1	0.485437
Koh Ses & Koh Rong	Kampot & Preah Sihanouk	1	0.485437
Prek Thnoat & Koh Kteh	Kampot	1	0.485437
Koh Rong & Koh Kras	Preah Sihanouk & Koh Kong	1	0.485437
Keo Phos & Koh Dong	Preah Sihanouk	1	0.485437
Keo Phos & Koh Rong	Preah Sihanouk	1	0.485437
Koh Damlong & Koh Smach	Koh Kong	1	0.485437
Koh Dong & Thmor Rong	Koh Kong	1	0.485437
Koh Ampil & Koh Chhan	Koh Kong	1	0.485437
Koh Ampil & Koh Smach	Koh Kong	1	0.485437
Koh Kras & Koh Rong	Koh Kong & Preah Sihanouk	1	0.485437
Koh Mnois & Koh Ampil	Koh Kong	1	0.485437
Koh Rong & Koh Smach	Preah Sihanouk & Koh Kong	1	0.485437
Koh Rong & Koh Mnois	Preah Sihanouk & Koh Kong	1	0.485437
Koh Smach & Koh Dong	Koh Kong	1	0.485437
Koh Smach & Koh Sdach	Koh Kong	1	0.485437
Koh Chhan & Koh Smach	Koh Kong	1	0.485437
Phum Dong, Chamkar Leu, & Sre Trav	Koh Kong	1	0.485437
Koh Rong, Koh Smach, & Koh Kras	Preah Sihanouk & Koh Kong (last two)	1	0.485437
Total		***206***	***100***

Appendix 4. Fishing net (gear) use and effort by province

Net gear type and effort (days per month)																							
	Crab					**Crab Total**	**Fish**			**Fish Total**	**Lobster**	**Lobster Total**	**Multiple**		**Multiple Total**	**Other**		**Other Total**	**Shrimp**				**Shrimp Total**	**Grand Total**
Province	**5-10**	**10-15**	**15-20**	**20-25**	**25-31**		**10-15**	**20-25**	**25-31**		**15-20**		**20-25**	**25-31**		**0-5**	**25-31**		**10-15**	**15-20**	**20-25**	**25-31**		
Kep	2		2	5	3	12			1	1			3	1	4	2		2						19
Koh Kong		2	5	9	3	19		2	2	4				9	9						4		4	36
Kampot				2		2	1	6	2	9			3	1	4				1		2		3	18
Preah Sihanouk		2	4	4		10		1	1	2	1	1	1	15	16		1	1	4	7	15	9	35	65
Grand Total	**2**	**4**	**11**	**20**	**6**	**43**	**1**	**9**	**6**	**16**	**1**	**1**	**7**	**26**	**33**	**2**	**1**	**3**	**5**	**7**	**21**	**9**	**42**	**138**