Bycatch Mortality Of Leatherback Turtles

In Trinidad's Artisanal Gillnet Fishery

By

Jordan Gass

Date:________________

Approved:

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Dr. Scott Eckert, Advisor

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Abstract

Although listed globally as critically endangered, leatherback turtles maintain a strong nesting population in Trinidad. Trinidad supports an estimated population of 6,000 nesting females, which despite increased beach protection still face significant risk in the form of coastal gillnets. Incidental captures also impact fishers, who incur financial losses in reduced fishing time from net damage and associated repair costs. During the 2005 nesting season, my project used fisher participation in villages in the northeast region of Trinidad to attempt to measure bycatch levels. The methods used to quantify bycatch are described and results discussed. Challenges encountered during the project are also assessed to plan modifications of project methods to enhance fisher participation and confidence in results.

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RATIONALE

Access to local knowledge provides fisheries managers a powerful tool to aide in decision making. Often, local knowledge is ignored or disregarded as anecdotal, and managers are forced to make decisions based solely on 'objective' scientific data—data which are frequently insufficient to reliably support conclusions. Fisheries management is beginning to evolve in order to take into account the experience and knowledge of fishers, who are often the first to identify the problems that arise, and can often suggest practical measures that will allow them to continue earning their living (see Haggan et al. 2003).

In February, 2005, the Government of Trinidad, represented by the Fisheries Division and the Wider Caribbean Sea Turtle Conservation Network conducted a workshop to facilitate information exchange between fishers, scientific experts and conservation stakeholders with regards to the bycatch of leatherback turtles (*Dermochelys coriacea*) in coastal gillnet fishery (Eckert & Eckert 2005). This meeting sought to incorporate fisher experience into efforts to decrease the bycatch and mortality of turtles during the nesting season, thereby protecting fishers from the economic costs of net damage resulting from the entanglement. In concert with this workshop, my project was designed with the goal of collecting scientifically viable data from fishers while minimizing the anecdotal nature of the information. The data collection methods used in this project address the primary criticism raised of a previous bycatch estimation project conducted by L. Lee Lum (2003), which used interview-based survey methods to quantify bycatch.

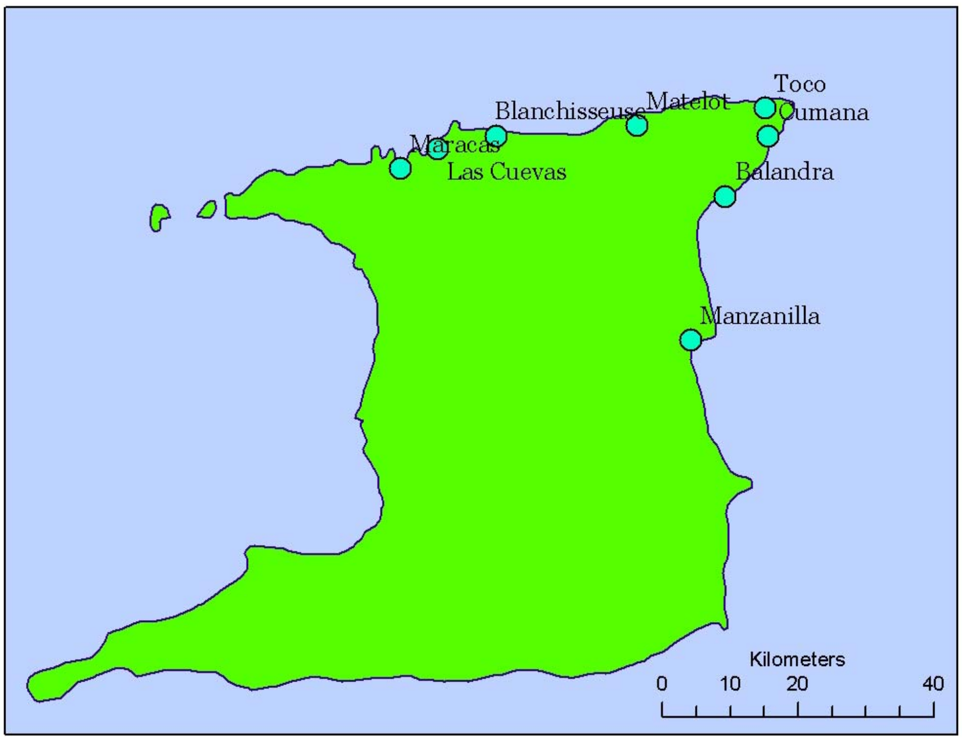
BACKGROUND

The leatherback is one of the few marine animals that rely primarily on nutritionally sparse jellyfish as a food source. This puts them in a unique and vital ecological niche. Jellyfish are a multi-level predator, with some species feeding on zooplankton and others feeding on a wide variety of finfish, some of which are important commercial species. The functional absence of leatherbacks to suppress open water jellyfish populations may lead to an exacerbation of the ecological pressures already imposed by overfishing.

Leatherback turtles are listed as Critically Endangered globally (IUCN 2004). Previous estimates of the global population of nesting leatherbacks suggest that it may consist of between 26,000 and 42,000 females (Spotila et al. 1996). Leatherback population decline has been particularly severe in the Pacific, due primarily to fishing practices and chronic overharvest of eggs (Eckert & Sarti 1997; Sarti et al. 1996) with adult female mortality being estimated at 20-30% annually (Spotila et al. 2000). Spotila et al. (2000) found that the Eastern Pacific population of leatherbacks had dropped to 2,955 females, or 3.2% of the 1980 population size. The authors concluded from this decline that the Pacific population is on the verge of collapsing. In contrast, Western Atlantic and Caribbean populations of leatherbacks appear to be stable or increasing. Dutton et al. (2005) document increases of the number of females returning to some Caribbean nesting beaches. The divergence of population trends between the Atlantic and Pacific leatherbacks may be due to several factors, including increased protection of nesting beaches, lower fisheries bycatch levels and less overlap between fishing areas and high-use habitats in the Atlantic region (Chan & Liew 1996; Troeng et al. 2004).

French Guiana, Suriname and Trinidad and Tobago, situated in the Eastern Caribbean, support the largest regional nesting populations of leatherbacks (Eckert 2006; Girondot & Fretey 1996; Hilterman & Goverse 2005). The northeastern region of Trinidad (Figure 1) is the primary nesting area, supporting a nesting population of approximately 6,000 turtles. Recent evidence suggests that the Trinidadian population is stable, or possibly increasing due to conservation measures being enacted on northeastern beaches during the nesting season (Eckert pers. comm.). While other populations in the region continue to decline, Trinidad's have responded positively to efforts initiated in the early 1990's by local conservation groups formed to protect important nesting beaches. As the turtles protected by beach conservation efforts return to Trinidad to nest, they are now being threatened by nearshore fishing practices.

Figure 1. Location of fishing villages on the north and east coasts of Trinidad.



TRINIDAD FISHING INDUSTRY

The Trinidadian fishing industry consists primarily of small scale artisanal fishers operating from fishing ports interspersed around the island. Fishers use 'pirogues', which are 15-20 foot long, open deck fiberglass boats to access the coastal fishery. Although the pirogues are capable of traveling longer distances, the fishers typically stay within a few miles of their home ports.

There are 65 landing sites in Trinidad, including 8 on the east coast and 9 on the north coast. Reports vary on the total number of fishing boats on these coasts, and the numbers that use gillnets. Nagassar (2000) reports the results of a 1998 census (Chan A Shing 1999), stating that there are 76 boats on the east cost, 31 of which use gillnets, and 147 boats on the north coast, 34 of which use gillnets. Lee Lum (2003) also reports 31 gillnet operators on the east coast, but she reports that 80 boats use gillnets on the north coast. This discrepancy results from Lee Lum's inclusion of a west coast landing site that uses gillnets on the north coast during the turtle nesting season. This inclusion makes Lee Lum's estimate of the total fishing fleet more relevant for analyses and recommendations.

Fish Target Species

Fishers target a variety of fish species during the course of the year. Table 1 lists the species commonly caught in the gillnet fishery.

Table 1. List of species caught in the fishery of Trinidad and Tobago (from Nagassar 2000).

Anchovy (*Cetengraulis edentulus*)	Macrio Tuna *(Katsuwonus pelamis)*
Atlantic Bumper *(Chloroscombrus chrysurus)*	Maryanne *(Holocentrus ascensionis)*
Beechine (Sphyraena guachancho)	Moonshine *(Selene spp.)*
Blacktip Shark (*Carcharhinus limbatus)*	Mullet *(Mugil curema)*
Blinch *(Diapterus rhombeus)*	Ocean gar
Blue bone (Strongylura marine)	Pampano *(Trachinotus carolinus)*
Blue marlin *(Makaira nigricans)*	Redfish *(Lutjanus spp.)*
Bonito *(Euthynnus alletteratus)*	Sailfish *(Istiophorus albicans)*
Crevalle Jack *(Caranx hippos)*	Sea Catfish *(Bagre spp.)*
Cutlassfish *(Trichiurus lepturus)*	Shark *(Carcharhinus spp.)*
Dolphin *(Coryphaena hippurus)*	Sierra Mackerel *(Scomberomorus brasiliensis)*
Flying fish	Snook *(Centropomus ensiferus)*
Grand ecaille *(Megalops atlanticus)*	Tuna *(Thunnus spp.)*
Grunt *(Haemulon spp.)*	Weakfish *(Cynoscion spp.)*
Herring	Whitefish
Jack	Whitemouth Croaker *(Micropogonias furnieri)*
Kingfish *(Scomberomorus cavalla)*	Zapate *(Ogoliplites saurus)*
Mackerel Tuna	

Gear

The fishers employ several types of gear, each of which differs in its efficiency at catching the target species. The gear includes several types of hand lines, fish pots, and gillnets.

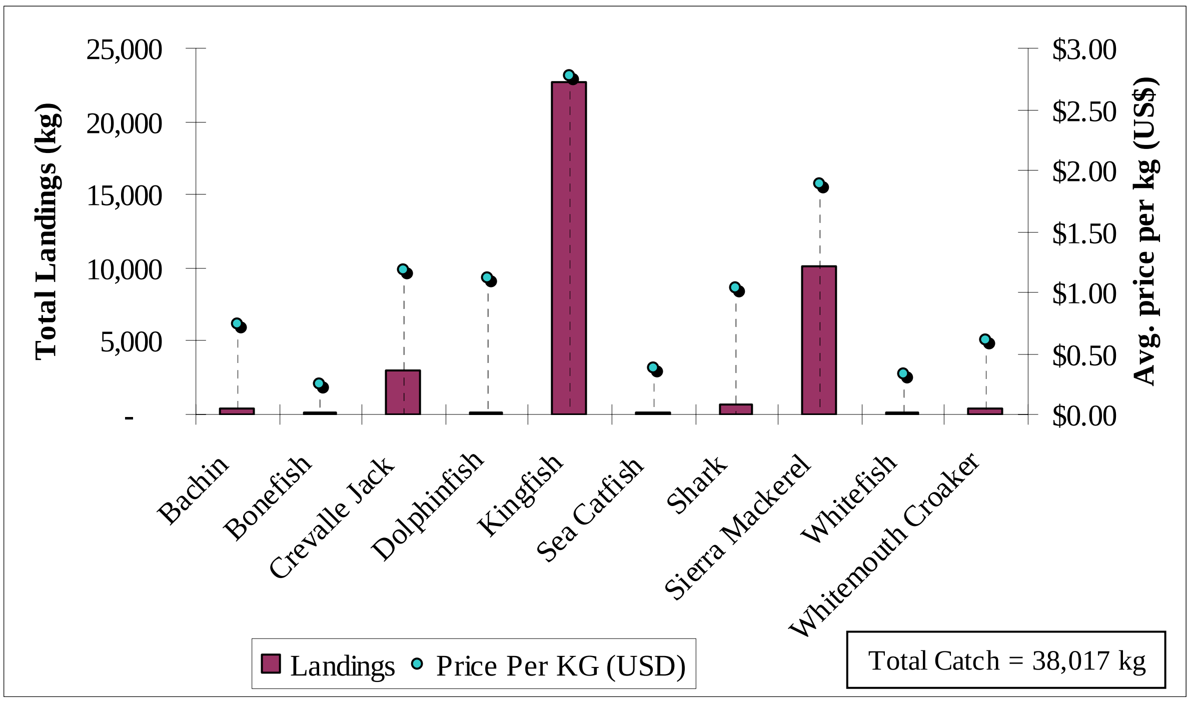
Hand Lines

Hand line fishing methods are the most selective gear used. Fishers vary between moving and stationary methods that may be set just below the water surface or on the sea floor. Hand lines include multiple techniques such as trolling, banking and live-bait fishing. Each of these are discussed in more detail below. In all of these methods, lines are kept on a plastic spool, approximately 1 foot in diameter and manually let out and pulled in.

Trolling

Trolling and banking are the most commonly used hand line methods during the nesting season. Trolling involves driving the boat while towing lines set with up to 3 baited hooks. Fishers tow hooks just below the water surface in order to target upper-pelagic species such as kingfish and carite. Trolling is highly selective, landing almost exclusively kingfish and sierra mackerel, both of which command high prices from consumers (Figure 2).

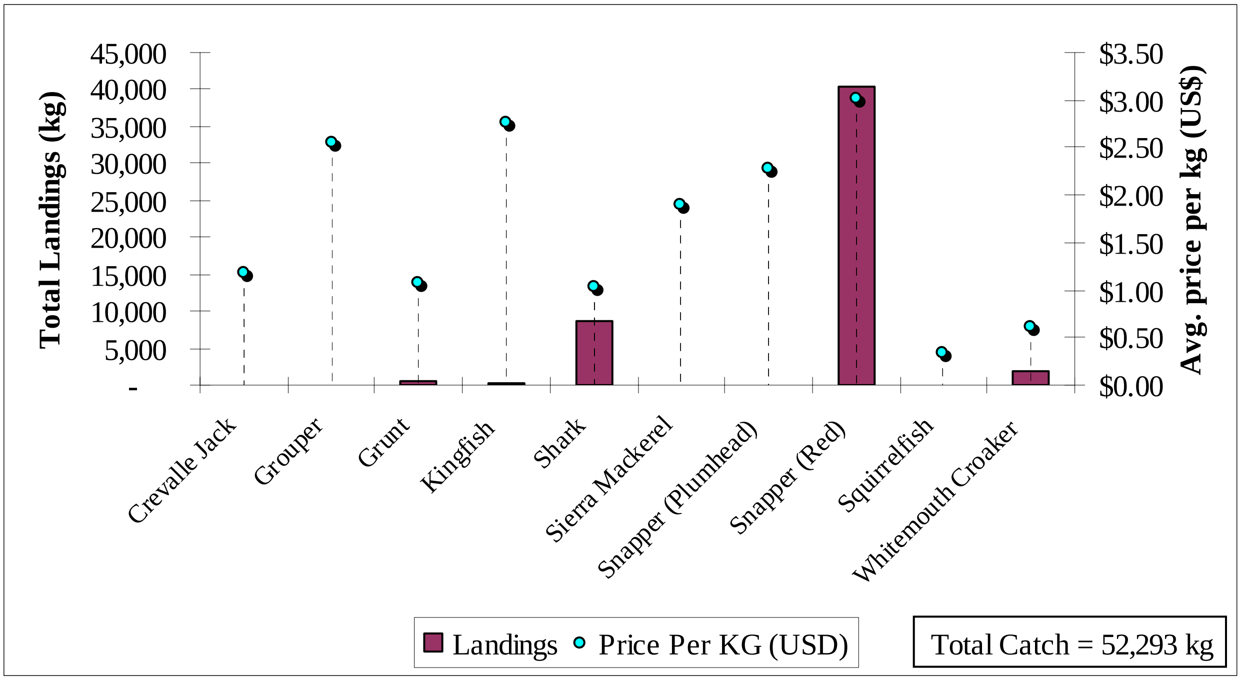
Figure 2. Trolling landing data from northeast Trinidad Ports, 2000-2004.



Banking

Banking consists of setting a weighted line with multiple baited hooks on the seafloor. The pirogue is allowed to drift with the current. Fishers bank with multiple lines concurrently, as the motion of the pirogue through swells creates movement of the lines. Banking typically targets benthic species, primarily shark and red snapper (Figure 3).

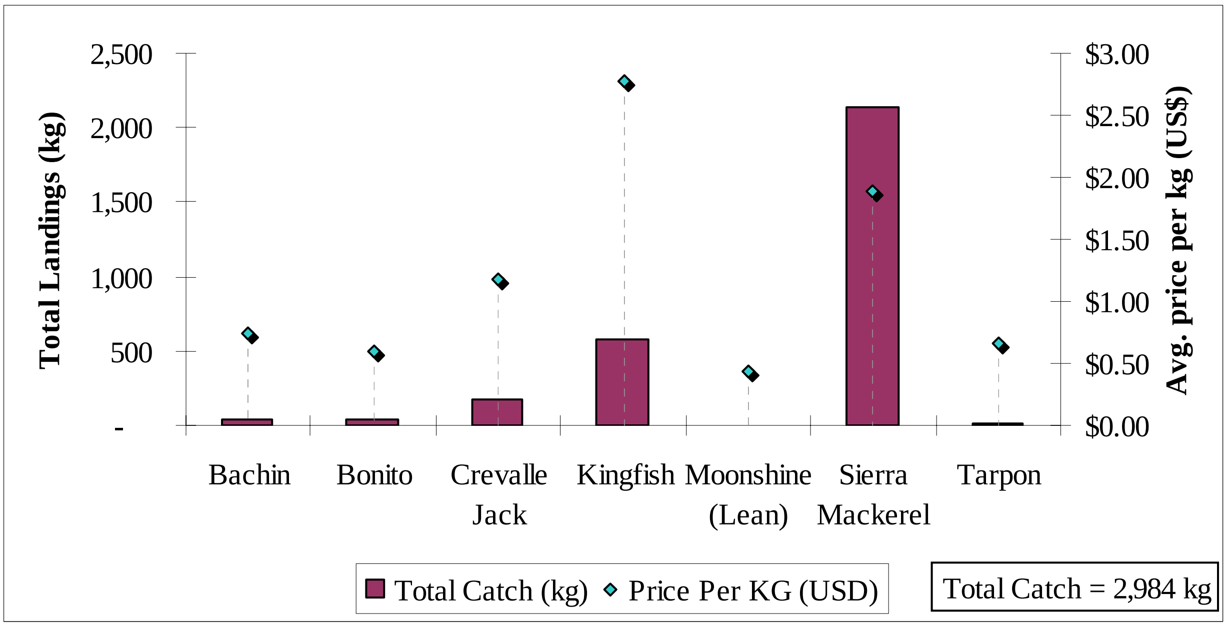
Figure 3. Banking landing data from northeast Trinidad Ports, 2000-2004.



Live Bait Fishing

Live-bait fishing, known as "a la vive", may be employed seasonally, but success depends on the seasonal availability of Jashua (*Sardinella aurita*), the most commonly used live bait. Since Jashua are generally not catchable during the leatherback nesting season, a la vive is not currently a viable alternative method (Eckert & Eckert 2005). The total a la vive landings are much lower than other hand-line methods (Figure 4), although this may be the result of much lower effort with this method.

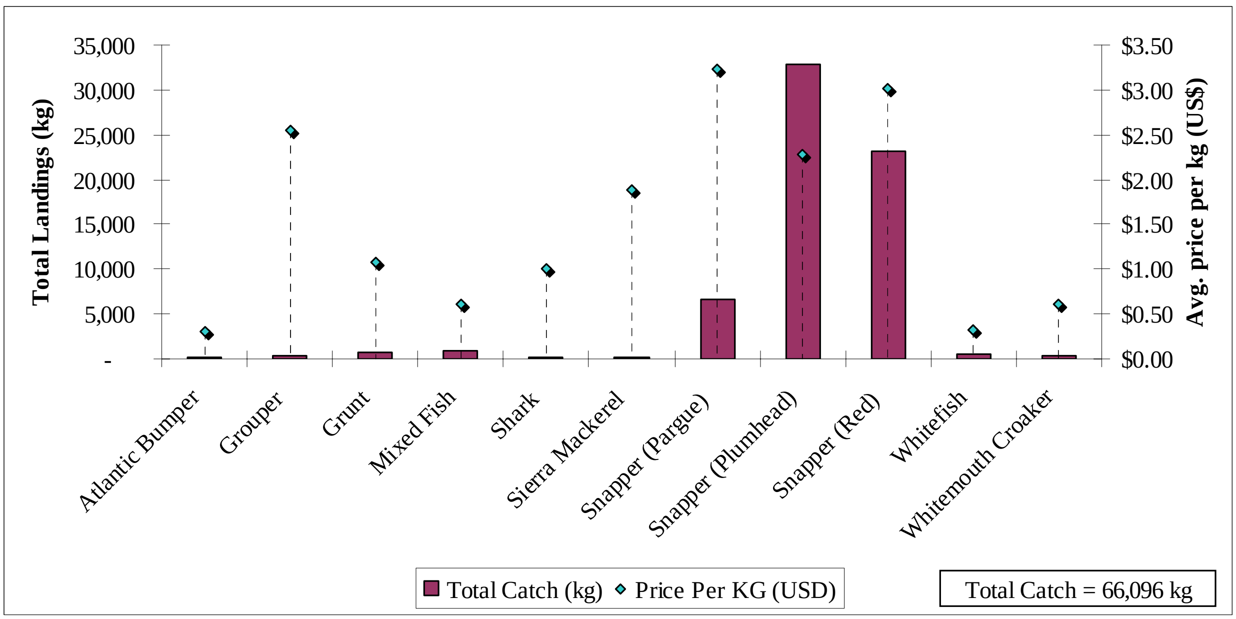
Figure 4. A la vive landing data from northeast Trinidad Ports, 2000-2004.



Fish Pots/Traps

Fish pots are cages that are baited and sunk to the sea floor. Fish pots are less selective than hand lines, resulting in higher finfish bycatch, primarily of sea catfish, which are not saleable. Fish pots are often constructed of less expensive materials that corrode easily. This is done intentionally to reduce the damage done by ghost-fishing of pots that fishers are unable to retrieve. Fish pots primarily target the demersal snapper species. Fish pots target several species resident in Trinidad, including red snapper, all of which are commercially valuable (Figure 5).

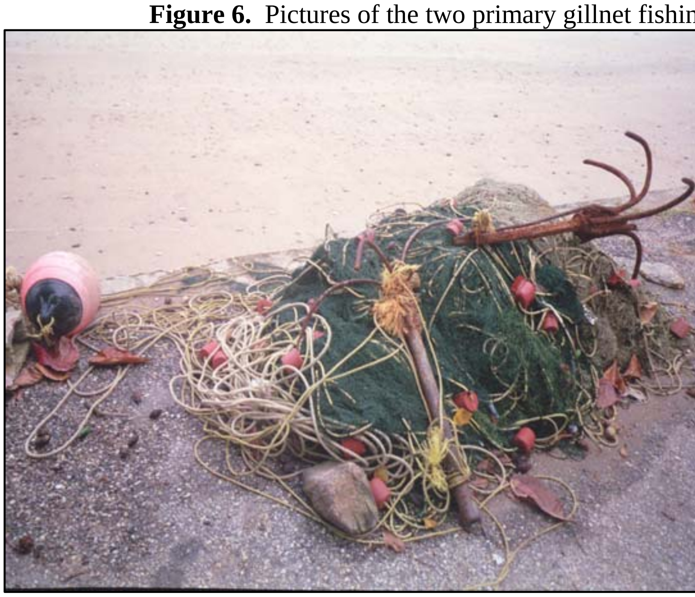
Figure 5. Fish pot landing data from northeast Trinidad Ports, 2000-2004.



Gillnets

Gillnets are the least selective fishing gear used in Trinidad's coastal fishery, and are commonly regarded to cause high impacts to non-target species (Chuenpagdee et al. 2003; Morgan & Chuenpagdee 2003). Current fishery regulations state that gillnets must have a minimum diagonal mesh size of 4 inches (Gomez pers. comm.). In Trinidad, fishers use two gillnetting methods, each with gillnets made of different materials. Bottom-set gillnetting involves anchoring the net to the seafloor, while drift netting, commonly known in Trinidad as filletting, involves floating the entire net just below the surface of the water. Bottom-set gillnets are typically constructed of monofilament line, whereas top-set nets are constructed of multifilament nylon (Figure 6). These fishing techniques are conducted year-round in northeastern Trinidad.

Figure 6. Pictures of the two primary gillnet fishing gears, drift nets and bottom-set nets.



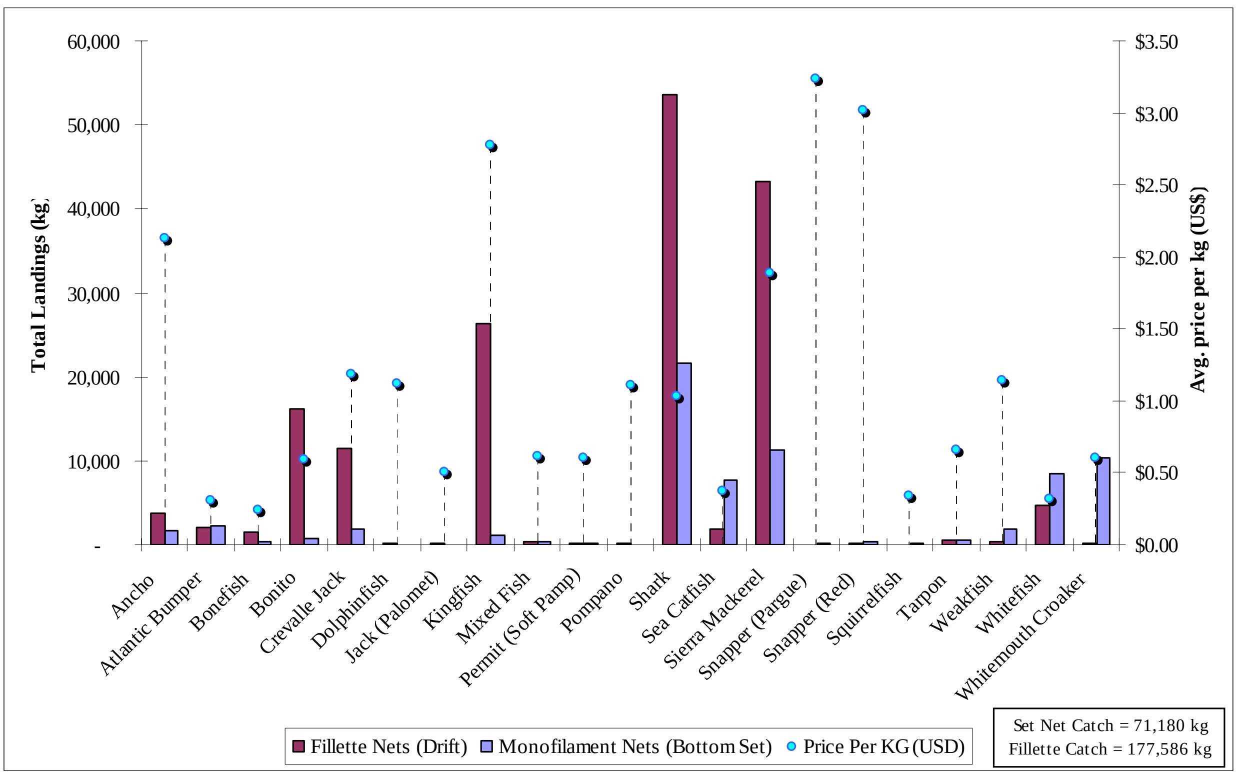
Fillette
(Multifilament drift nets)

Bottom nets
(Monofilament set nets)

Rather than measuring gillnets based on their overall length, fishers measure gillnets by their weight. Bottom-set nets may weigh between 50-150 lbs., while fillette nets may reach 250 lbs. or more. Nagassar (2000) reported an average monofilament net weight of approximately 100 lbs. and an average fillette net weight of approximately 150 lbs. She found that island-wide, monofilament nets comprise 60% of the total number of nets. Gillnet fishing is not selective, and the assemblage of fish caught is very large.

The value of the catch depends highly on the species caught, with certain species being highly valued, such as kingfish and sierra mackerel. Many other less valuable species are kept only when nothing else is caught. Multifilament and bottom nets target similar species, but there is a large difference between the relative proportion and total catch of species. Figure 7 shows the total landings and price per kilogram of the species most commonly caught in monofilament and fillette gillnets as recorded by fisheries observers from 2000-2004 in villages near leatherback nesting beaches. Although gillnets catch large numbers of valuable species, the gillnet fishery lands an overwhelming majority of the "trash fish" species that hold little economic value.

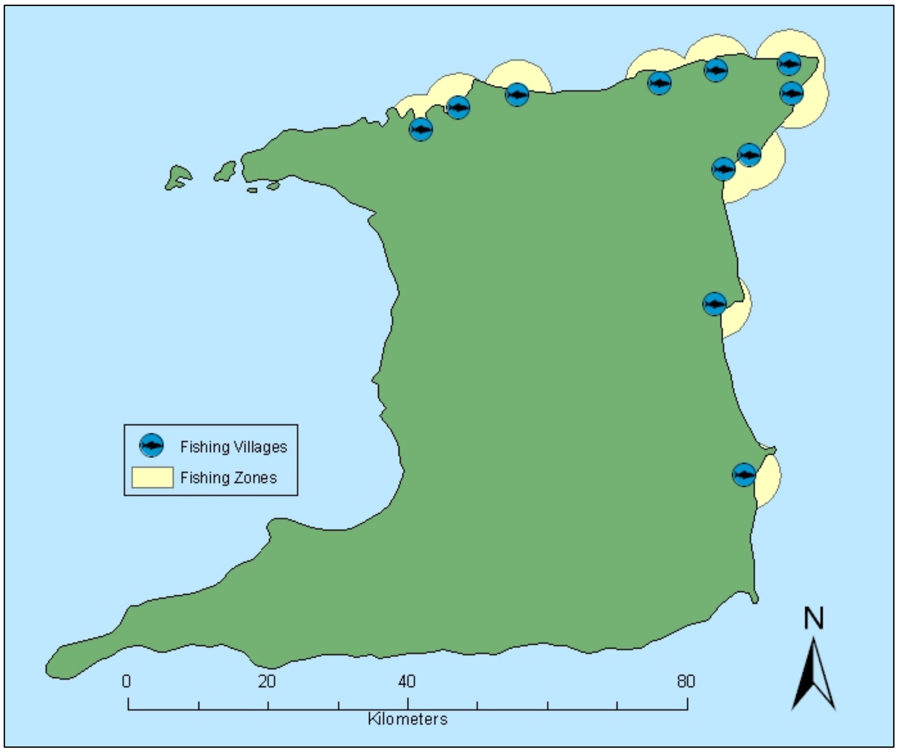
Figure 7. Gillnet landing data from northeast Trinidad Ports, 2000-2004.



Fishing Effort

Based on data from Lee Lum (2003) and Nagassar (2000), there are approximately 110 gillnet fishers operating on the north and east coasts. The fishers operate primarily near their home fishing ports (Fig. 8), generally within a few miles. Depending on weather and other conditions, the fishers will typically spend at least 15-20 days per month at sea year-round.

Figure 8. Location of fishing villages and 5 kilometer fishing zones around ports.



Bycatch of Leatherbacks

Considering the level of effort, the number of turtles caught annually in Trinidadian gillnets is an issue of concern. A 2003 survey conducted by the Institute of Marine Affairs concluded that in 2000, nearly 7,000 leatherbacks were captured in gillnets on the north and east coasts, and their survival rate was approximately 71% (Lee Lum 2003). Lee Lum administered a questionnaire to more than 100 gillnet fishers island-wide, representing more than 58% of the reported gillnet boats. The survey was completed over 11 months from March 2001-February

2002. Table 2 presents the north and east coast survey results, which were calculated by assuming a linear relationship between the survey results, and multiplying the results by the appropriate factor to the total number of fishing boats.

Table 2. Projected total incidental capture and live releases of leatherback turtles in 2000. (Lee Lum 2003)

Category	North Coast	East Coast	Total
Number of Gillnet Boats	80	31	111
Number of Turtles Capture	5,159	1,759	6,918
Number Released Alive	3,788	1,158	4,946
Percent Released Alive	73%	66%	71%

This projection suggests that nearly all leatherbacks nesting in Trinidad will be caught in gillnets during the nesting season, with nearly 30% of them drowning in the process. These estimates were based on the fisher recollection of the number of turtles caught previously, and then extrapolated to the overall fishing community. This methodology necessitates assumptions about the fishing effort and the accuracy of reporting of the previous year's bycatch. Because the survey was administered during the 2001 leatherback nesting season, it is possible that fishers may have included catches from multiple years when they reported their bycatch. From my own informal conversations with fishers, it was apparent that some fishers tend to catch a large number of turtles, while others catch very few. Thus, the linear extrapolation of survey results to the entire fishing industry may greatly overestimate the number of turtles caught . This calls into question the applicability of the survey results to management decisions. The quantitative nature of the data and analyses to be conducted suggest that a different approach needs to be taken to obtain a reliable, accurate estimate of leatherback bycatch.

The goal of this project was to initiate a pilot program to determine the extent of interactions between leatherback turtles and Trinidad's coastal fishery and to develop more quantified methodology for investigating this problem. Specifically, I sought to begin collecting data to investigate the following questions:

- What are the mortality rates of turtles caught in monofilament set nets and multifilament drift nets? Is there a difference?
- How does the use of fishing gear change over the course of the turtle nesting season? Is there a pattern to those changes and are these changes pre-planned or reactive?
- What level of support exists among gillnet fishers to use alternative gear during the nesting season?

METHODS

There are approximately 50-60 boats fishing from these villages, of which about 15 employ gillnets in the northeast region of Trinidad (Lee Lum 2003; Nagassar 2000) . This project involved the recruitment of fisher volunteers in local communities to collect data. The primary fishing villages involved were Toco, Matelot, Grande Riviere and Balandra. There were three types of information that this project required—fishing effort, number of leatherbacks caught in gillnets and number of leatherbacks stranding on beaches. Overall fishing effort was estimated based on numbers of gillnet fishermen and observer data supplied by the Fisheries Division. For the purpose of bycatch index calculations, effort was based on gillnet length fished per day, using data from participating fishers only.

To address bycatch mortality rates, I initiated meetings in the fishing villages of Toco, Grande Riviere and Matelot. These meetings were advertised by Fisheries Division, and all fishers and interested community members were invited to attend. During these meetings, I explained the goals of the project, and recruited gillnet fishers who were willing to report all incidental catches of turtles. After the meetings, I made arrangements to travel to sea with volunteer fishers to demonstrate tagging and data recording procedures. As no turtles were caught in gillnets on the days I went to sea with the fishers, I could not demonstrate tagging procedures. As a result, I did not give fishers tagging equipment, so any turtles they caught could not be identified if they were recaptured or if they stranded.

I modified strandings data forms provided by WIDECAST, which I gave to fishers to record any bycatch incidents (see Appendix). I provided the data forms, printed on waterproof paper, clipboard cases and mechanical pencils for fishers to keep on their pirogues while fishing. I explained the data reporting forms to fishers, and showed to them how to complete the forms. Although I was unable to show fishers how to tag turtles or complete data forms at sea, the trips served to build rapport between myself and the fishers, who provided a great deal of information about the fishing industry and issues facing them.

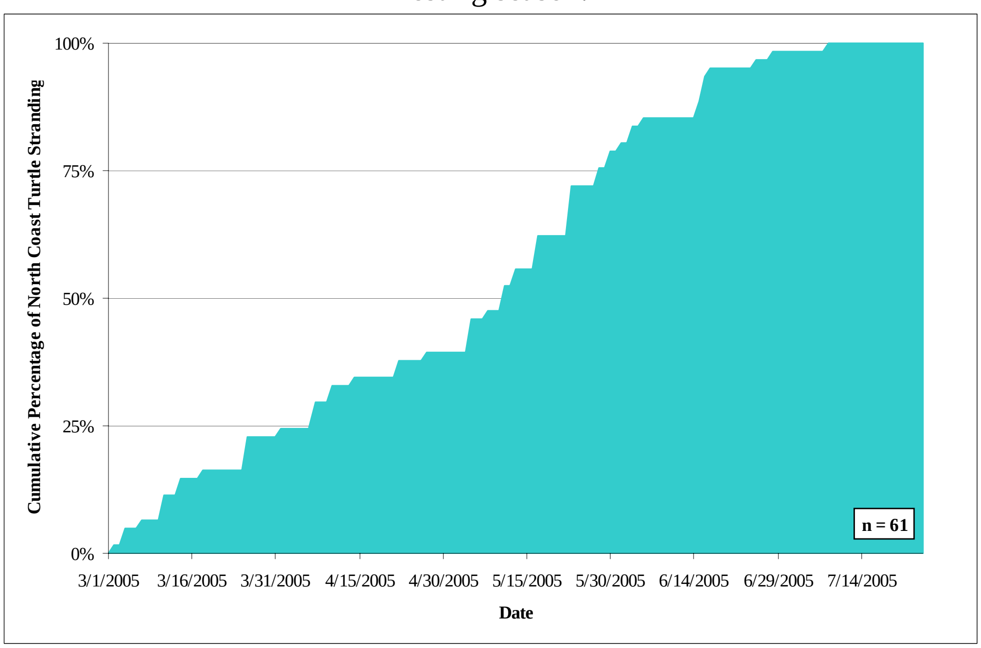
Turtle stranding records were compiled from two sources. During recruitment meetings, community members in Toco and Matelot were identified who already received notification of stranded turtles in their communities. These people agreed to relay this information to me as they received it. When reported, I traveled to the locations to collect data on the stranded turtles, primarily checking for flipper or PIT tags. Members of the local conservation group, Pawi, maintained records for the entire nesting season of any stranded turtles they encountered on the north coast. In addition to records made by others, I also conducted biweekly surveys of the coastline from Matura on the east coast to Matelot on the north coast. These surveys were conducted by driving on the coastal roads, and were augmented in July by hiring a boat to survey the coastline from the sea. As the coastline had long sections of rocky cliffs which were not visible from the road, sea-based surveys allowed for more complete coverage of the coastline than was possible with car-based surveys.

RESULTS

Strandings

During two months in Trinidad, I observed a total of 10 leatherbacks stranded on the north and east coasts. Of these, none had PIT tags, and only 1 had a flipper tag. They were all found by June 17th. This is noteworthy because late May and early June is the peak nesting season, when turtle concentrations on the nesting beaches are at their highest. The data supplied by the Pawi Club show a similar temporal trend of strandings on the north coast. The Pawi Club recorded 51 strandings, starting on March 2nd. With these data combined, they support claims made by fishers that although peak nesting occurs in June and July, peak bycatch occurs earlier in the year (Figure 9). In fact, nearly 75% of the total observed strandings had occurred before I began this project in late May.

Figure 9. Cumulative percentage of leatherback strandings on the north coast during the 2005 nesting season.



During the nesting season, 61 leatherbacks stranded on northeastern Trinidad beaches. Similar to the data for turtles caught at sea, only 13 of the stranded turtles was located alone. The majority (79%) were co-located with other stranded turtles, suggesting a pattern of aggregation of turtles in commonly fished areas.

Bycatch Reports

During June and July, I received reports on a total of 38 leatherbacks captured in fishing nets. Table 3 summarizes these reportings. Multifilament drift nets are used more extensively than monofilament set nets, with a total driftnet catch more than double that of the set nets. Comparably, fishers caught more than twice as many leatherbacks in driftnets than set nets. As expected, drift nets had a much higher survival proportion than set nets. It is remarkable to note that 4 turtles caught in bottom nets were released alive. These turtles likely became entangled shortly before the fishers returned to their nets in the morning. None of the turtles caught at sea

Table 3. Summary of reported leatherback bycatch in northeast Trinidad during May-July, 2005.

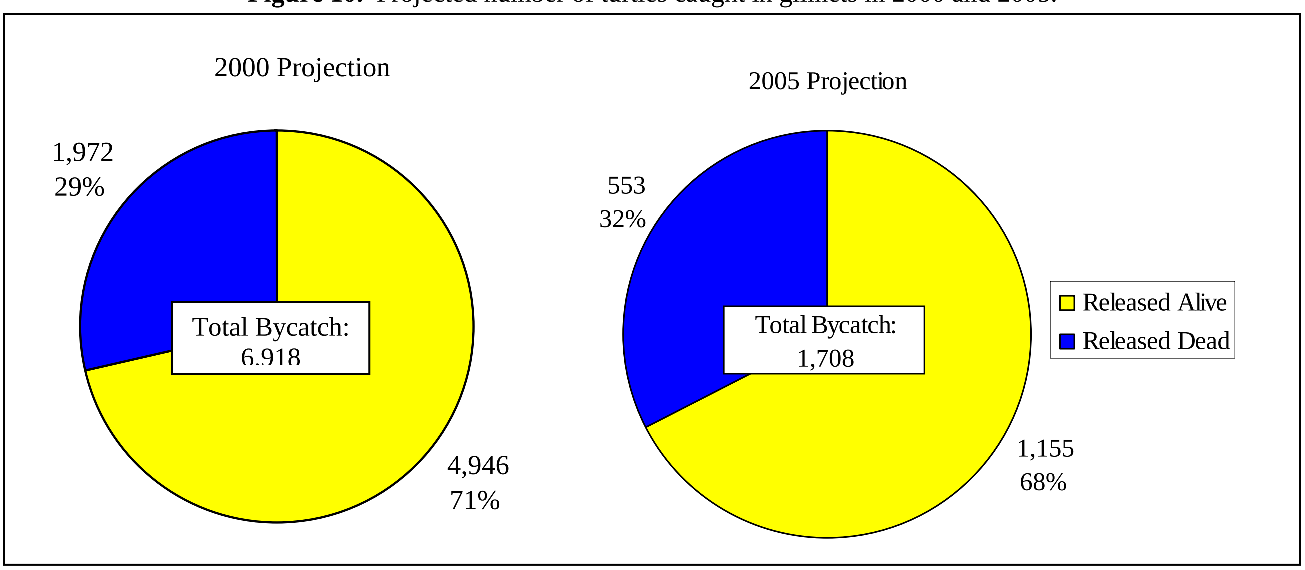
	Drift Net (Multifilament)		Set Net (Monofilament)		Total	
Alive	22	85%	4	33%	26	68%
Dead	4	15%	8	67%	12	32%
Total	26		12		38	

had flipper tags. Fishers did not have equipment to check for the presence of PIT tags, so it is unknown if the turtles they caught had been previously tagged, or caught more than once during the season. Fishers identified 27 of the turtles caught as female, 6 as male, and 5 unknown. Of the 38 turtles reported caught, 26 were caught with at least one other turtle during the same fishing trip.

Projections to all gillnet boats

Based on the bycatch reported by gillnet fishers, I attempted to emulate the calculations performed by Lee Lum to estimate the total bycatch for the fishery. The strandings data show that my data would not describe the majority of the bycatch. I assumed that a multiplier of 4 would reflect the proportion of strandings data which I was not in Trinidad to observe. I additionally used a multiplier of 11 to extrapolate my data from the 10 volunteer fishers to the entire north and east coast. Both of these multipliers assume linear spatial and temporal bycatch relationships. Figure 10 shows the results of my calculations. I estimated a substantially lower bycatch of 1,708 turtles relative to the estimated 6,918 turtles caught in 2000. However, the assumption of linearity is likely not valid in this case because of the large proportion of turtles caught during the March and April. Likewise, the assumption that the number of turtles washing ashore is directly proportional to the total number of turtles being caught and killed may not hold true. The violation of these assumptions could result in significant underestimation of the total bycatch and mortality of leatherbacks.

Figure 10. Projected number of turtles caught in gillnets in 2000 and 2005.

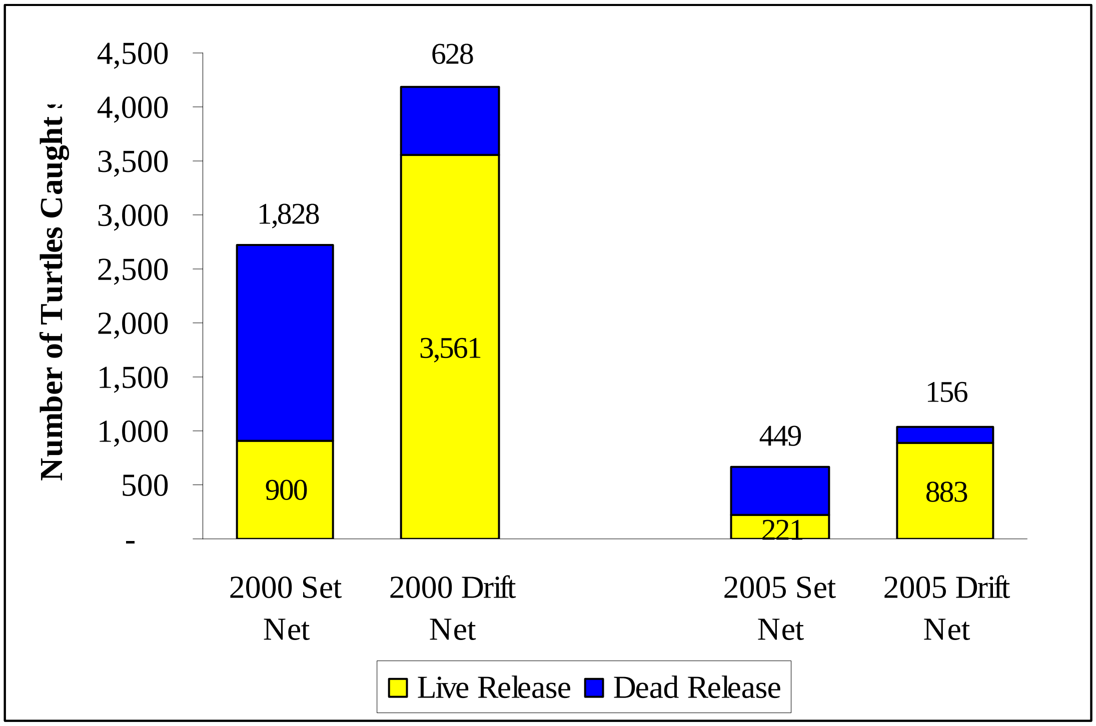


Relative Effects of Gillnet Types

When preparing for sea, fishers must choose the gear they believe will catch the highest value of fish. This choice also has important implications for the animals they catch of little or no value to them. As I discussed earlier, hook and line gears such as trolling or banking will yield large proportions of high-value fish with virtually no bycatch. Similarly, gillnet fishers can choose either to drift or set their nets to maximize catch, or to minimize bycatch.

Figure 11 shows a comparison of leatherback mortality between drift nets and set nets. I used the estimated catch in 2000, partitioning the data according to estimated proportions of drift net boats and set net boats in order to estimate the total catch and mortality of each gear method. I assessed the likelihood of mortality at 67% for set nets and 15% for drift nets. These figures were calculated based on my results from the 2005 field season. I also assessed the level of mortality for 2005, assuming the catch rates I calculated to be accurate. Although in both years the drift net catch was nearly double that of set net, the total mortality of set nets was approximately three times higher than the mortality of drift nets.

Figure 11. Estimated number of leatherbacks caught in drift nets compared with set nets.



The relatively low mortality rate of drift nets has important conservation implications for the management of Trinidad's fisheries. The disparity in mortality rates provides managers an opportunity to reduce the damage of gillnetting to the leatherback population by regulating the type of gillnet methods that can be used to catch fish.

DISCUSSION

Hall (1996) suggests four types of regulatory measures for reducing bycatch: gear or operational restrictions, individual bycatch limits, partial area or temporal closures and the initiation of positive or negative incentives. Due to limited enforcement capacity, it would be impractical to attempt bycatch limits or partial fishing closures. This leaves gear restrictions and incentives as possible regulatory measures.

Gear restrictions might include the phasing out of gillnets in favor of more selective gear types. Gillnets can be removed incrementally from the fishery by first limiting set nets, which kill the majority of turtles. This step would not address the economic losses to fishers resulting from damaged nets, so it must be coupled with incentives from the government. Incentives should be given both to assure a higher release rate of live leatherbacks and to assist in the purchase of other gear types. Releasing live turtles involves cutting large holes in the gillnets, while waiting until the turtle exhausts itself and dies allows the fisher to untangle the turtle without significant damage to the nets. The Fisheries Division should initiate a program that supplies net repair services, providing that turtles are released alive. This will provide fishers an incentive that should lead to higher live release rates. As this program will achieve increased survival from gillnet captures, but not reduce the level of incidental catch, it cannot represent a long-term bycatch reduction solution. Furthermore, enforcement or validation of this method is impossible. To address future bycatch levels, the use of gillnet gear should be phased out through progressive regulatory changes implemented in conjunction with monetary incentives and technical incentives to purchase and implement other fishing methods to be researched as per Eckert and Eckert (2005).

An objective of this pilot study was to compare the number of leatherbacks caught in gillnets with the number of stranded turtles during the same period (Epperly et al. 1996). Moreover, the original methods included the tagging of all turtles caught, so as to be able to use mark-recapture statistics to estimate total mortality. Although the data are insufficient to support this type of analysis, the study was successful in that it began the process of engaging local fishers in the collection of data that ultimately affect their livelihoods. The addition of local knowledge and input into management decisions increases the potential for success of future recovery efforts by fostering partnership between the managers and fishers (Bird et al. 2003). The data support earlier bycatch estimates made by Lee Lum (2003), particularly with respect to relative mortality rates of drift nets. Because leatherbacks commonly nest on many beaches of northeastern Trinidad, future monitoring needs to be expanded to incorporate more fishing communities on the North and East coasts.

During the course of this project, I identified a number of challenges that need to be addressed prior to the implementation of a full-scale project of bycatch monitoring and mitigation. Some data were clearly questionable, including the identification of a number of male turtles caught in late June. Since other research indicates that males should not be present in Trinidad waters at this time (James et al. 2005), this is likely a result of fishers assuming they could identify turtles without being properly trained. Better training of volunteers needs to be conducted to ensure consistency in reporting. One of the major difficulties in conducting this project was its timing. Although the nesting season extends from March until August, and the peak nesting occurs in June and July, the majority of bycatch occurs in April and May. Due to the logistics of fieldwork, by the time I began conducting recruiting meetings on May 28th [see arrow], 75% of the total number of recorded turtle strandings for the season had already occurred (Figure 2). Conversations with several fishers support the suggestion that an accurate assessment of incidental catch rates has to focus on the spring months. For future monitoring programs to accurately reflect mortality rates, they must target the most active bycatch months (March 1 – May 31).

Although volunteers were recruited in some villages, other villages which also experienced significant bycatch were not adequately represented. The use of incentives should be considered to increase participation, since many fishers will not realize an immediate benefit by participating in a monitoring program for its own sake, or for the sake of turtle conservation. From discussions with fishers, certain relatively inexpensive gear, such as GPS units, could provide sufficient incentive for participation without resulting in excessive implementation costs.

Fisheries managers must recognize that fishers are by nature independent, and will likely resist attempts to impose additional rules or regulations on what they deem should be a free-access fishery. The Fisheries Division therefore needs to continue its efforts to include all fishers and promote the use of fisher knowledge as vital to adequate management. This will improve the ability of fishers and managers to work together towards the common goal of bycatch mitigation. As their input continues to be utilized, fishers will regard themselves as a part of the management process. Their role can then be expanded from advisors to reliable data sources, and potential problems stemming from underreporting can be decreased.

THE "PERFECT STUDY"

This project provided an important insight into bycatch levels in Trinidad. However , the methods used could be improved to further elucidate the relationship between gillnets and leatherback bycatch. As stated earlier, bycatch appears to occur primarily between March-May. Any future studies must be designed to target these months specifically, regardless of the peak nesting period. Moreover, surveys of strandings should be expanded to include more of the coastline during the peak bycatch period. The use of boat-based surveys presented an opportunity to assess strandings in rocky coastal areas that cannot be surveyed from land. Since the north and east coasts consist of large segments of rocky coast not visible from land, boats should be used to conduct stranding surveys whenever possible to maximize coverage.

While independent data are important, the voluntary reportings provided by fishers cannot be replicated by other means. Trinidad presents a unique opportunity in that the goals of conservationists and fishers are similar, in that bycatch, which damages turtle populations, also represents economic hardship to fishers. In order to assess the level of incidental bycatch accurately, more fishers in more villages need to be recruited to volunteer their information about their interactions with leatherbacks. Ideally, some fishers would be recruited at each fishing port. Moreover, efforts need to be made to assess the use of coastal areas by fishers.

Research has been completed on the habitat usage by leatherbacks, but there has been little assessment made of how fishers utilize the coastal zone. Any future management actions need to be cognizant not only of how animals use the nearshore areas, but also of how people use these same areas. This research can be done while at the same time investing in the fishers by providing GPS units that they would be allowed to keep at the end of the project. By asking them to record their fishing locations, fisheries managers can gain much needed data on fishing location preferences. While the fishers are instructed in GPS usage, they can be shown the benefits to their own fishing practices, such as recording the locations of their nets or pots when they set them for easier retrieval. The data need only be retrieved by fisheries officers weekly or even monthly to be useful for later analysis.

Any future studies should also attempt to clarify the temporal relationships between fishing activities and leatherback bycatch. The establishment of timing issues such as day/night patterns, tidal cycles, or lunar position can all have potentially dramatic impacts for management. As such, all future reportings should explicitly document these variables to investigate possible linkages.

CONCLUSION

Conversations with fishers have revealed a belief that the number of leatherbacks nesting in Trinidad have increased in the past few years even as other nesting Atlantic nesting colonies have shown decreases. Interactions with gillnet fishers threaten the long-term survival of the nesting population and economic viability of the fishery. This project has demonstrated the willingness of fishers to participate in developing mechanisms to monitor themselves. Although long-term management of the fishery must be conducted by a regulatory agency, the inputs from the fishing industry have an important role to play in collecting data and assessing the impacts of proposed management actions on the fishery.

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Appendix: Data form provided to fishers

Fisher Capture Event Data Sheet

Species________________________ **Gender**________________

Date _____________**Time**___________ **Weather**____________

Weather **Key**
Broken Clouds
Clear
Overcast
Rain
Stormy/Strong Wind
Unknown

Location

Longitude ___________ **Latitude** __________

Location Name ______________________________

	Landmark Name / Number	**Dist. from Landmark**
A	____________________________	__________
B	____________________________	__________
C	____________________________	__________

Tag Number

	New
Flipper___________________	☐
Flipper___________________	☐
Flipper___________________	☐
Flipper___________________	☐
Flipper___________________	☐

Turtle Condition Upon Release

☐ Alive ☐ Dead

Diagnostic Injuries:____

____

____

____

Fishing Effort

Type of Gear:____

Mesh Size:__________________________ **Soak Time:**___________________________

Notes