

The Effect Various Bycatch Reduction Device Shapes have on *Malaclemys terrapin* and *Callinectes sapidus*

Abstract

The invention of crab pots has facilitated crab harvesting. However, abandoned crab pots (or 'ghost pots'), are dangerous for many different organisms, a key one being the Northern Diamondback Terrapin (*Malaclemys terrapin terrapin*). Terrapins fall prey to the deadly design of crab pots and often cannot escape after entering, leaving them to starve and drown. This led to the development of Bycatch Reduction Devices (BRDs), which hinder the terrapins' ability to access crab pots. They are normally rectangular in shape, but a different shape was hypothesized to be more effective. The first part of the experiment had terrapins of various sizes interacting with a crab pot with either triangular, square, or rectangular BRDs attached to see which shape was the most efficient at keeping terrapins out and/or allowing them to escape once inside the crab pot. The results indicated that the triangular BRD was the most effective. The latter part of the experiment was done to see which shape collected the most Blue Crabs (*Callinectes sapidus*) and the least bycatch daily. Nine crab pots were lowered into Barnegat Bay; three crab pots each had one of the three BRD shapes. Over the course of a week, a total of 471 crabs were caught. It was revealed that the triangular and square shapes were significantly better than the rectangles, so overall, the triangular BRD was most effective. This study is useful in that we can reduce terrapin mortality and maintain capture rates in crab pots to improve effectiveness and capture efficiency.

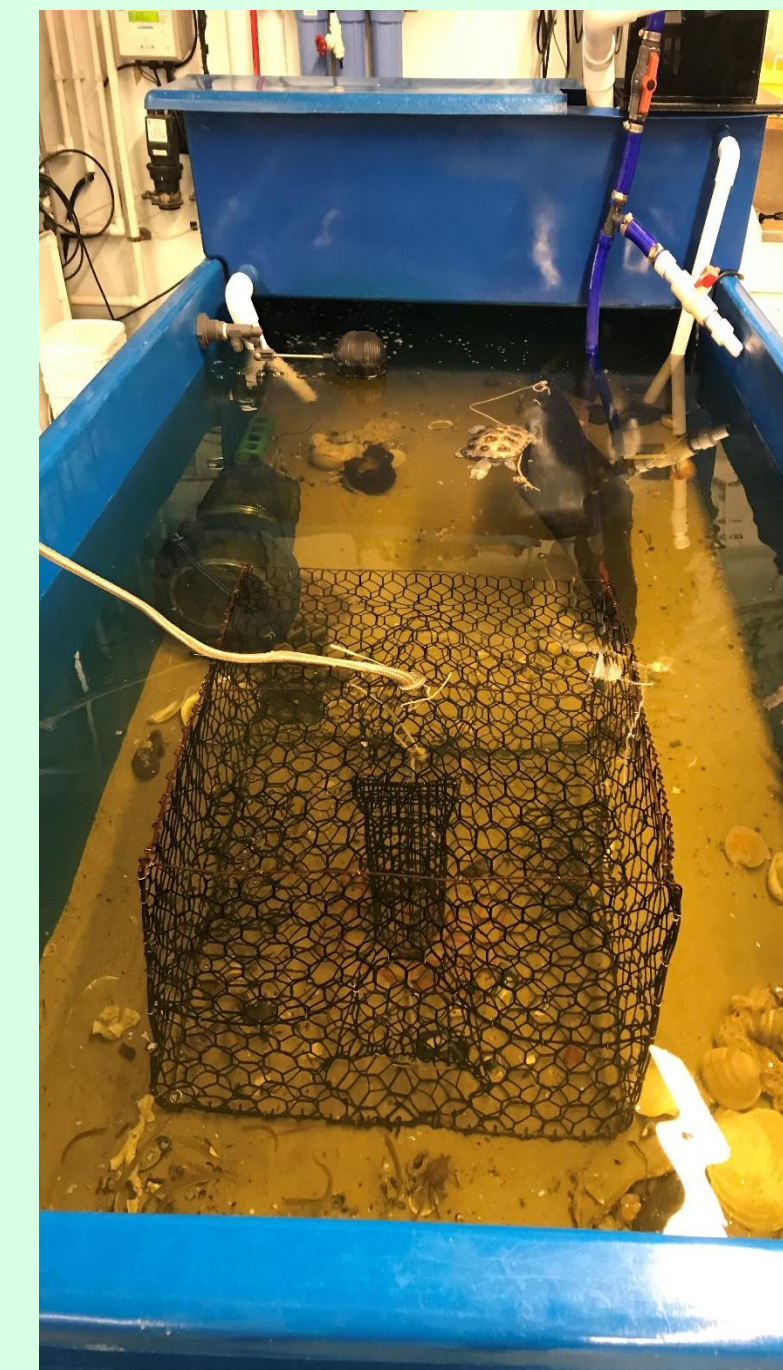


Figure 7: Tank (at MATES) and crab pot that the terrapin part of the experiment took place.

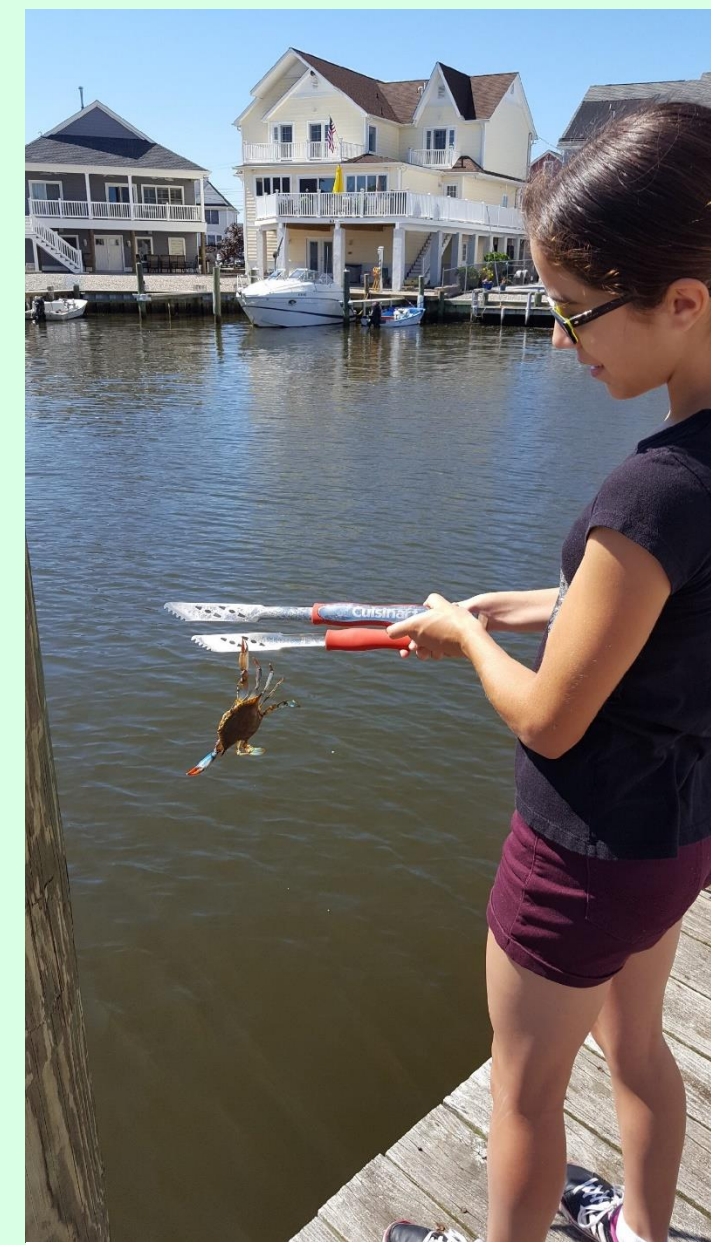


Figure 11: Myself trying to put the Blue Crab back in the water after measuring it.



Figure 12: One terrapin trapped inside the crab pot.

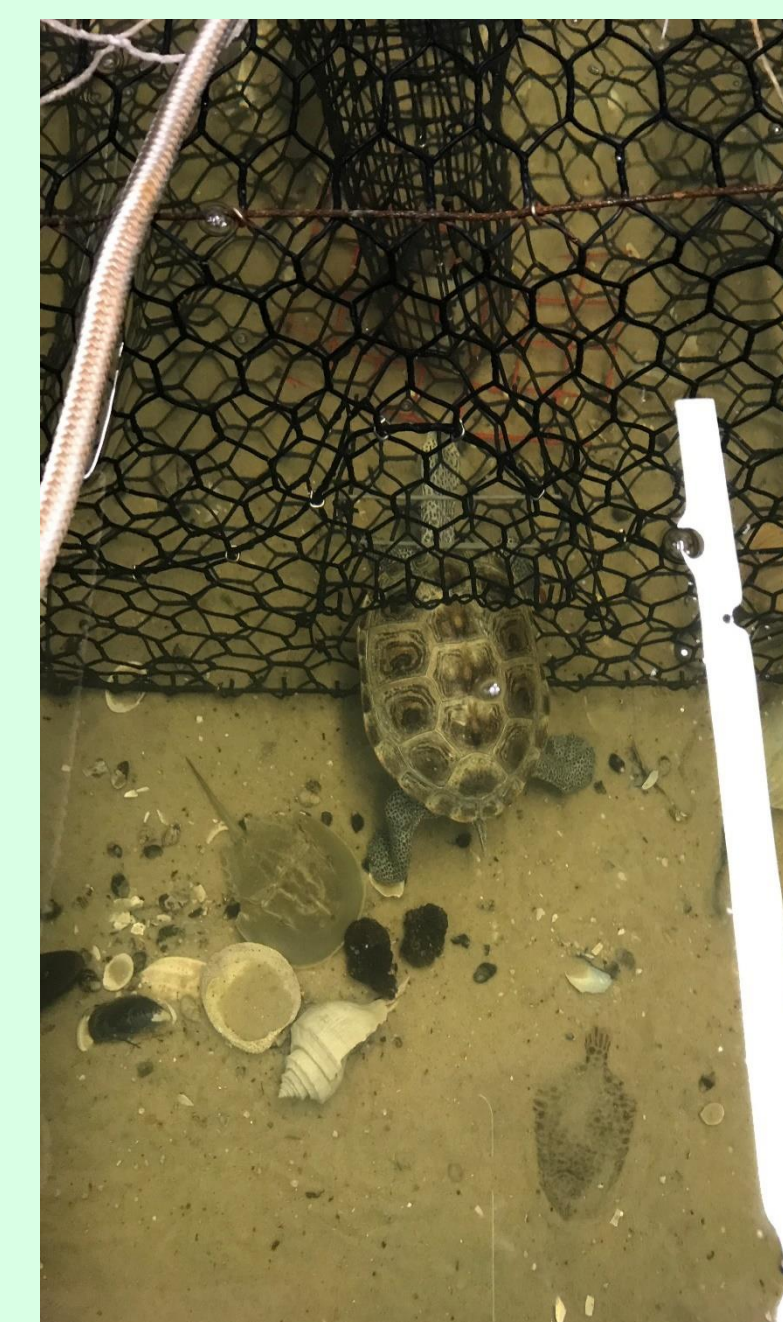


Figure 8: One of the larger terrapins struggling to access the crab pot (with rectangular BRDs attached).

Objective

To determine the efficiency of triangular and square bycatch reduction devices (BRDs) in comparison to traditional rectangular ones, in terms of limiting terrapin accessibility and admitting an adequate amount of Blue Crabs.

Methodology

Part 1: Northern Diamondback Terrapins

- Obtained four metal rectangular BRDs, and made four triangular and square version out of them
- Attached rectangular BRDs onto crab pot's funnels
- Placed crab pot into tank (Figure 7) with shrimp bait and selected terrapins, and monitored them for two hours each trial
- A timer started from 25 minutes once the crab pot was accessed. If the terrapin resurfaced before time ended, the attempt was recorded as "escaped." If underwater after 25 minutes, the crab pot and terrapin(s) was removed and it was recorded as "presumed drowned"
- The number of attempts and how many escaped was recorded
- Ran 6 more trials with the rectangular BRD shape and different terrapins in each trial. Terrapin carapace length ranged from 46 to 175 mm and height ranged from 22 to 70 mm
- Repeated the same process with triangular and square BRDs that I created

Part 2: Blue Crabs

- Created triangular and square BRDs out of the normal rectangular models
- Attached each BRD shape to 3 crab pots each
- Traveled to 2 Seville Dr. in Brick, NJ, used bunker as bait for the pots dropped them to collect species for 24 hours (Figure 9, 10)
- Returned the next day to pull up each crab pot
- Recorded how many crabs were trapped in each pot and measured the width of each crab with a ruler
- Recorded other species in the crab pot
- Emptied each crab pot and re-baited them and dropping them back in the water
- Repeated the above six steps 7 times, over the span of a week
- Compared recorded data of the different BRD shapes and conclude which one is best at letting in good-sized crabs
- Compared the conclusion to the conclusion made about the best BRD shape for keeping out terrapins from the terrapin part of the project

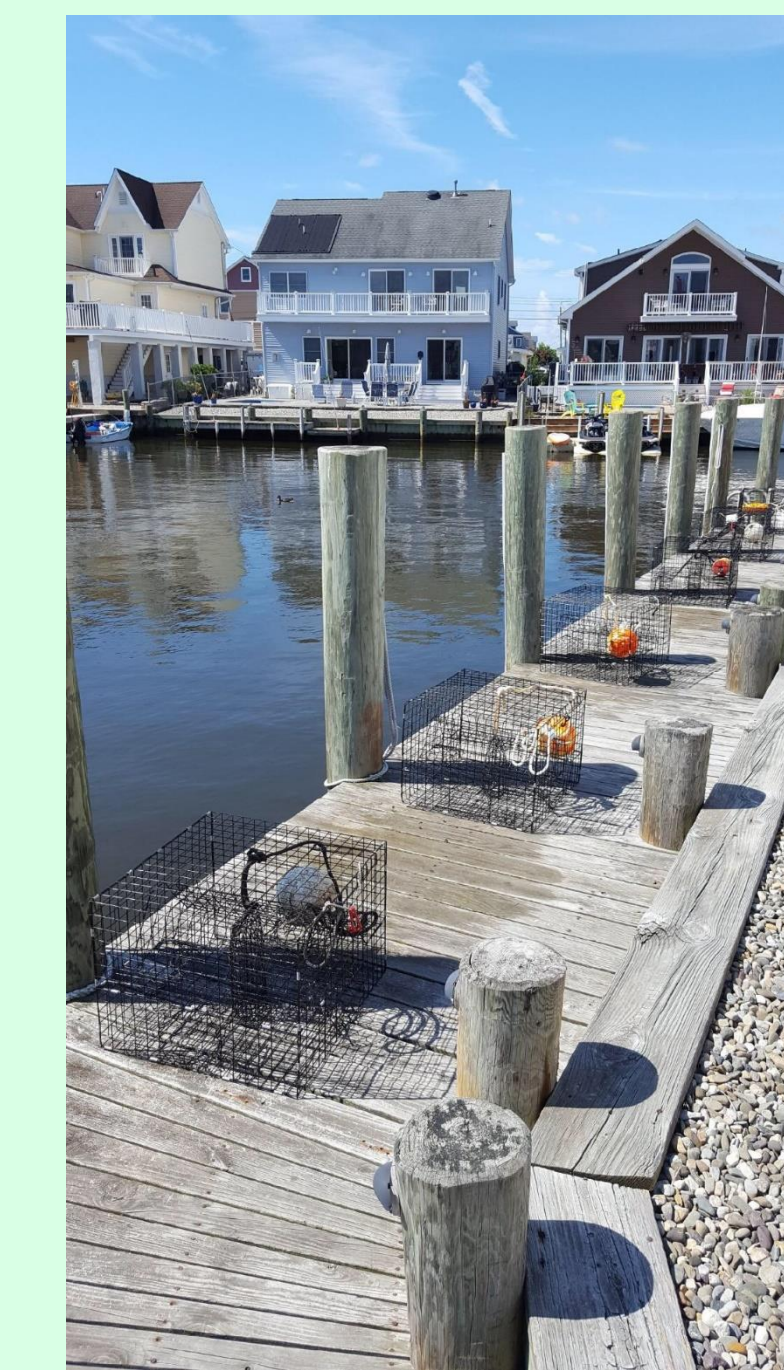


Figure 9: The six crab pots set up on the dock (3 have triangular BRDs and 3 have rectangular BRDs).



Figure 10: The remaining 3 crab pots near the dock (all have square BRDs).

Discussion

The hypothesis was proven to be correct. The hypothesis was that if rectangular BRDs were replaced with ones of different shapes, then they would reduce bycatch better because their size and shape would limit accessibility to the crab pot by terrapins, but increase crab accessibility. All of the data collected supports the conclusion that the triangular BRDs were most efficient at keeping terrapins out and allowing blue crabs in.

The smallest of the terrapins were able to access the crab pot easily because of their size, but larger terrapins had the opposite problem, their size prevented them from accessing the pot, no matter how determined they were (Figure 8). Terrapin sizes range from 4 to 5.5 inches long in males and 6 to 9 inches long in females ("Northern Diamondback Terrapin," 2016). As a result, most terrapins will be limited by BRDs, and even less are allowed through with the more restrictive size of the triangular and square BRDs. Overall, the triangular BRDs were the most effective in keeping the terrapins out (Figure 5).

For the Blue Crabs, both the triangular and square BRDs collected a statistically significantly higher amount of total crabs (Figure 1). This is likely because of the greater the flexibility of the crabs. Blue Crabs mostly move horizontally and are very flexible because of three pairs of walking legs (Cover, 2018). So while the terrapins struggle with the restrictive BRDs, crabs can orient themselves in any way without difficulty to enter the crab pot. However, the square BRD shape was the only shape that ever caught a terrapin when pulled up, so that was a major point against it, leaving the triangular shape as the best.

Conclusion

In conclusion, the triangular BRD performed the best overall for both terrapins crabs. For the crabs, the triangular and square BRDs performed significantly better than the traditional rectangular ones for the crabs, and there was no significant difference between triangular and square BRDs. The triangular shape was the best for the terrapins, as it had the highest terrapin escape rate. The triangular shape seemed to limit terrapin accessibility and allow satisfactory amounts of crabs in the most effectively. In the future, if this model was adapted to crab pots across the nation, terrapin mortality from crab pots would likely decrease, while still allowing crabbers to collect a catch just as large as catches from crab pots with rectangular BRDs or none at all.

Acknowledgements

I would like to thank my advisors for guiding throughout this project from start to finish. Also, many thanks to my parents for helping me through the whole thing: picking me up from school, and driving me to Brick every day for a week. Lastly, I'd like to thank my aunt and uncle for letting me use their dock for my project.

Selected References

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Introduction

Crab pots were invented in the 1920s and changed the way crabs were harvested forever. They are metal cages that lures crabs in with bait. Once crabs push inside, they are trapped and many are unable to escape. Crab pots can be cube-like, rectangular, circular, or pyramid-shaped and have different sized openings. They can be made from various materials, but usually, "the frames are typically composed of thick steel bars covered with netting or wire mesh," ("How Crab Pots Work," 2014). The crab pots being used in this experiment are a 2' x 2' x 2' Maryland Commercial Style Crab Pot with four mesh funnels. All crab pots have a rope attached to them, which is attached to a buoy that stays on the surface of the water, marking the pot's location.

'Ghost pots' are crab pots whose buoy lines have been severed. Often times, buoy lines are cut when debris catches on the pot, when boats hit the buoy or the line gets cut in the gears, and during storm events. Even after the original bait is gone, the pots "re-bait" themselves. As new animals get trapped in the pots and die, they attract others that then become trapped as well. One study estimated that there are 85,000 ghost pots in the Maryland portion of Chesapeake Bay alone (Soper, 2017). Animals that get stuck in a 'ghost pot' die from starvation, cannibalism, infection, and prolonged exposure to poor water quality. Most of the time, the animals caught in crab pots are Blue Crabs (*Callinectes sapidus*) and Northern Diamondback Terrapins (*Malaclemys terrapin terrapin*). Some projects such as NOAA, try to collect these derelict crab pots so they don't keep luring animals in. Others have used a device called a BRD to keep terrapins out. But animals are still dying every year from crab pots.

Is the traditional rectangular BRD the best at reducing bycatch? To answer this, it was hypothesized that if rectangular BRDs were replaced with ones of different shapes, then they will reduce bycatch more efficiently and simultaneously allow Blue Crabs access, because their shape will limit access by terrapins and admit the crabs which have more maneuverability.

Results

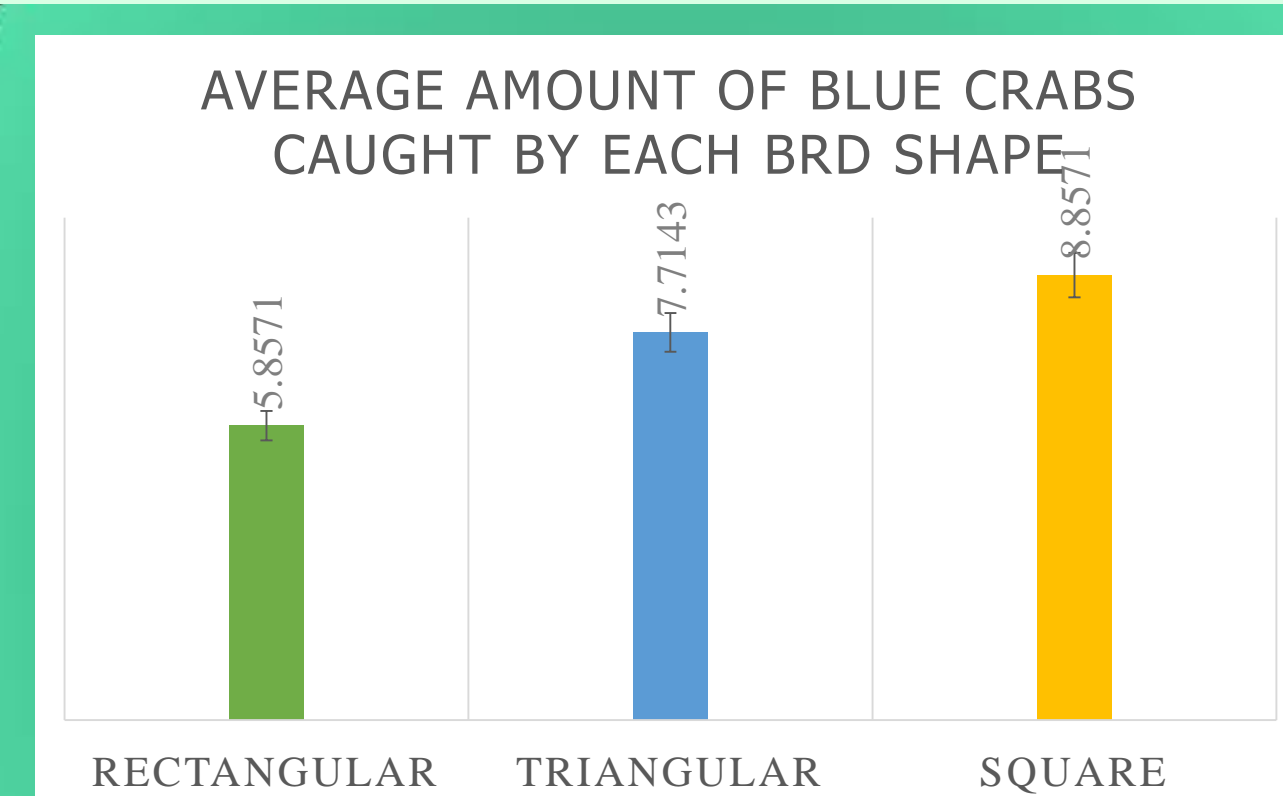


Figure 1: The average amount of all crabs that were caught in crab pots with each BRD shape. T-tests revealed statistical differences between rectangular vs. triangular BRDs and rectangular vs. square BRDs ($\alpha=0.05$, p-values were 0.02 and 0.0046, respectively).

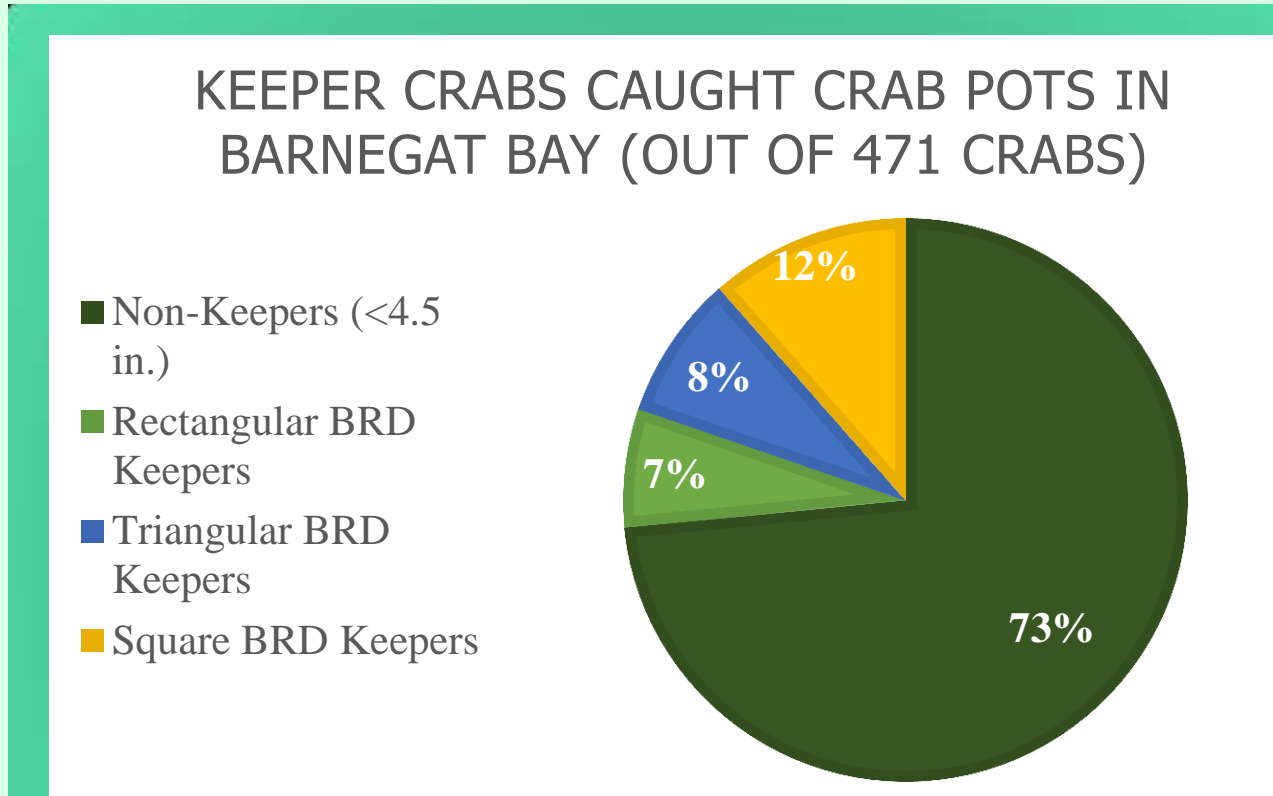


Figure 2: The percentage of keeper crabs caught by crab pots fixed with each BRD shape, out of the total 471 crabs. The square BRD had the highest amount of keeper crabs. T-tests ($\alpha=0.05$) revealed a statistical difference only between rectangular and square BRDs.

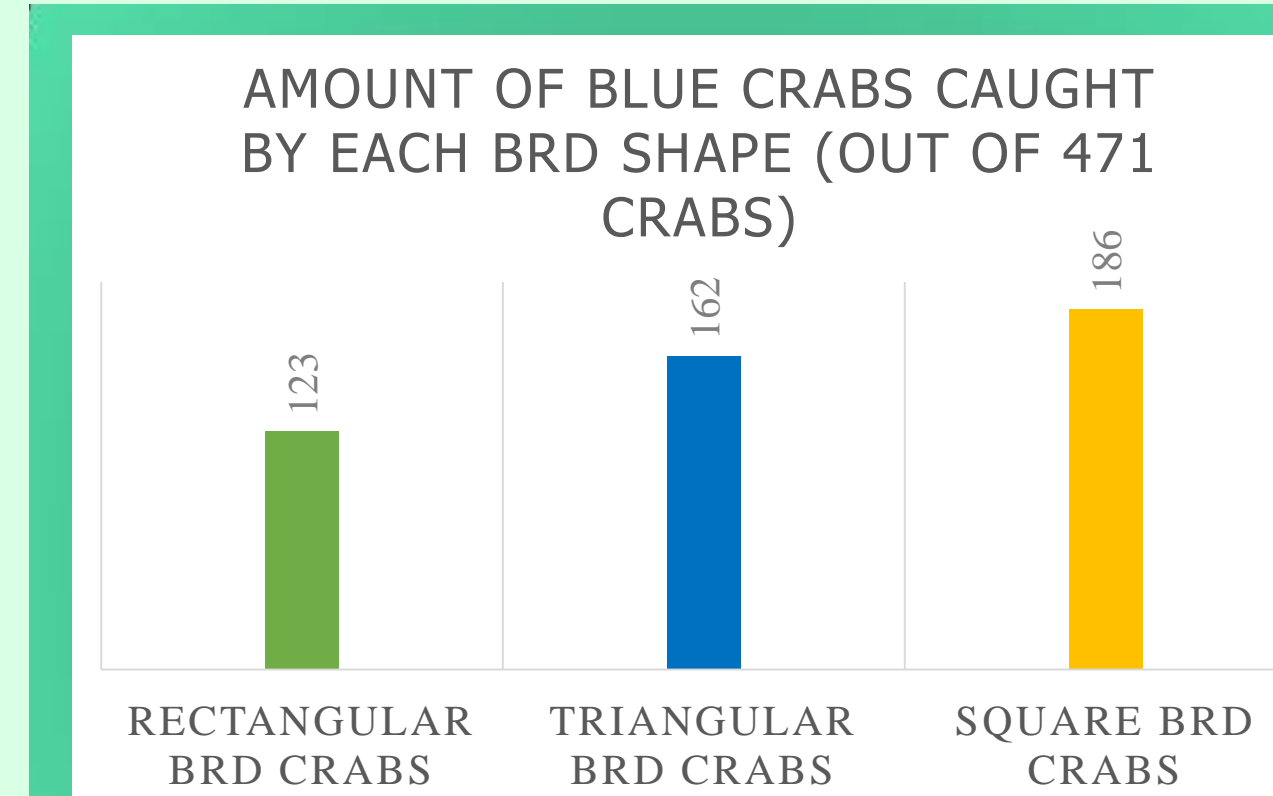


Figure 3: The amount of total crabs caught by the crab pots, separated by each BRD shape (each out of 471 crabs). The square BRD caught the most crabs.

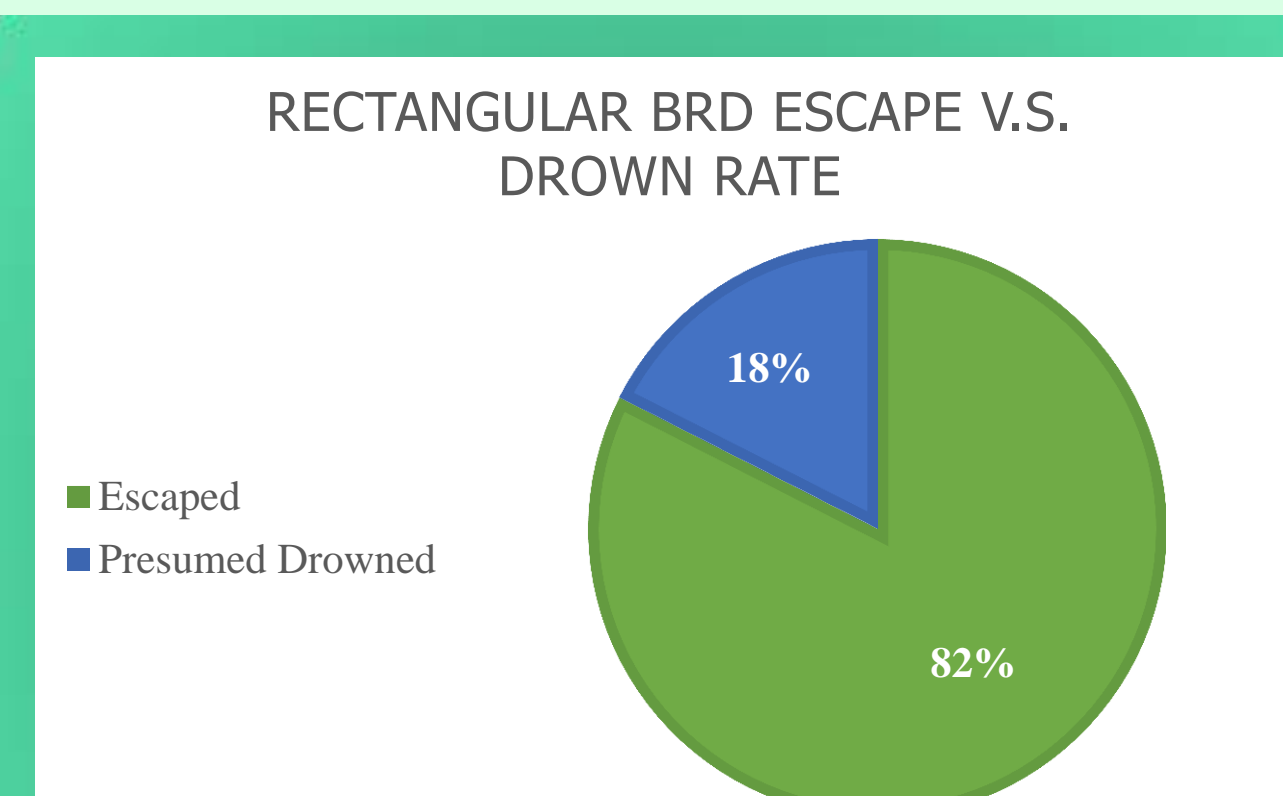


Figure 4: The percentages of terrapins (out of 40 times) that accessed the crab pot and escaped or had to be removed after 25 minutes (presumed drowned) when the rectangular BRDs were attached.

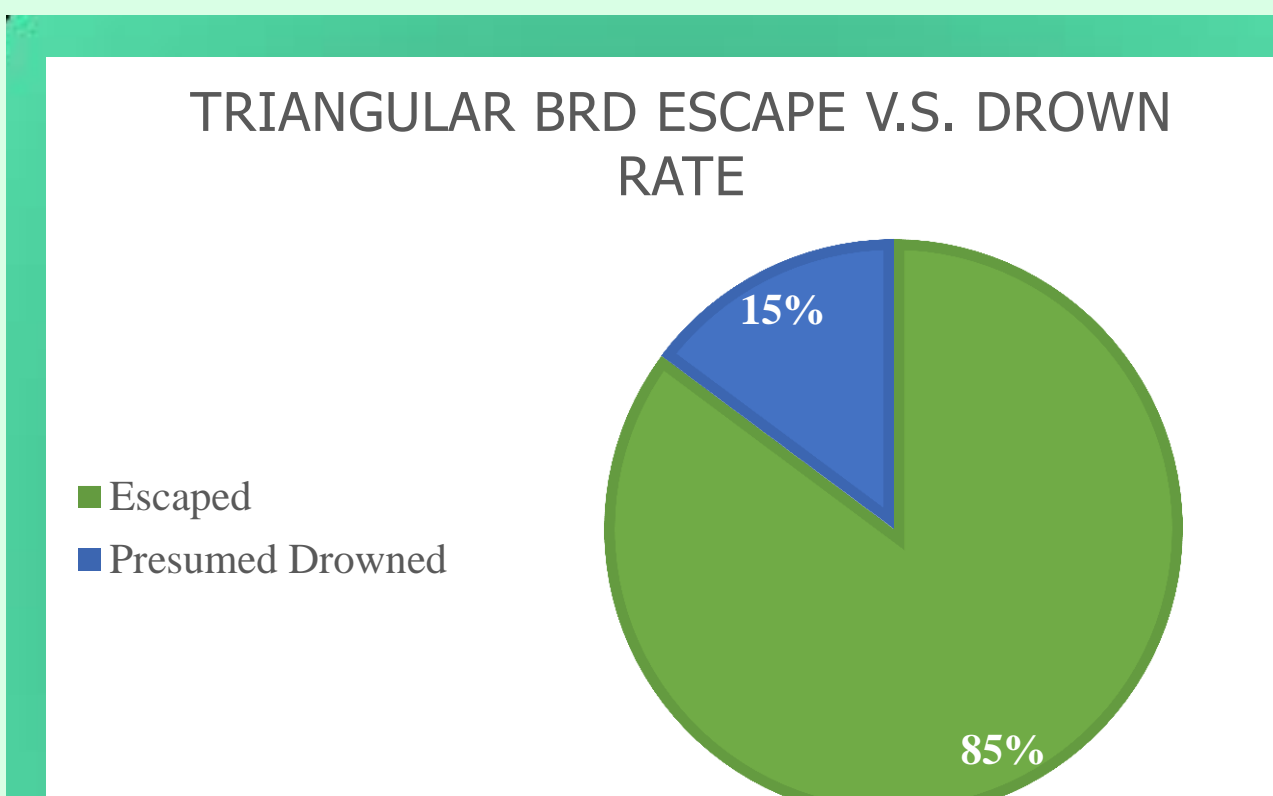


Figure 5: The percentages of terrapins (out of 27 times) that accessed the crab pot and escaped or had to be removed after 25 minutes (presumed drowned) when the triangular BRDs were attached.

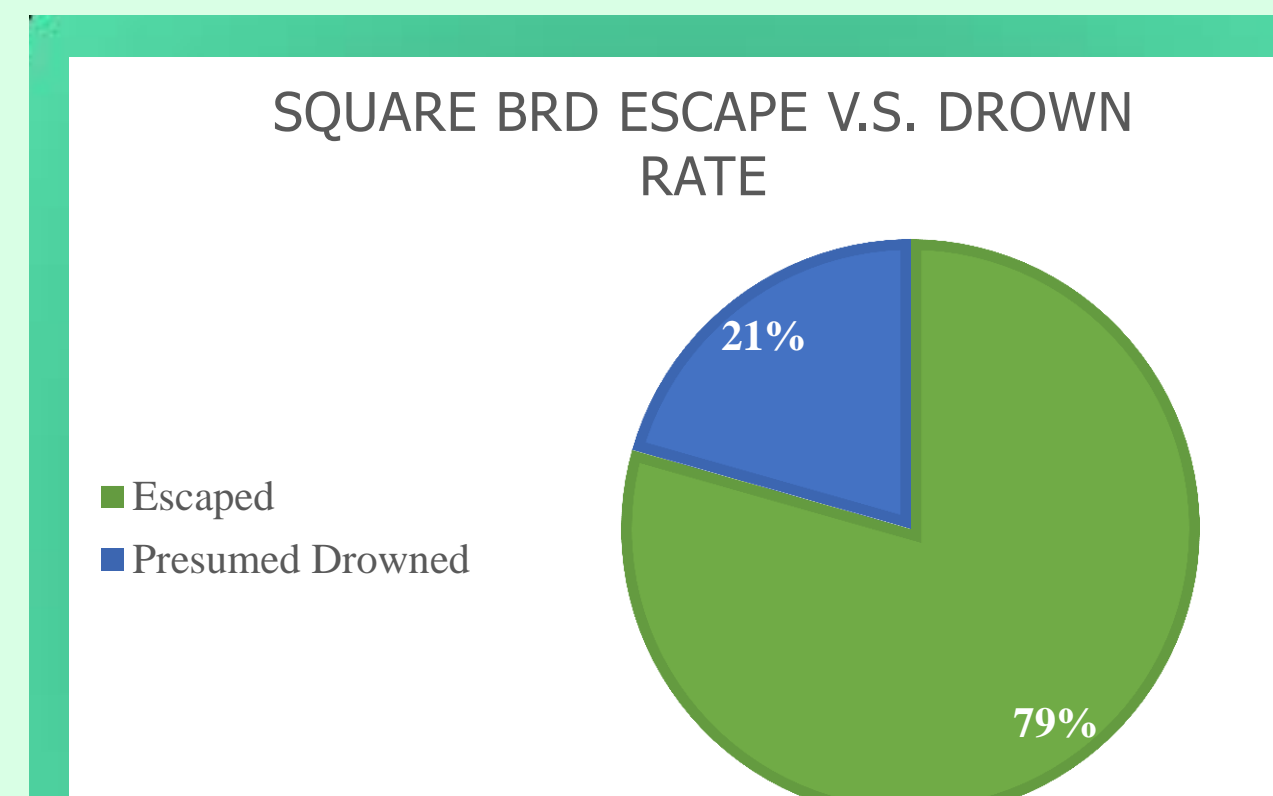


Figure 6: The percentages of terrapins (out of 34 times) that accessed the crab pot and escaped or had to be removed after 25 minutes (presumed drowned) when the square BRDs were attached.