Original Article

Analysis Of Anadara Tuberculosa Capture Analysis At The Manglares El Morro Wildlife Refuge And Protected Zone Of Guayas In 2022

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Abstract

Mangroves in Ecuador are affected by human activities such as logging, construction of shrimp farms and housing, urban development that alters the hydrological and geomorphological processes, overexploitation of resources with indiscriminate fishing, disrespect for fishing and capture bans, aquaculture, the introduction of exotic species that can displace native species; and environmental pollution by sewage, solid waste, agro-industrial waste, heavy metals and oil spills. Therefore, to evaluate the behavior of the capture of the concha prieta (Anadara tuberculosa) in the capture sites of the Manglares El Morro Wildlife Refuge (REVISMEN), an in situ data collection was carried out in a total of 48 landings monitoring during February to July 2022. As a result, the sizes ranged from 4.2 cm to 6.9 cm, with an average of 5.4 cm, which is positive since most catches are being made above the minimum catch size (4.5 cm). In terms of weight, the mean was 27.24, within a range of 22 to 32 g. The fish's average weight was 27.24, with a range of 22 to 32 g. On the other hand, it was determined through the Catch Per Unit Effort (CPUE) indicator that the highest peak was in May, where the indicator was 160 shells caught per fisherman during a day of collection, while in February, the trend was low with a value of 122, followed by July with 128. When comparing the annual CPUE it was evidenced that since 2016 the catch efforts have increased substantially, with the year 2022 being the highest peak, representing a significant increase in the fisheries of the shell resource. It is important to continue with the management and control of this protected area, emphasizing those sites where there is a higher rate of non-compliance with the law, to ensure this resource's sustainability and conservation.

Keywords: catch, CPUE, concha prieta, mangrove, mangrove, REVISMEN

1. Introduction

Ecuador has a great diversity of marine ecosystems, and each ecosystem has a particular habitat with its biota and geography that characterizes them, from microorganisms to a great variety of fish, crustaceans and mollusks that coexist in harmony, despite the qualities of each species or group. In particular, mangroves, as ecosystems of great importance for the biological functions they fulfill and for the use that humans can make of their resources, are essential due to the associations they carry with the fauna that inhabit them (Pernía et al., 2019).

These ecosystems are highly productive and generate a large number of nutrients, which are exported by the tides to the marine waters of the coastal strip closest to the coast, where they are used by seagrasses and a variety of commercially important fish, crustaceans and mollusks, such as bivalve mollusks. The latter benefit the economy of the surrounding human populations through their extraction for commercialization and self-consumption (Pomareda & Zanella, 2016). Therefore, most of the studies on mollusks associated with mangroves have been carried out based on the bivalve group since they represent a great interest from the economic and food point of view.

However, mangroves in Ecuador are affected by human activities such as logging, construction of shrimp farms and housing, urban development that alters hydrological and geomorphological processes, overexploitation of resources with indiscriminate fishing, disrespect for fishing and capture bans, aquaculture, the introduction of exotic species that can displace native species; and environmental pollution from sewage, solid waste, agro-industrial waste, heavy metals and hydrocarbon spills (Poveda & Avilés, 2018).

Therefore, the declaration of the Manglares El Morro Wildlife Refuge as protected mangrove areas adjacent to Puerto El Morro in 2007, and the detection of one of the main threats to the sustainability of natural resources, such as overfishing, were the main reasons that led the Ministry of Environment of Ecuador to have a registry of information corresponding to the most economically important mollusk and crustacean fisheries in the sector, in order to establish, through the protected area management plan, control actions that guarantee the preservation of the resources (MAE, 2010).

The resource conch or Anadara tuberculosa is a species of bivalve mollusk of the Arcidae family, which is considered one of the most important due to its high commercial demand, making it one of the main resources that generate economic stability for people dedicated to its extraction and commercialization (Silva & Bonilla, 2015). However, this resource is threatened by several human activities, such as mangrove logging, pollution of the estuaries, construction, overexploitation due to indiscriminate capture, lack of awareness, knowledge and non-compliance with legislation and closed seasons.

Therefore, if the catches of this resource are not regulated correctly, the stocks of the species may be affected and even collapse; however, the lack of data and information on time series allows for deriving minimum estimates that contribute to its conservation, then in order to achieve a sustainable use that ensures that biological systems remain productive over time, it is necessary to make annual estimates that provide information on the catches of this specimen (Aguirre, 2019).

This research aims to evaluate the capture and landings of the concha prieta (Anadara tuberculosa) through the collection of in situ data in the Manglares El Morro Wildlife Refuge (REVISMEN) in the province of Guayas.

2. Objectives

2.1 General Objective

To evaluate the capture behavior of the concha prieta (Anadara tuberculosa) in the capture sites of the Manglares El Morro Wildlife Refuge (REVISMEN), through in situ data collection to compare catch per unit effort data.

2.2 Specific objectives

- Record biometric weight-height data of Anadara tuberculosa landed in the ports of the REVISMEN protected area.
- Determine the catch per unit effort in the landing areas of the REVISMEN fishing ports through in situ landing monitoring.
- Compare catch-per-unit-effort and size data for Anadara tuberculosa from July 2017 to July 2022 in the REVISMEN protected area port landings.

Methodology

3.1 Study area

The study area corresponds to the Manglares El Morro Wildlife Refuge and protected zones, created by ministerial agreement N.- 266 on September 13, 2007. This area covers an area of 10,130.16 hectares and is located in the canal zone of Puerto El Morro in the parish of El Morro, Guayaquil canton, Guayas Province (Figure 1) (PMRC, 2006).

The Manglares El Morro Wildlife Refuge is at an altitude of 6 masl and corresponds to the following UTM coordinates: X 17577443E and Y 9711478N, characterized by a tropical desert climate, temperatures ranging from 23 to 25°C and an annual rainfall of 500 mm (PMRC, 2006).

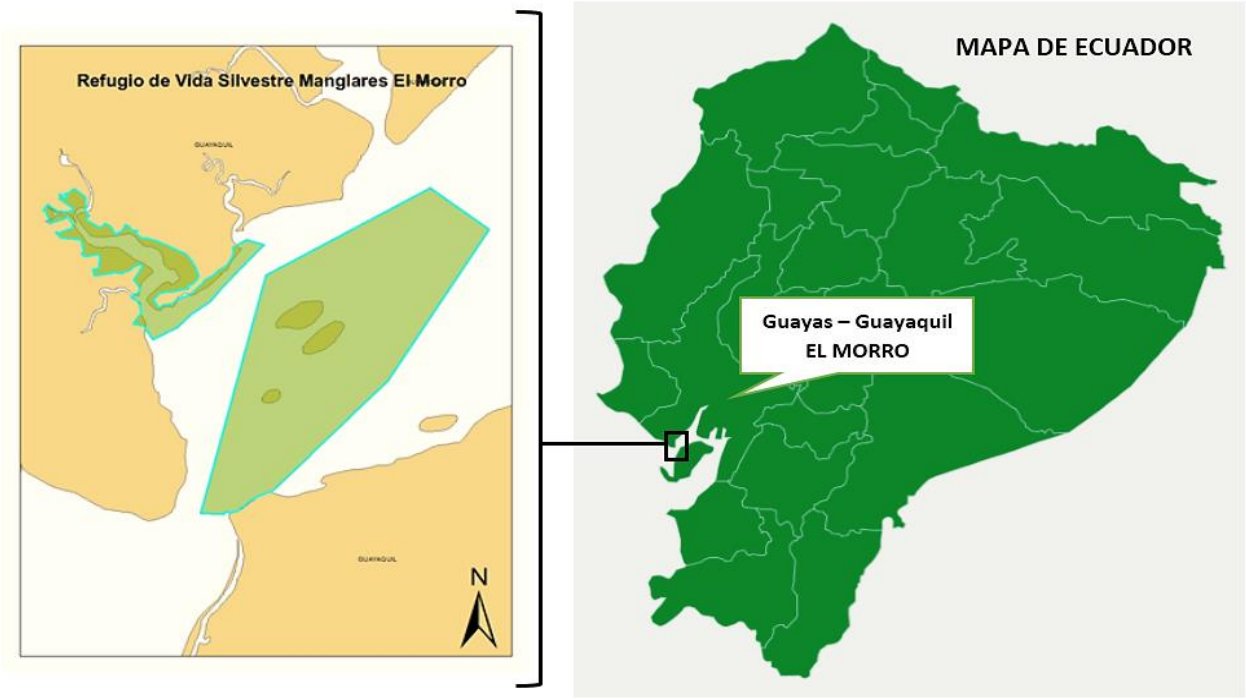

Figure 1. Geographical location of REVISMEM (1000m).
Source: MAATE, 2010.

3.2 Type of research

This work is based on an exploratory type of research since a problem was studied and identified, determining through data analysis how the different variables in question have manifested themselves over the years, specifying positive and important properties for the study (Hernández, 2004).

3.3 Sampling

Sampling was carried out twice a week during February to July 2022, where the biometric data of the shells were recorded in each of the capture sites through technical forms of the Ministry of Environment, Water and Ecological Transition (MAATE), directed to the community members who carry out the activity of shell extraction.

Field materials

- Balance
- Vernier caliper
- Notebook
- Ballpoint pen
- Digital manual counter
- Containers
- Covers

Equipment:

- Camera
- Laptop computer
- GPS

Process:

- Transfer to the shell disembarkation points in the protected area's park rangers' boat.
- Transfer of captured shells from the shells' vessels to the monitoring vessel.
- Count of specimens per shell using a manual digital counter.
- Weighing of shells on balance (g).
- Size measurement with a Vernier caliper.
- Data recording.
- Taking of photographic evidence
- Return of the shells caught to the fishermen.

3.4 Catch per unit effort

To estimate the catch per unit effort (CPUE), the number of shells collected per shell was recorded and divided by the number of shells/day; then the average monthly/year CPUE was estimated.

$$\overline{CPUE} = \left(\frac{\sum_{i=1}^{n} C_i}{n} \right) \quad (1)$$

Where:
CPUE = catch per unit effort
+ + n = number of shells sampled
Ci = number of shells caught

3.5 Capture sites

To determine the capture sites with the highest catch of this resource, monitoring and controls will be carried out in each of the sites that make up the Manglares El Morro Wildlife Refuge, which is controlled by the Ministry of Environment, Water and Ecological Transition of Ecuador (Table 1).

In general, in this protected area, it is important to highlight the presence of the mangrove ecosystem in its different species: red mangrove (Rhizophora harrizonii); white mangrove (Laguncularia racemosa); mangrove jeli (Conocarpus erecta), also called “button mangrove”; and finally, the black mangrove (Avicennia germinans). In addition to this, the fauna of the area, such as birds, 80 species have been identified, including

frigate birds, white, gray and pink herons, pelicans, blue-footed pelicans, and land and marine mammals, including the bottlenose dolphin (Mora et al., 2010).

Name of the extraction site	Coordinates	
	X	Y
BAGRECITO	0595909	9699934
SINKED SHIP	0578488	9712610
LIZARD MOUTH	0582142	9708077
BOLSICO	0582937	9709597
CABALLITO	0581049	9711178
CAPON	0578022	9712646
CHABUCO	0591432	9699035
CHALACO	0585883	9708931
CORVINA	0586500	9709543
DIABLICO	0584182	9709508
EL FARO	0856312	9709377
THE MORROW	0577902	9711783
THE MORRO REVISMEM	0578241	9711909
AYALAN ESTERO	0579376	9712167
AYALANCITO ESTUARY	0579611	9712586
OLMO ESTERO	0578541	9712339
GUARILLO ESTUARY	0582877	9704506
LAGARTO ESTERO	0582182	9708292
GUARILLOS	0582775	9705381
NEW ISLAND	0596055	9701778
THE CRYSTAL	0582675	9710668
LA CRUZ	0582586	9710807
THE ISLAND	0581336	9711012
LA OLLA	0588054	9712086
LAGARTITO	0580572	9708551
WOMEN	0581108	9710636
LAURA	0580320	9710594
LIMBO	0596954	9709854
THE THREE BIG MOUTHS	0586379	9714304
NAGRECO	0591379	9712851
PALO ALTO	0582407	9711012
PUNTA AYALAN	0579469	9711897
PUNTA EL SAIBO	0587160	9710513
THICK POINT	0592426	9714688
BACKHAND FROM BELOW	0583970	9708759
BACKHAND FROM ABOVE	0584382	9709060
MIDDLE BACKHAND	0584066	9709556

PONCE COW	0583557	9710261

Table 1. REVISMEM capture sites
Source: Fajardo (2021).

5. Results

5.1. Recording of biometric weight-height data of Anadara tuberculosa landed in the ports of the REVISMEN protected area.

During the sampling period, 12,379 specimens of concha prieta (Anadara tuberculosa) were recorded, corresponding to captures made by community members near the Manglares El Morro Wildlife Refuge during February and July 2022.

When analyzing the size data through the statistical program Statgraphics, the following data table was obtained where the statistics of the size frequency of the Anadara tuberculosa shell is observed, which was determined in a range that goes from 4.2 cm as the minimum limit and 6.9 cm as maximum, the average size of the sampling was 5.4, with a standard deviation of 0.498224 (see table 2). Therefore, and in agreement with the data mentioned in the work of Gamboa (2019), the mean length was 43.6. It can be deduced that there has been a slight increase in this arithmetic value.

Data	**Value**
Count	12379
Average	5.40668
Standard Deviation	0.498224
Coefficient of variation	9.21496%
Minimum	4.2
Maximum	6.9
Media	5.4
Range	2.7

Table 2. Statistical data from the frequency table

Similarly, Figure 2 of the size frequency for each size class or range shows that there is a greater incidence of sizes between 5.2 and 5.5 cm, so it can be observed that a large number of samples presented sizes ranging from 5.3 to 5.5 cm.4, demonstrating that thanks to the efforts made to control the minimum catch sizes since the creation of this protected area, the sizes show signs of stabilization and responsible fishing by the shellfish harvesters by catching specimens above the minimum extraction size of 4.5 mm, according to Ministerial Agreement 149 published in the Official Register 412 of August 27, 2008.

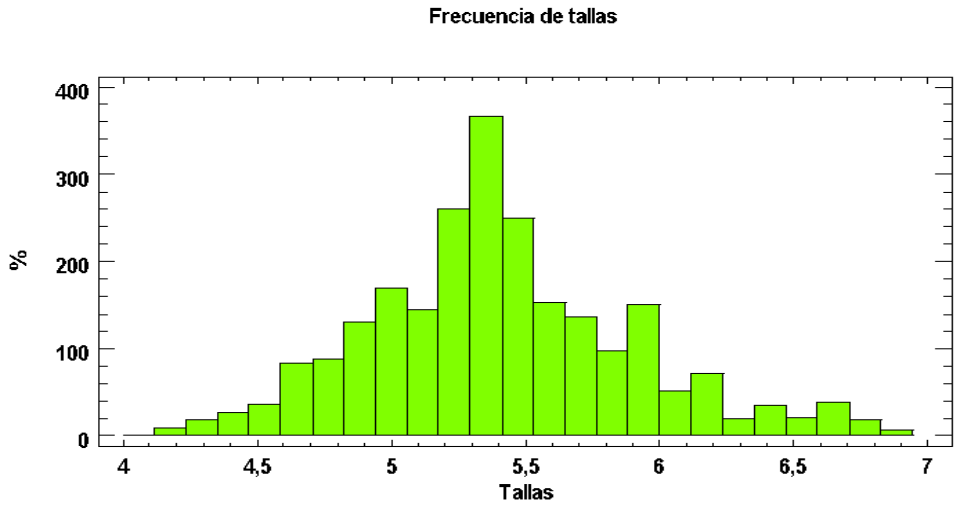

Figure 2. Size frequency

Therefore, it is important to maintain the efforts of technicians from the Ministry of Environment, Water and Ecological Transition to achieve sustainable use of this biological resource, such as the Anadara tuberculosa shell.

On the other hand, when an analysis of the sizes is made through a box-and-whisker plot, it can be determined that since the median is in the center of the box, there is a symmetrical distribution of the data and that the data are not statistically dispersed.

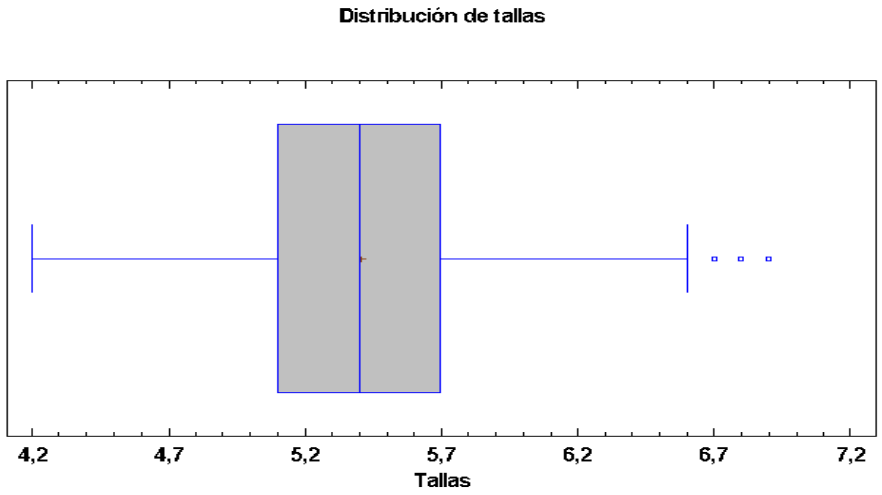

Figure 3. Size frequency

Morphometry studies, specifically weight, revealed that specimens of Anadara tuberculosa captured in the Manglares El Morro la Concha Prieta Wildlife Refuge had weights ranging from 22g to 32g; however, the mean was 27.24 and a standard deviation of 2.61048% (Table 2).

Data	Value
Count	2379
Average	27.2471
Standard Deviation	2.61048
Coefficient of variation	9.58077%
Minimum	22.0
Maximum	32.0
Media	27.2471
Range	10.0

Table 3. Statistical data from the frequency table

Figure 3 shows the frequency distribution of the recorded weights of Anadara tuberculosa, showing a higher frequency in the 28 g range.

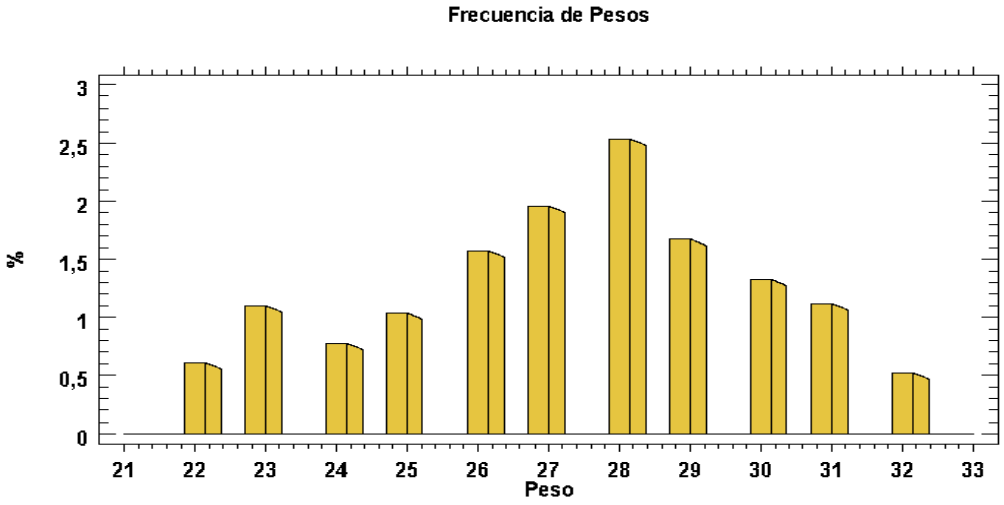

Figure 4. Frequency of Weights

In addition, when analyzing the weights through a box-and-whisker plot, it can be determined that since the median is not in the center of the box, there is an asymmetric distribution with a negative skew since the longest part is on the left side of the median, indicating that the data are more dispersed within the range from 22 to 28 g of weight.

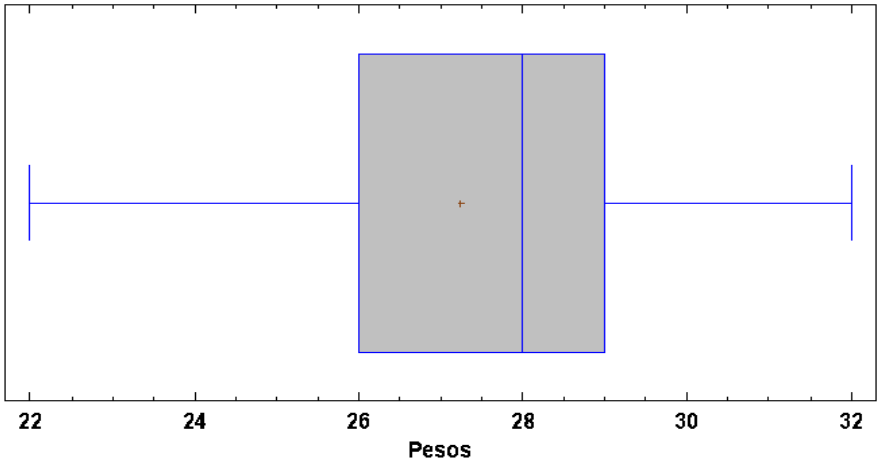

Figure 5. Frequency of Weights

5.2 Determine the catch per unit effort in the REVISMEN fishing ports' landing areas through in situ landing monitoring.

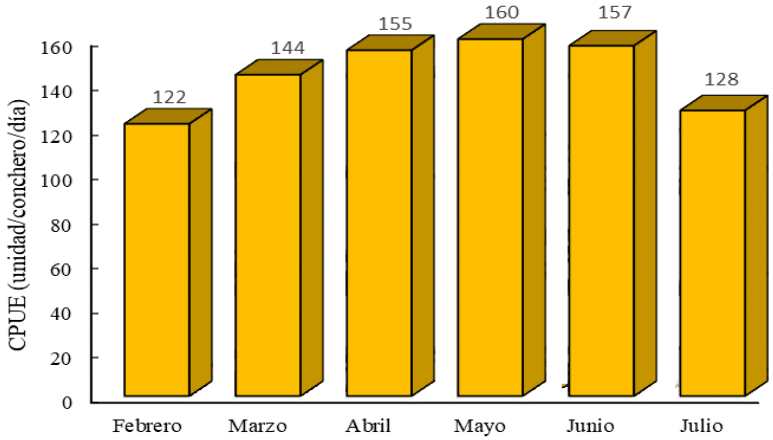

Figure 6. CPUE (unit/shell/day) from February to July 2022

Figure 6 shows the monthly CPUE during February and July 2022 with a total of 2379 specimens of A. tuberculosa shells; it can be observed that in February, the CPUE was 122; in March, with a slight increase, it reached a value of 145, while in April the increase was rising so that it reached a value of 157, and considering May as the highest peak with a value of 161, it can be deduced that in that month there was a great demand for the resource by community members and traders. However, for July, there was a notorious decline, reaching 128 units per shell.

5.3. Compare catch per unit effort and size data for Anadara tuberculosa from July 2017 to July 2022 in the landings of the REVISMEN protected area ports.

- **CPUE**

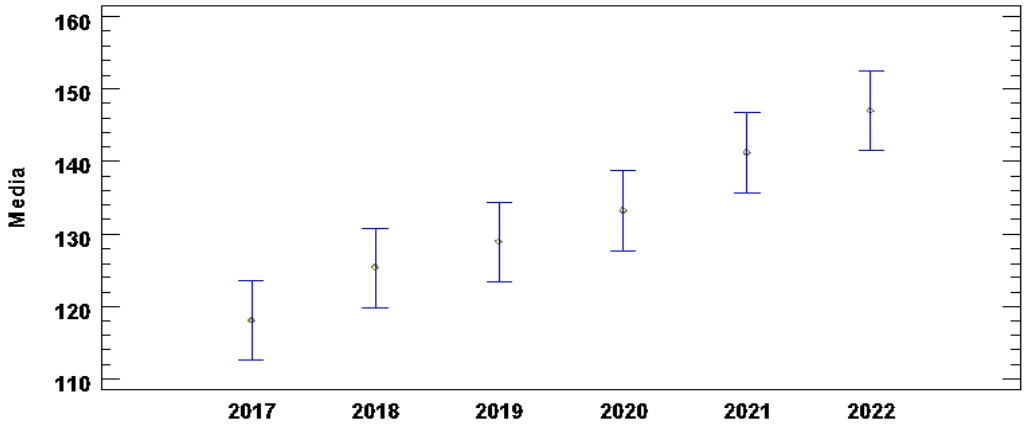

Figure 7. CPUE during the period 2017 - 2022

The concha prieta A. tuberculosa recorded the highest extraction in 2022, and through Figure 7 it is determined that the catch effort of shells per shell has been steadily increasing since 2017, and these differences could be associated with the intensity of fishing that is occurring in the areas of extraction coupled with the rotation of sites exercised by the shellers. However, the consequence of unsustainable fishing due to a lack of awareness and sensitization of shellfish farmers on responsible fishing issues may bring about the depletion of this natural resource in conjunction perhaps with the efforts in shell control and conservation made in recent years and the support of the laws articulated in the protection of the resources.

- **Sizes**

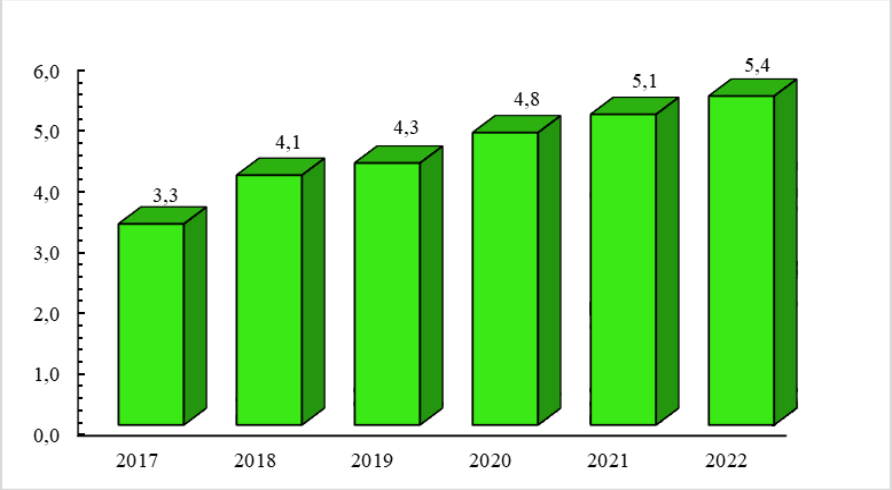

Figure 8. Sizes during the period 2017 - 2022

In general, the average annual sizes of Anadara tuberculosa shellfish caught in the Manglares El Morro Wildlife Refuge during the period 2017 - 2022 and represented in Figure 8, show that average catch sizes are increasing, and in turn, giving signs that there has been a positive and very significant change in the shellfish harvesters to capture and sustainably exploit the resource, This is due to the control and surveillance system that currently exists to regulate the fishery in question, including the institutions in charge of control and surveillance, such

as the Vice Ministry of Aquaculture and Fisheries, through the fisheries inspectorates whose offices are located in the main landing ports.

6. Conclusions

When recording the biometric data on length and weight, it was concluded that the samples collected during the study period showed sizes ranging from 4.2 cm to 6.9 cm in length, with an average of 5.4, which is positive since most of the catches are being made above the minimum catch size (4.5) established in Ministerial Agreement 149 published in the Official Register 412 of August 27, 2008. Likewise, in terms of weight, the average was 27.24 within a range of 22 to 32 g.

It was determined through the Catch Per Unit Effort (CPUE) indicator that the highest peak was in May, where the indicator was 160 shells caught per fisherman during a day of fishing, while in February, the trend was low, with a value of 122, followed by July with 128. However, the CPUE will vary based on multiple factors mainly associated with the intensity of exploitation and thus, the greater the effort (number of shells in a day) and using better mechanisms of capture, the volume of shells will be proportional.

When comparing the annual CPUE, it was evident that since 2016 the catch efforts have increased substantially, with the year 2022 being the highest peak, representing a significant increase in the fisheries of the conch resource. However, and as a positive aspect, when comparing the catch sizes, an increase is evidenced for the year 2017, when the average size was 3.3, and for 2022, it increased, reaching an average size of 5.4. This shows signs of stabilization and responsible fishing on the part of the shell fishermen by catching specimens well above the minimum catch size of 4.5.

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