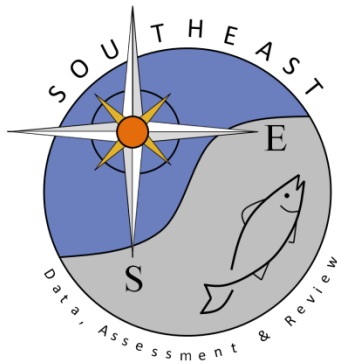


Abundance and spatial distribution of queen conch (*Aliger gigas*) in the U.S. Virgin Islands and Puerto Rico

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Abundance and spatial distribution of queen conch (*Aliger gigas*) in the U.S. Virgin Islands and Puerto Rico

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SEDAR 103: US Caribbean Application of Alternate Assessment Methods

Introduction

Fishery-independent surveys of queen conch populations in the Caribbean have been ineffective in generating the data needed for stock assessments for several reasons. Among them, inconsistencies across survey methodologies and temporal and spatial replication have resulted in generating datasets inappropriate for generating abundance indices. In recent years scientists from the Population and Ecosystem Monitoring (PEM) Division's Habitat Ecology Branch (HEB) have collaborated with the SEAMAP-C Monitoring Program to standardize survey designs and methodologies across NOAA survey efforts. This collaboration developed a standardized survey approach and each group embarked on large-scale survey efforts across the U.S. Caribbean. The HEB conducted population surveys in St. Thomas and St. John, USVI, in 2023; St. Croix, USVI, in 2024; and Puerto Rico in 2026. This document summarizes the methodology and data collected from each survey effort conducted by the HEB.

Sampling Method

Survey sites were randomly stratified by benthic habitat type and depth (5 m) bins based on the benthic habitat and bathymetry maps available for each region (Kendall et al. 2001). Prior to each survey trip spatial coordinates for each survey were randomly generated and target points were identified. At each survey site, we dropped a weighted line attached to a buoy and recorded the location using a hand-held GPS receiver. A pair of divers descended the buoy line to the bottom, where they clipped a 10-m survey line above the weight and recorded water depth. Each team of divers, one diver positioned at the midpoint and one positioned at the endpoint of the survey line, swam the line around the center point and searched the entire circular area (314 m²) for conch. In addition, to facilitate comparison between cross-shelf and within-aggregation density estimates we targeted a known queen conch aggregation in St. John, USVI, to test a pilot method for characterizing aggregations. We towed a hand-held GPS unit on the water surface and swam the visual boundary of the aggregation to map and calculate a spatial estimate of the coverage of the aggregation area. We then haphazardly completed radial surveys within the confines of the boundary such that 10% of the estimated areal coverage of the aggregation was surveyed.

Sampling Years

This survey effort was initiated as a three-year project with one year dedicated to each U.S. Caribbean territory. In 2023 we surveyed St. Thomas and St. John, USVI; in 2024 we surveyed St. Croix, USVI; and in 2026 we completed surveys in Puerto Rico.

Geographic Range

Survey points were randomly generated across the coastal shelf of each island group (St. Thomas, St. John, St. Croix, and Puerto Rico including Culebra and Vieques), extending from 0 m out to the 30-m depth contour. Although efforts were made to survey all coastal areas surrounding each island, poor weather and sea conditions occasionally prevented completing surveys along some shorelines and depth zones. See Figures 1-3 for specific site locations where surveys were successfully completed.

Sample Size

The objective during each survey mission was to complete as many surveys as possible at designated sites, subsequently using each dataset to inform a power analysis for future survey efforts. In St. Thomas and St. John we completed 134 radial surveys (59 in St. Thomas and 75 in St. John), in St. Croix we completed 124 surveys, and in Puerto Rico we completed 143 radial surveys.

Variables or Data Types Collected

Environmental variables measured at each survey site were water depth, spatial coordinates, and benthic habitat type following published benthic habitat type categories (Kendall et al. 2001). Specific habitat categories used during site selection and benthic habitat categorization are shown in Tables 1-4. When a conch was located during a survey the shell length (tip of the spire to the anterior end of the siphonal canal) was measured *in situ* with calipers and recorded. We also measured shell lip thickness of queen conch with flared lips and recorded any observations of reproductive activity in the form of active mating, spawning, or the presence of egg masses on the substrate. We categorized maturity status based on the current fishing regulations that legal queen conch must be 9 in (228.6 mm) in shell length or have a minimum lip thickness of 3/8 in (9.5 mm). Conch with shell measurements larger than either of these minimum values were classified as adults and individuals with shell measurements under these minimum values were classified as juveniles.

Results

In total we conducted 397 radial surveys, not including targeted aggregation surveys, and located and measured 1594 queen conch, 963 juveniles and 631 adults. Island-specific survey results are detailed in the sections below.

St. Thomas, USVI

We completed 59 surveys around the island of St. Thomas and located 140 queen conch (12 juveniles and 128 adults), equating to a mean density estimate of 75.5 ± 34.4 conch ha^{-1} . Juvenile conch had a mean density of 6.5 ± 2.3 conch ha^{-1} while the mean density of adult conch was 69.1 ± 33.4 conch ha^{-1} . There were only five surveys where densities exceeded the suggested population threshold level of 100 conch ha^{-1} and 47 surveys that contained no conch. The highest density of conch (1464.2 conch ha^{-1}) occurred within a potential reproductive aggregation discovered near Great St. James Island. Shell lengths of queen conch measured ranged from 100 to 240 mm and shell lip thickness of adult conch ranged from 7 to 43 mm. Length frequency distribution showed the highest numbers of conch had shell lengths from 180 to 200 mm.

St. John, USVI

We completed 71 random radial surveys around St. John with an additional four surveys completed within a known aggregation area. Not including the aggregation sites we located 136 queen conch, 88 juveniles and 48 adults. The overall mean density was 61.0 ± 22.4 conch ha^{-1} , with a juvenile density of 39.5 ± 19.0 conch ha^{-1} and an adult density of 21.5 ± 11.5 conch ha^{-1} . The highest density of conch found was 955.0 conch ha^{-1} and there were 53 surveys completed that contained no conch. Shell lengths of queen conch measured ranged from 60 to 270 mm and shell lip thickness of adult conch ranged from 3 to 37 mm. Length frequency distribution showed the highest numbers of conch had shell lengths between 190 and 230 mm.

The aggregation area mapped on St. John enclosed approximately 1 ha and we completed four targeted radial surveys within the perceived boundaries. In those four surveys we recorded 213 total queen conch, 78 juveniles and 135 adults, resulting in a mean density of 1695.0 conch ha^{-1} . Including these survey results with the overall dataset compiled for St. John more than doubles the island-wide density estimate to 148.1 conch ha^{-1} . Reproductive activity in the form of mating and spawning was frequently noted while mapping the aggregation extent, but we encountered only one mating pair while conducting the radial surveys.

St. Croix, USVI

We completed 124 radial surveys around St. Croix and located 1036 queen conch (777 juveniles and 259 adults), corresponding to an overall mean density of 266.0 ± 72.0 conch ha^{-1} . Juveniles had a mean density of 199.5 ± 63.7 conch ha^{-1} and adults had a mean density of 66.5 ± 13.9 conch ha^{-1} . The highest density of conch found within a survey was 6620.8 conch ha^{-1} , which is equivalent to 208 conch within a 314 m^2 circle. This survey occurred within a likely juvenile recruitment aggregation as the age composition was dominated by juveniles at 181. There were 23 surveys that contained densities exceeding 100 conch ha^{-1} , and of these, six sites contained more than 1000 conch ha^{-1} . There were 57 surveys completed where no conch were found. Shell lengths of queen conch ranged between 56 to 64 mm and shell lip thickness of adult conch ranged from 1 to 39 mm. The length frequency distribution showed the age composition to be dominated by large juveniles between 150 and 200 mm in shell length.

Puerto Rico

We completed 143 radial surveys around the island of Puerto Rico including the outlying islands of Mona Island, Desecheo, Culebra, and Vieques. We located and measured 282 queen conch, 88 juveniles and 194 adults in all areas combined. The estimated overall mean density was 62.8 ± 16.1 conch ha^{-1} . Juveniles had a mean density of 19.6 ± 5.5 conch ha^{-1} while the mean density of adults was 43.2 ± 15.0 conch ha^{-1} . The highest densities of queen conch occurred at Desecheo, where the highest density survey contained 1591.5 conch ha^{-1} and 10 conch were observed actively mating. There were 14 surveys that contained densities exceeding 100 conch ha^{-1} ; however, there were 97 surveys completed that contained zero conch. Shell lengths of measured queen conch ranged from 80 to 285 mm and lip thickness of adult conch ranged between 3 and 44 mm. The length frequency distribution showed the population to be dominated by aging adults with shell lengths from 250-260 mm with lip thicknesses averaging 25 mm.

Discussion

Surveys conducted around each island revealed unique characteristics for their respective queen conch populations, highlighting the region-specific difficulties of integrating survey data into the stock assessment process. With the exception of St. Croix, queen conch were quite patchy as evidenced by the high numbers of empty surveys. The highest overall density occurred in St. Croix, followed by St. Thomas, Puerto Rico, and St. John. We found the highest density of juvenile conch in St. Croix and the highest density of adult conch in St. Thomas.

Benthic habitat type and water depth may be important variables that influence the distribution and abundance of queen conch. Hardbottom habitat types such as colonized pavement, colonized pavement with channels, patch reef, and scattered coral rock had the highest densities of conch in St. Thomas, St. Croix, and Puerto Rico, while macroalgae habitat had the highest density of conch in St. John. There were also high densities of conch in seagrass habitats in St. Croix. In Puerto Rico and St. Thomas the highest densities of conch were found in the deeper depth bins of 21-25 m and 26-30 m, driven by the discovery of potential reproductive aggregations of adults. Fishing activity may also be contributing to this depth distribution pattern, as fishing pressure can alter distributions of mature conch in relation to water depth. Conversely, in St. John and St. Croix, higher densities of conch were found in shallower water depths.

The results of the survey project summarized here illustrate the difficulty in collecting sufficient data across varying habitat types and depth zones to fully inform the stock assessment process. This is further complicated by the presence of unknown or poorly documented aggregations or populations in depths exceeding 30 m. Increased temporal and spatial replication are needed before reliable inferences about population abundance can be made from either island-wide or habitat-specific densities.

References

Kendall MS, Monaco ME, Buja KR, Christensen JD, Kruer CR, Finkbeiner M, Warner RA (2001) Methods used to map benthic habitats of Puerto Rico and the US Virgin Islands. NOAA Tech Memo NOS NCCOS 152, Silver Spring, MD.

Tables and Figures

Table 1. Densities of queen conch by benthic habitat type and depth bin for surveys completed around St. Thomas, USVI, in 2023. Densities are means expressed as conch ha⁻¹ ± SE.

Habitat Type	No. of Surveys	Juveniles	Adults	Overall
Colonized bedrock	7	0	0	0
Uncolonized bedrock	2	0	0	0
Colonized pavement	10	15.9 ± 8.1	235.5 ± 122.8	251.5 ± 127.7
Colonized pavement w/ channels	3	0	0	0
Linear reef	4	0	0	0
Scattered coral rock	1	0	0	0
Sand	4	0	47.8 ± 41.3	47.8 ± 41.3
Continuous macroalgae	1	0	0	0
Patchy seagrass	18	9.4 ± 3.2	76.1 ± 34.1	85.5 ± 36.2
Continuous seagrass	9	7.1 ± 6.7	0	7.1 ± 6.7
Depth Bin (m)				
1-5	7	0	0	0
6-10	21	3.0 ± 3.0	3.0 ± 2.0	6.1 ± 3.5
11-15	16	13.9 ± 5.6	91.5 ± 86.6	105.4 ± 88.0
16-20	8	4.0 ± 3.7	111.4 ± 81.7	115.4 ± 85.3
21-25	3	0	0	0
26-30	4	15.9 ± 13.7	413.8 ± 235.5	429.7 ± 248.0

Table 2. Densities of queen conch by benthic habitat type and depth bin for surveys completed around St. John, USVI, in 2023. Densities are means expressed as conch $ha^{-1} \pm SE$.

Habitat Type	No. of Surveys	Juveniles	Adults	Overall
Individual patch reef	2	0	0	0
Aggregate patch reef	1	0	0	0
Colonized pavement	13	7.3 $\pm$ 7.1	4.9 $\pm$ 4.7	12.2 $\pm$ 11.8
Colonized pavement w/ channels	1	0	0	0
Linear reef	1	0	0	0
Spur and groove reef	1	0	0	0
Scattered coral rock	3	0	0	0
Mud	3	0	0	0
Patchy macroalgae	4	0	116.7 $\pm$ 77.0	116.7 $\pm$ 77.0
Continuous macroalgae	1	0	0	0
Patchy seagrass	19	88.9 $\pm$ 26.0	7.4 $\pm$ 2.2	96.3 $\pm$ 28.2
Continuous seagrass	25	25.5 $\pm$ 10.0	21.6 $\pm$ 18.7	47.1 $\pm$ 25.8
Depth Bin (m)				
1-5	16	25.9 $\pm$ 12.7	4.0 $\pm$ 2.6	29.8 $\pm$ 13.9
6-10	18	122.0 $\pm$ 70.1	35.4 $\pm$ 25.7	157.4 $\pm$ 74.8
11-15	14	9.1 $\pm$ 8.8	0	9.1 $\pm$ 8.8
16-20	14	2.4 $\pm$ 2.3	61.2 $\pm$ 47.4	63.7 $\pm$ 47.2
21-25	4	8.0 $\pm$ 6.9	8.0 $\pm$ 6.9	15.9 $\pm$ 13.8
26-30	6	0	0	0

Table 3. Densities of queen conch by benthic habitat type and depth bin for surveys completed around St. Croix, USVI, in 2024. Densities are means expressed as conch $ha^{-1} \pm SE$.

Habitat Type	No. of Surveys	Juveniles	Adults	Overall
Aggregate patch reef	12	163.7 $\pm$ 37.4	90.9 $\pm$ 13.8	254.6 $\pm$ 42.7
Colonized bedrock	1	0	0	0
Uncolonized bedrock	1	0	0	0
Colonized pavement	19	432.2 $\pm$ 298.7	110.6 $\pm$ 59.3	542.8 $\pm$ 349.7
Colonized pavement w/ channels	2	0	0	0
Linear reef	2	0	0	0
Spur and groove reef	10	0	3.2 $\pm$ 3.0	3.2 $\pm$ 3.0
Scattered coral rock	7	668.4 $\pm$ 609.1	63.7 $\pm$ 35.8	732.1 $\pm$ 624.8
Sand	5	82.8 $\pm$ 60.1	70.0 $\pm$ 36.5	152.8 $\pm$ 71.7
Patchy macroalgae	10	66.8 $\pm$ 22.3	146.4 $\pm$ 65.6	213.3 $\pm$ 86.8
Patchy seagrass	35	257.2 $\pm$ 56.7	95.7 $\pm$ 26.8	352.9 $\pm$ 73.5
Continuous seagrass	20	54.1 $\pm$ 21.1	4.8 $\pm$ 3.4	58.9 $\pm$ 21.0
Depth Bin (m)				
1-5	46	36.7 $\pm$ 17.3	9.0 $\pm$ 3.7	45.7 $\pm$ 19.9
6-10	37	349.3 $\pm$ 165.1	105.8 $\pm$ 37.6	455.1 $\pm$ 192.1
11-15	27	350.1 $\pm$ 171.4	84.9 $\pm$ 22.2	435.0 $\pm$ 178.0
16-20	10	63.7 $\pm$ 37.7	159.2 $\pm$ 57.5	222.8 $\pm$ 86.2
21-25	3	10.6 $\pm$ 8.7	10.6 $\pm$ 8.7	21.2 $\pm$ 17.3
26-30	1	0	0	0

Table 4. Densities of queen conch by benthic habitat type and depth bin for surveys completed around Puerto Rico in 2026. Densities are means expressed as conch $ha^{-1} \pm SE$.

Habitat type	No. of Surveys	Juveniles	Adults	Overall
Individual patch reef	12	29.2 ± 20.0	193.6 ± 84.1	222.8 ± 84.5
Colonized pavement	21	24.3 ± 15.1	28.8 ± 20.7	53.1 ± 25.8
Colonized pavement w/ channels	3	10.6 ± 8.7	626.0 ± 399.9	636.6 ± 397.0
Linear reef	3	0	0	0
Spur and groove reef	3	53.1 ± 43.3	191.0 ± 155.9	244.0 ± 199.3
Scattered coral rock	1	0	477.5 ± 0	477.5 ± 0
Coral rubble	2	63.7 ± 22.5	0	63.7 ± 22.5
Mud	3	0	0	0
Sand	9	7.1 ± 4.4	10.6 ± 7.1	17.7 ± 7.3
Patchy macroalgae	15	7.1 ± 4.4	0	7.1 ± 4.4
Patchy seagrass	28	27.3 ± 11.6	1.6 ± 0.9	28.9 ± 12.1
Continuous seagrass	43	14.8 ± 6.2	3.7 ± 1.6	18.5 ± 6.3
Depth bin (m)				
1-5	40	13.5 ± 5.8	4.0 ± 2.0	17.5 ± 6.3
6-10	40	17.5 ± 8.7	1.6 ± 1.1	19.1 ± 9.4
11-15	45	26.9 ± 14.3	38.2 ± 34.9	65.1 ± 37.2
16-20	7	0	72.6 ± 62.6	72.6 ± 62.6
21-25	6	47.7 ± 24.6	275.9 ± 105.7	323.6 ± 116.6
26-30	5	12.7 ± 7.0	413.8 ± 121.5	426.5 ± 125.3

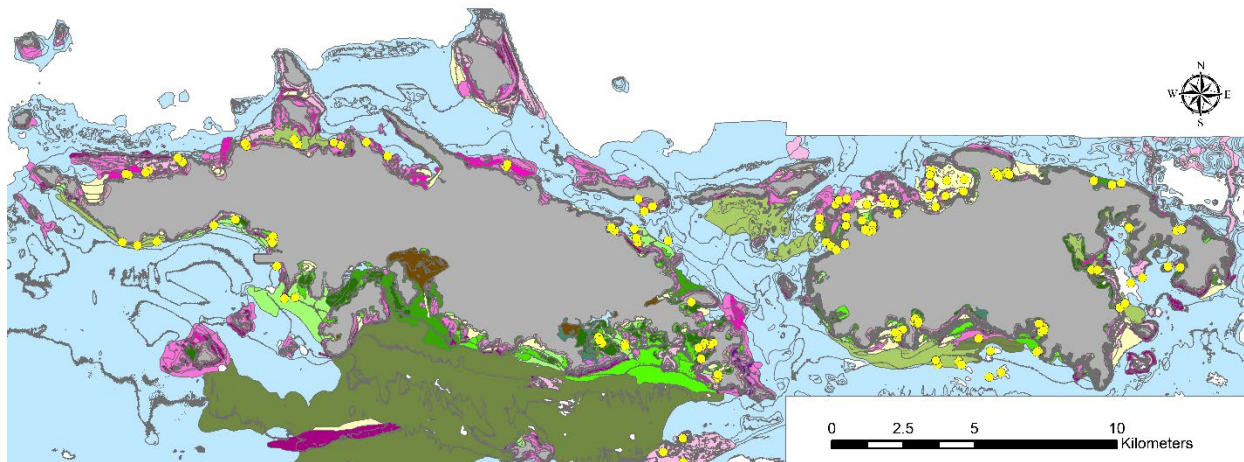


Figure 1. Map showing specific survey sites (yellow circles) completed around St. Thomas and St. John, USVI.

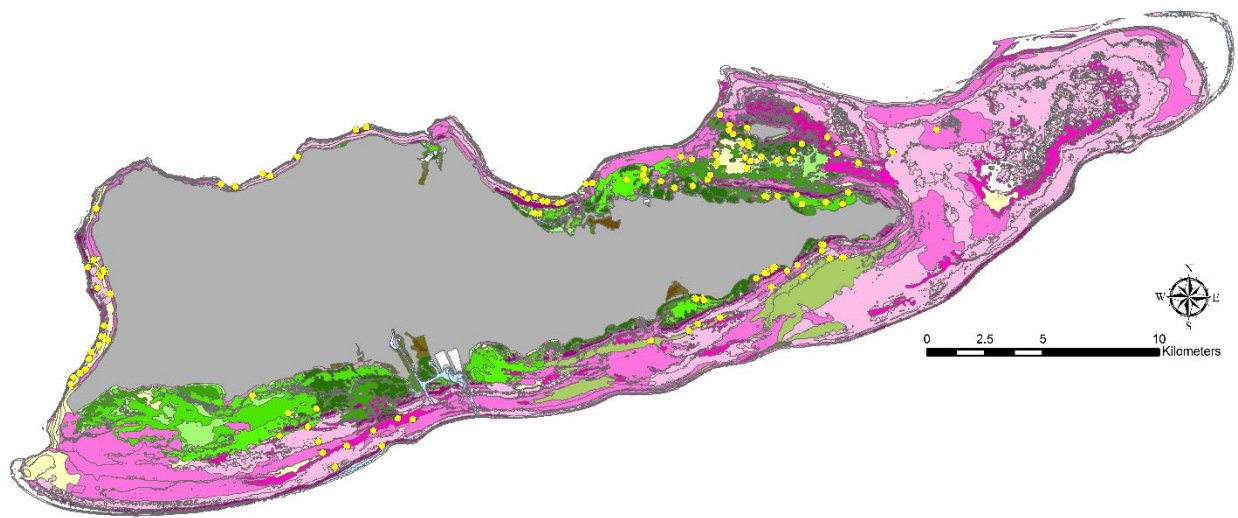


Figure 2. Map showing specific survey sites (yellow circles) completed around St. Croix, USVI.

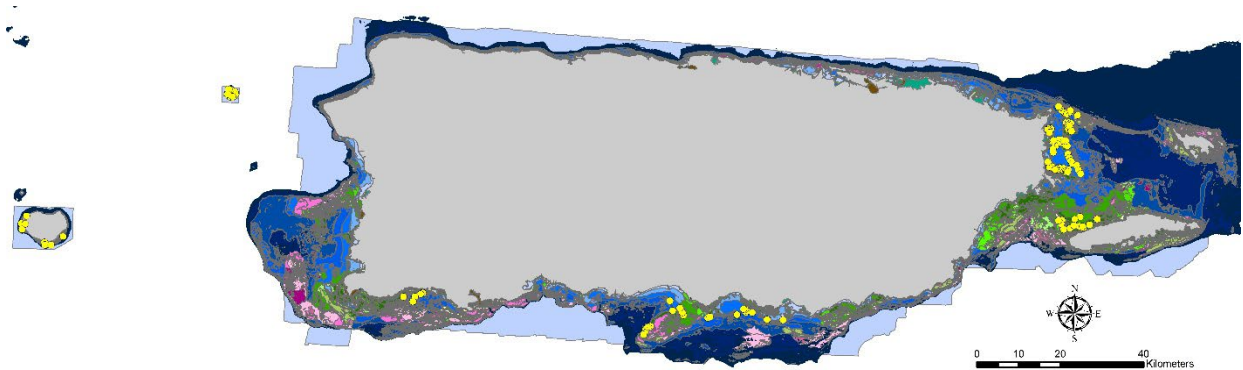


Figure 3. Map showing specific survey sites (yellow circles) completed around Puerto Rico.

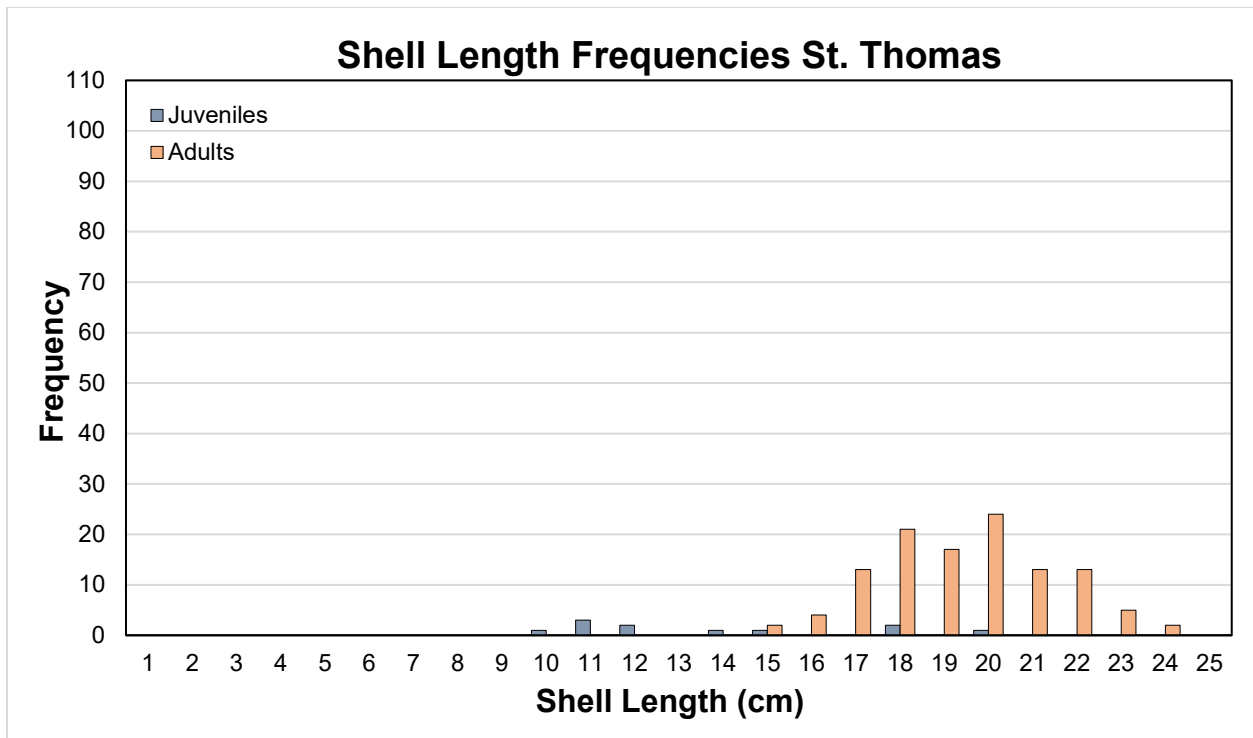


Figure 4. Shell length frequency distribution for juvenile and adult queen conch encountered during surveys in St. Thomas, USVI.

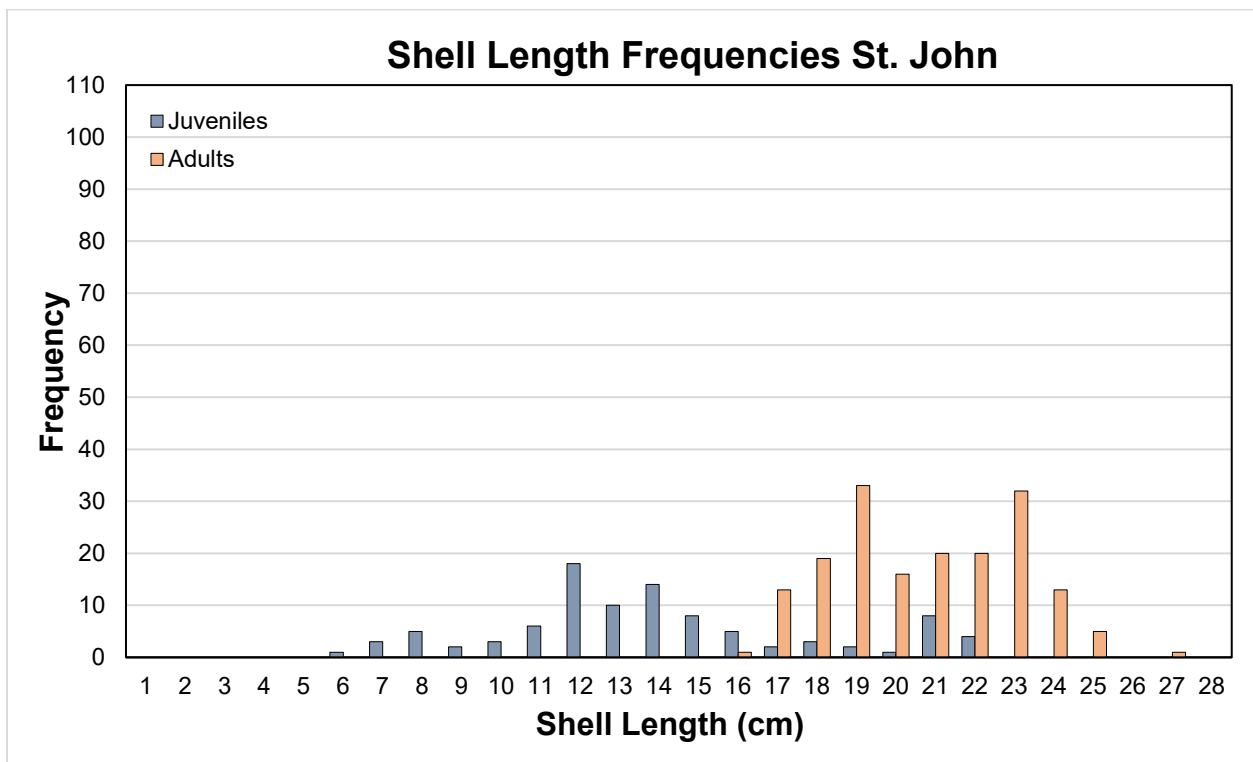


Figure 5. Shell length frequency distribution for juvenile and adult queen conch encountered during surveys in St. John, USVI.

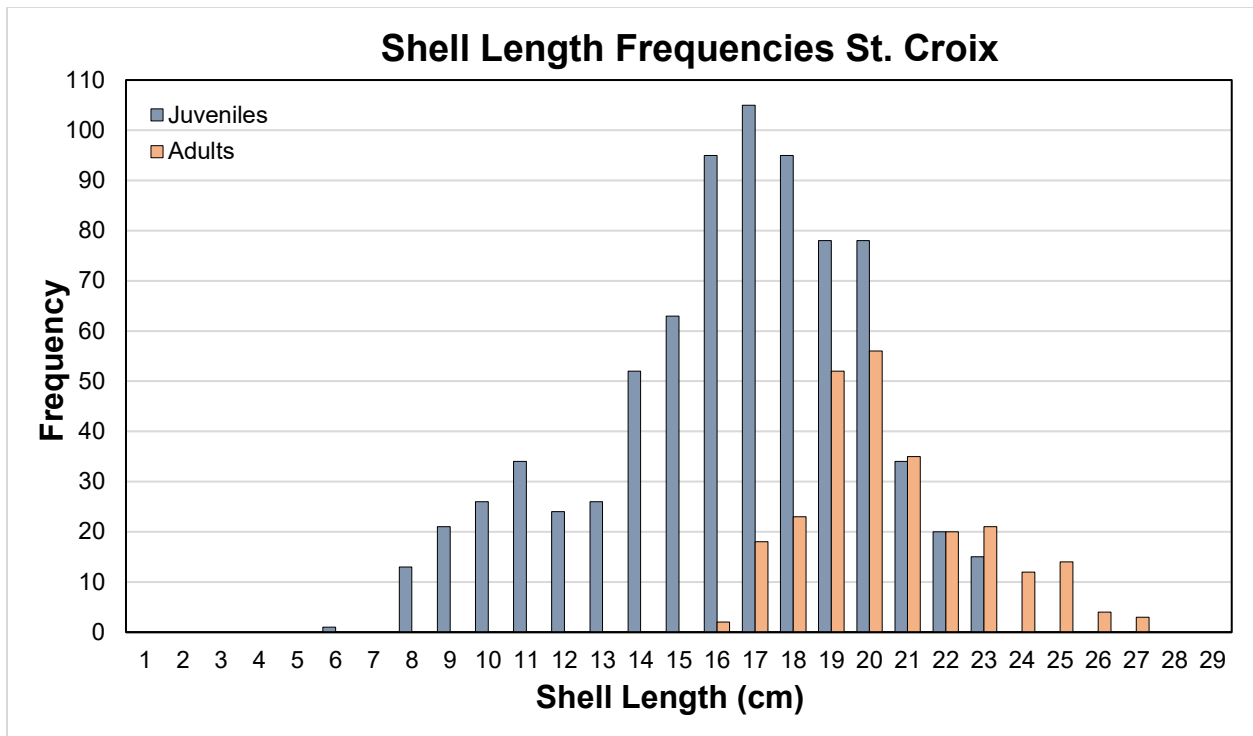


Figure 6. Shell length frequency distribution for juvenile and adult queen conch encountered during surveys in St. Croix, USVI.

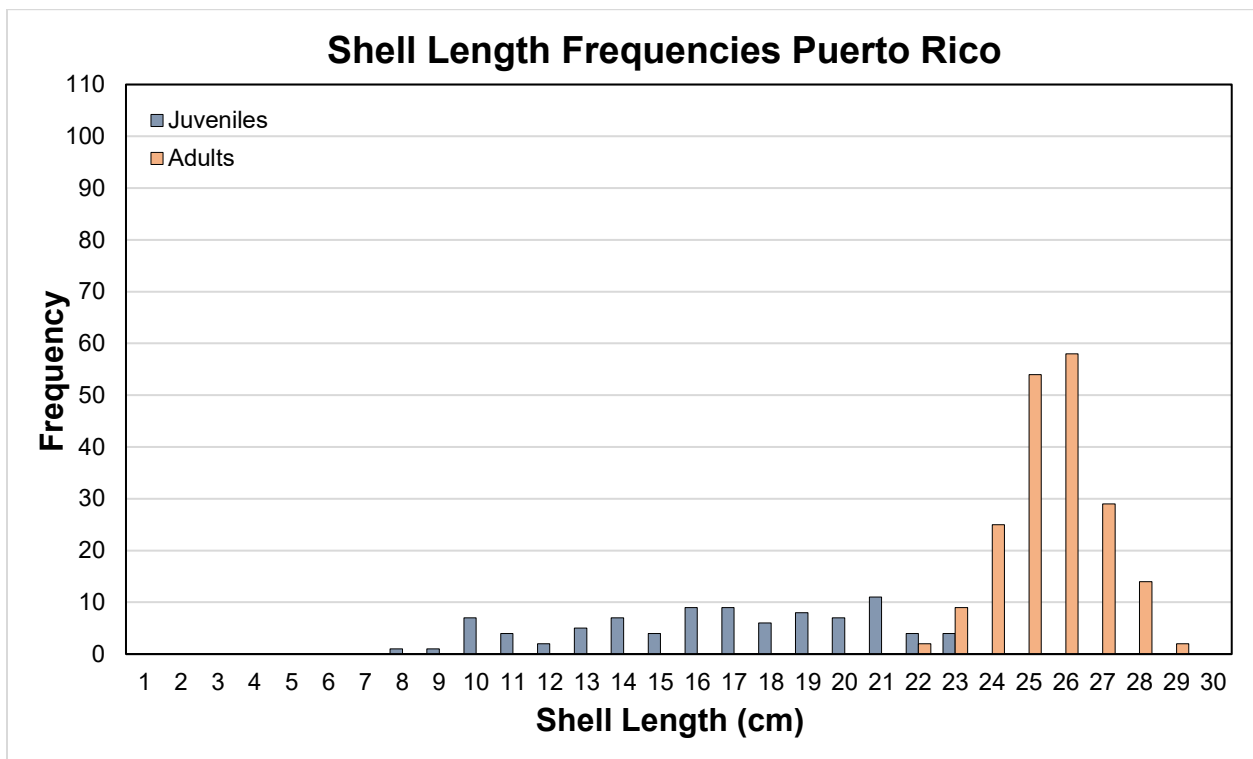


Figure 7. Shell length frequency distribution for juvenile and adult queen conch encountered during surveys in Puerto Rico.