

Cluster Analysis for the St. Croix Island Region
NOAA Fisheries
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Introduction

The U.S. Caribbean is composed of the Commonwealth of Puerto Rico and the Territory of the U.S. Virgin Islands. The Caribbean Fishery Management Council (Council) is currently developing island-based fishery management plans (FMPs) specific for each island region (Puerto Rico, St. Thomas/St. John, and St. Croix). These FMPs would incorporate and replace the current Caribbean-wide FMPs for Corals and Reef Associated Plants and Invertebrates, Reef fish, Queen Conch, and Spiny lobster of Puerto Rico and the U.S Virgin Islands. The purpose of the individual island FMPs is to tailor management to the uniqueness of each island region with respect to their biological, ecological, economic, and cultural resources.

As part of the development of these plans and their associated environmental impact statements, the Council is proposing a list of species to be managed on each of the islands. The Council will then evaluate if these species should be managed at the individual level and/or in groups. For this purpose, the FMP's interdisciplinary planning team requested a cluster analysis that evaluates different grouping scenarios and that could potentially be used for grouping the species for each island region. The purpose of this report is to conduct a cluster analysis to determine potential species groupings for species proposed to be managed in St. Croix.

Methods

On November 4, 2015, the Southeast Fisheries Science Center provided U.S. Caribbean commercial landings data to the NOAA Fisheries Southeast Regional Office. The data contained landings for every individual commercial trip along with information on species landed, depth, and gear. In June of 2011 there was a change to the landings reporting form where more detail of landings by species was included in the form (SEDAR 46). To capture as much species level landings as possible and current fishery dynamics the landings were provided for the calendar years of 2012 through 2014. Data from July to December of 2011 were not used because this was assumed to be an adjustment period where the fishers adjusted to the new form. The 2012 through 2014 data was filtered for the island region of St. Croix. In August of 2015 the Council chose a list of species for management for each island region. The Council shoes 43 species of finfish and also spiny lobster and queen conch for the St. Croix region. In December of 2015 the Caribbean Council's Scientific and Statistics Committee recommended removing spiny lobster and queen conch from the cluster analysis. Therefore, the commercial landings were filtered so only data for the 43 species of finfish remained.

The commercial trip data was converted to a presence/absence format. Specifically, if a fish was caught on a trip it was given a 1 and if it was not caught on a trip it was given a 0. This

format was chosen to allow each fish species to have equal weight. The cluster analysis was done with R software (www.r-project.org) with the `hclust` function. The “AVERAGE” clustering method was used which is a hierarchical method that calculates the distance between clusters by taking the average of all pairwise differences between the points within each cluster.

The cluster analysis was first run on the data available for all of the 43 species of finfish. However, the fisher’s catch report form only lists 23 of the 43 species chosen for management by the Council. Therefore 53% of the species chosen for management are not listed on the catch form. Any landings for the species not listed on the form were reported in the write-in spaces provided. Unfortunately, it’s unknown if the fishers report all of the write-in species every time they report landings or if the fishers only occasionally list the landings for these species not listed on the form. An additional cluster analysis was run that excluded all of the write-in species and only included the species that were listed on the catch form.

Additional cluster analyzes were done by separating the data into the gear reported for the trip. The gears were diving, hook & line, trap, and nets. Cluster analyzes were only conducted for diving, hook & line, and trap trips because the samples sizes for net gears were too small (<300 trips).

Cluster analysis was also done by depth, however not all of the trips recorded depth. Any trips without depth information were removed from the cluster analysis by depth. The remaining trips were separated into depth bins. An examination of the distribution of depths per trip showed two primary depth bins: 1) trips that recorded a depth of 100 feet or less, and 2) trips that recorded a depth greater than 100 feet. These two depth bins each had more than 300 trips, and these two bins were used to create additional cluster analysis results.

No recreational data were analyzed. This is because there have not been any recreational landings surveys conducted in St. Croix since 2000.

Results

The data was filtered for the island region of St. Croix for the years of 2012 through 2014. Then the data was filtered to only contain records for the 43 species of finfish chosen for management by the Council. There were a total of 8,149 commercial trips, and cluster analysis results for these trips are shown in Figure 1. There were eleven species that were chosen by the Council that did not have any landings from 2012-2014. These eleven species were black snapper, Nassau grouper, goliath grouper, black grouper, red grouper, blue parrotfish, midnight parrotfish, rainbow parrotfish, striped parrotfish, graysby, and rock hind. Since no landings were available for these species from 2012-2014 they were not included in the cluster analysis results for Figure 1.

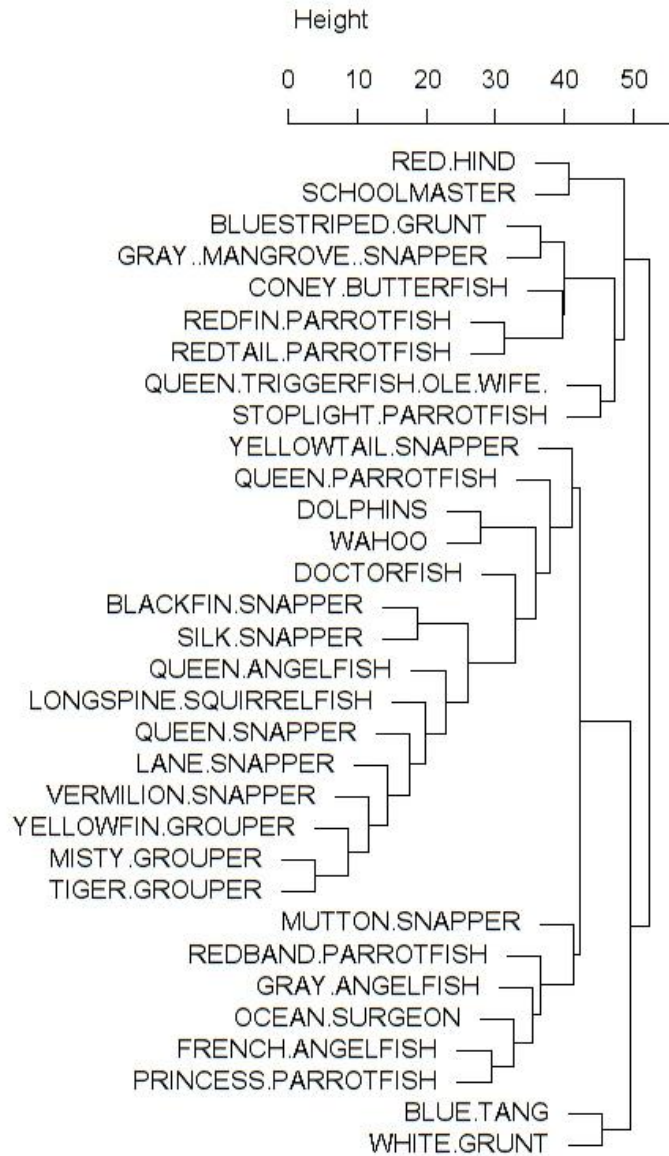


Figure 1. Dendrogram of fish species generated with a cluster analysis of the species chosen for management in St. Croix (n = 8,149 trips). The Caribbean council chose 43 species however 2012 through 2014 landings only had land for 32 of the 43 species.

The fisher’s catch report form only lists 23 of 43 species that the Council chose for management. The data was filtered to only include the 23 species that were both chosen for management and on the catch form. Landings were only available for 22 of the species because no landings were available for graysby. This resulted in 7,915 trips, and a cluster analysis result of these data is shown in Figure 2.

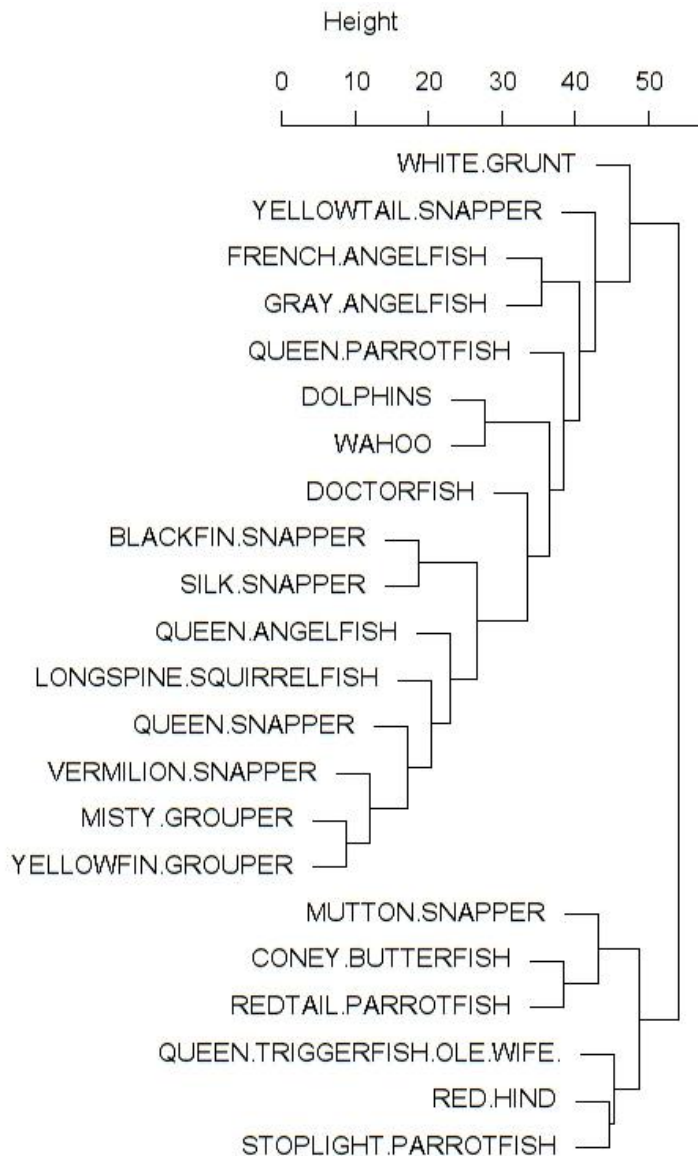


Figure 2. Dendrogram of fish species generated with a cluster analysis for the 23 species that were both chosen for management and on the catch form in St. Thomas/St. John (n = 7,915 trips). However, landings were only available for 22 of the 23 species because there were no landings for graysby.

The trips were separated by gear and included all (if landings were available) of the 43 species chosen for management. There were 3,586 diving, 2,841 hook & line, 1,678 trap, and 44 net trips. A cluster analysis was done for the diving, hook & line and trap trips, and the results are shown in Figures 3, 4, and 5. No cluster analysis was done for the net gear trips because of the low number of trips.

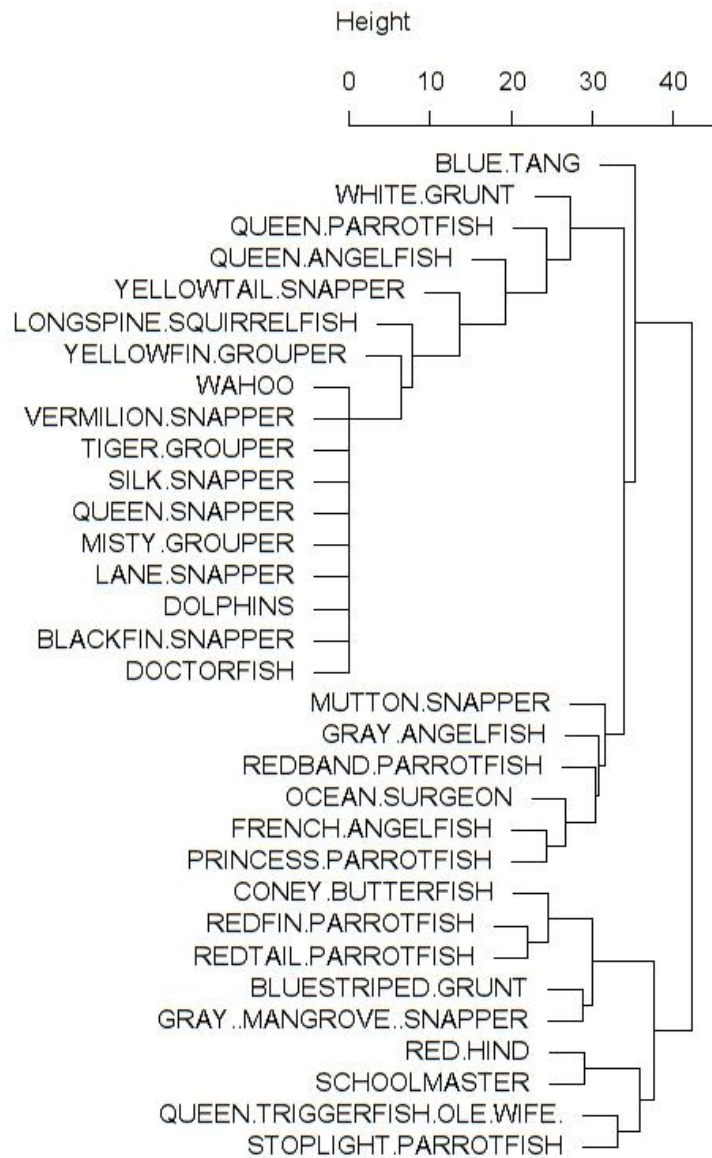


Figure 3. Dendrogram of fish species generated with a cluster analysis for only the diving gear trips (n = 3,586 trips). The dendrogram includes all of the 43 species chosen for management, however landings are not available for all of the species.

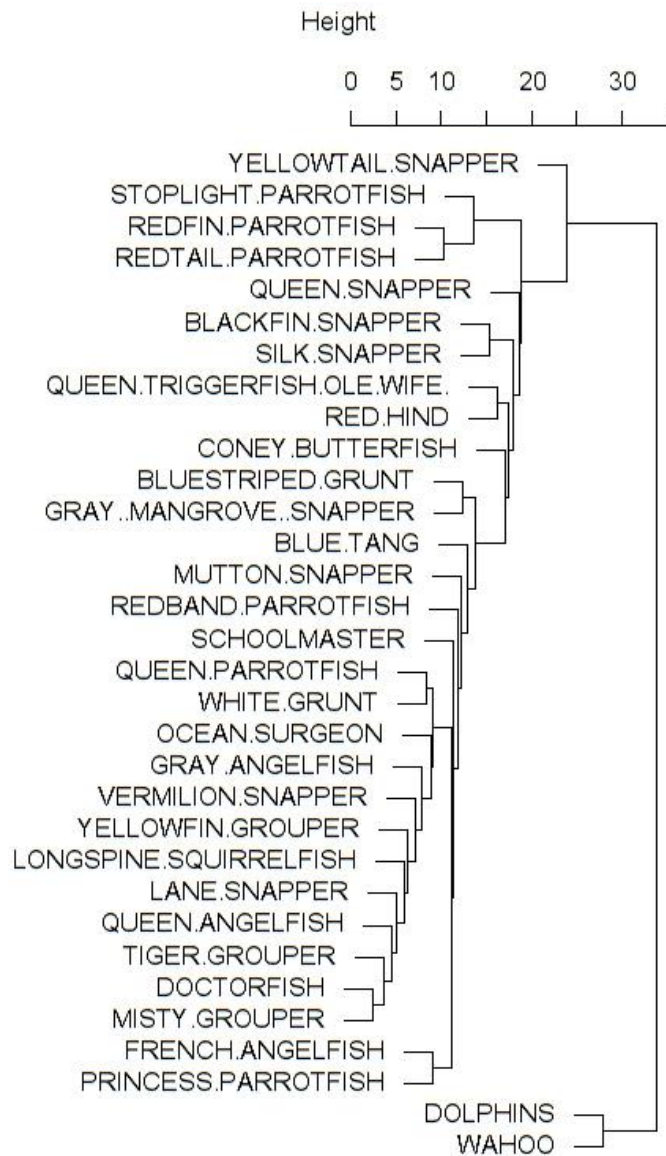


Figure 4. Dendrogram of fish species generated with a cluster analysis for only the hook and line gear trips (n = 2,841 trips). The dendrogram includes all of the 43 species chosen for management, however landings are not available for all of the species.

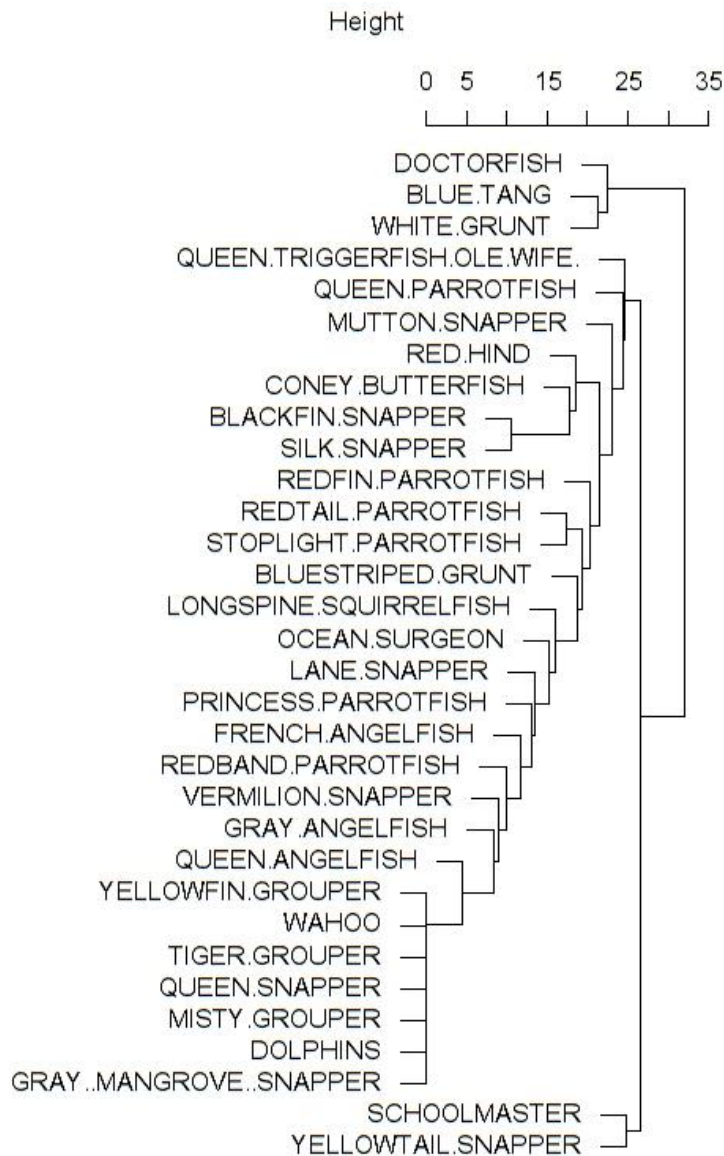


Figure 5. Dendrogram of fish species generated with a cluster analysis for only the trap gear trips (n = 1,678 trips). The dendrogram includes all of the 43 species chosen for management, however landings are not available for all of the species.

The trips were separated into the depth bins of: 1) trips that recorded a depth of less than 100 feet, and 2) trips that recorded a depth of 100 feet or greater. This analysis included all (if landings were available) of the 43 species chosen for management. There were 1,539 trips that occurred less than 100 feet and 3,038 trips that recorded 100 feet or deeper. Some trips did not record any depth information (n = 3,029 trips, 37% of total trips) and were removed from the cluster analysis by depth. Cluster analysis results for the two different depth bins are shown in Figures 6 and 7.

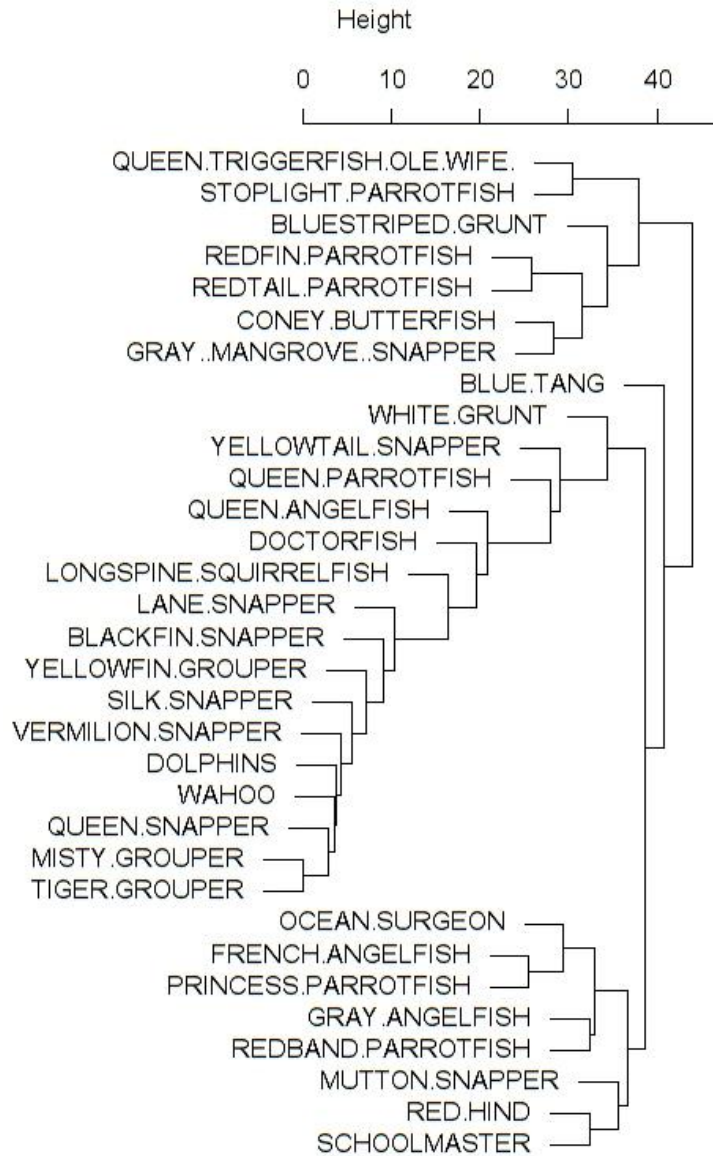


Figure 6. Dendrogram of fish species generated with a cluster analysis for only the trips that occurred in depths of 100 feet or less (n = 4,193 trips). The dendrogram includes all of the 43 species chosen for management, however landings are not available for all of the species.

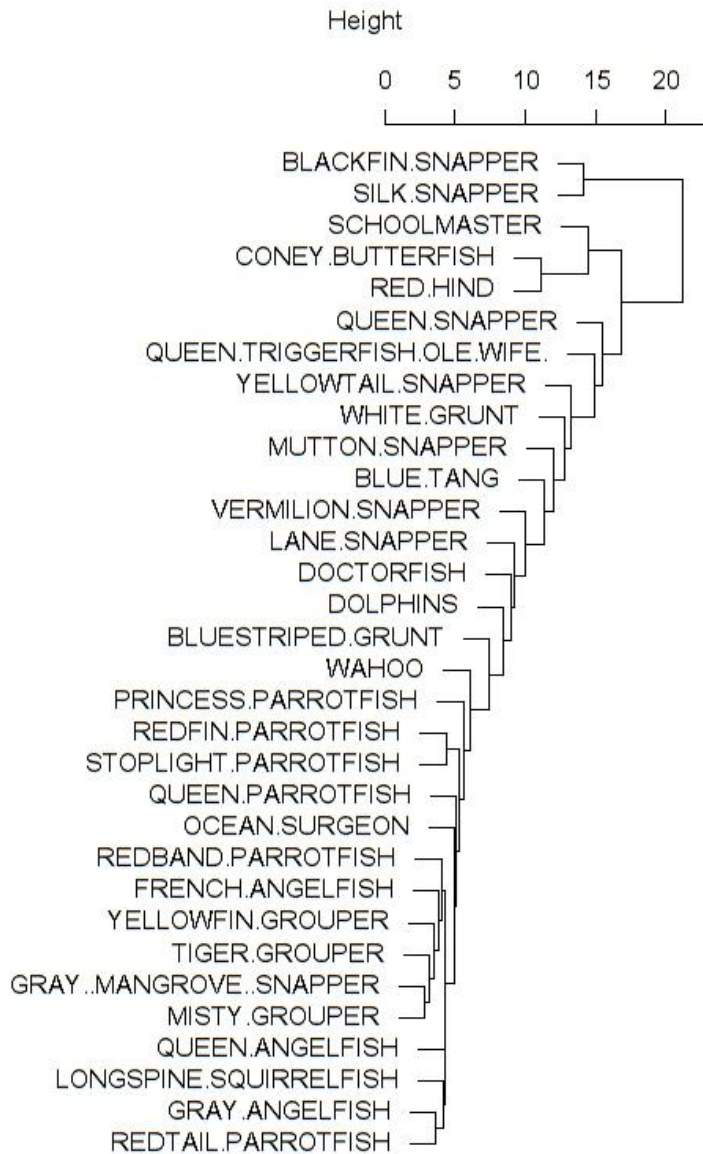


Figure 7. Dendrogram of fish species generated with a cluster analysis for trips that occurred in depths greater than 100 feet (n = 927 trips). The dendrogram includes all of the 43 species chosen for management, however landings are not available for all of the species.

Discussion

Obviously, each fishing trip does not catch all of the species the council chose for management. In recent years some species were not caught on any of the trips, and other species were only caught on a small number of trips. The species that were landed on a small number of trips are not able to be robustly separated in the cluster analysis. There simply is not enough data to form a robust distinction in the clusters. For example, the species of misty grouper and tiger grouper were on a combined total of 17 trips, and on Figure 1 they are shown close to the bottom of the dendrogram without clear separation of a cluster. In contrast, the species that were frequently landed on trips did have a clearly defined cluster. For example, red hind and

schoolmaster were each landed on over 2,000 trips. In Figure 1 there is a clear cluster of red hind and schoolmaster.

The dendrogram was pruned using the cluster analysis for all available data (Figure 1) to provide a list of clusters (Table 1). Clusters were based on the height of the dendrogram branches. There were 19 species that were not landed on any of the trips or they were on so few trips that dendrogram height was low and no clear clusters were formed. These 19 species are black snapper, Nassau grouper, goliath grouper, black grouper, red grouper, blue parrotfish, midnight parrotfish, rainbow parrotfish, striped parrotfish, graysby, rock hind, queen angelfish, longspine squirrelfish, queen snapper, lane snapper, vermilion snapper, yellowfin grouper, misty grouper, and tiger grouper. These twenty-three species were not included in the list of clusters in Table 1.

Table 1. Species clusters generated from a cluster analysis of all 43 species chosen for management in St. Croix (n = 8,149 trips). Only species with discernible clusters were included.

Cluster	Species
1	Red Hind Schoolmaster
2	Bluestriped Grunt Gray Snapper Coney Redfin Parrotfish Redtail Parrotfish
3	Queen Triggerfish Stoplight Parrotfish Yellowtail Snapper Queen Parrotfish
4	Dolphin Wahoo
5	Blackfin Snapper Silk Snapper
6	Mutton Snapper Redband Parrotfish Gray Angelfish Ocean Surgeon French Angelfish Princess Parrotfish
7	Doctorfish
8	Blue Tang White Grunt

Figure 2 had more defined clusters than Figure 1. The data for the cluster analysis shown in Figure 2 had the write-in species removed. The fishermen may not consistently report their land for the write-in species on the catch form which explains why they were in a small number of trips. Therefore, since Figure 2 had the species with the relatively low number of trips removed the cluster analysis was able to focus more on the species with more trips and develop further separation into the clusters.

The isolation of the trips by gear (Figures 3, 4, and 5) and their corresponding cluster analysis made different clusters of species. Interestingly, some species that were frequently landed on trips for one gear were infrequently caught with another gear. Thus, leading to different clusters of species. This same result was found when the data was filtered into the two depth bins.

It's unlikely that the Council will choose species groups for certain gears or depths. However, the cluster analysis by gear and depth allows evaluation of how any species groups that the Council chooses will impact the species observed by the different gears and depth.

References

Southeast Data Assessment and Review (SEDAR) 46. 2016. U.S. Caribbean Data-Limited Species data workshop report. 278 pp.