Cluster Analysis for the St. Thomas and St. John 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. Thomas/St. John FMP.

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. Thomas/St. John. In August of 2015 the Council chose a list of species for management for each island region. The Council shoes 47 species of finfish and also spiny lobster and queen conch for the St. Thomas/St. John region. In December of 2015 the Caribbean Council's Scientific and Statistics Committee recommended removing these spiny lobster and queen conch from the cluster analysis. Therefore, the commercial landings were filtered so only data for the 47 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 47 species of finfish. However, the fisher's catch report form only lists 24 of the 47 species chosen for management by the Council. Therefore 51% of the species chosen for management are not listed on the catch form. Any landings for these 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 used were hook & line, trap, diving, and nets. Cluster analyzes were only conducted for hook & line and trap trips because the samples sizes for diving and 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. Thomas/St. John since 2000.

Results

The data was filtered for the island region of St. Thomas/St. John for the years of 2012 through 2014. Then the data was filtered to only contain records for the 47 species of finfish chosen for management by the Council. There were a total of 5,117 commercial trips, and cluster analysis results for these trips are shown in Figure 1. There were twelve species that were chosen by the Council that did not have any landings from 2012-2014. These twelve species were Nassau grouper, goliath grouper, black grouper, blue parrotfish, midnight parrotfish, rainbow parrotfish, redband parrotfish, striped parrotfish, redfin parrotfish, sea bream, sheepshead porgy, and pluma. Since no landings were available for these species from 2012-2014 they were not included in the cluster analysis results for Figure 1.

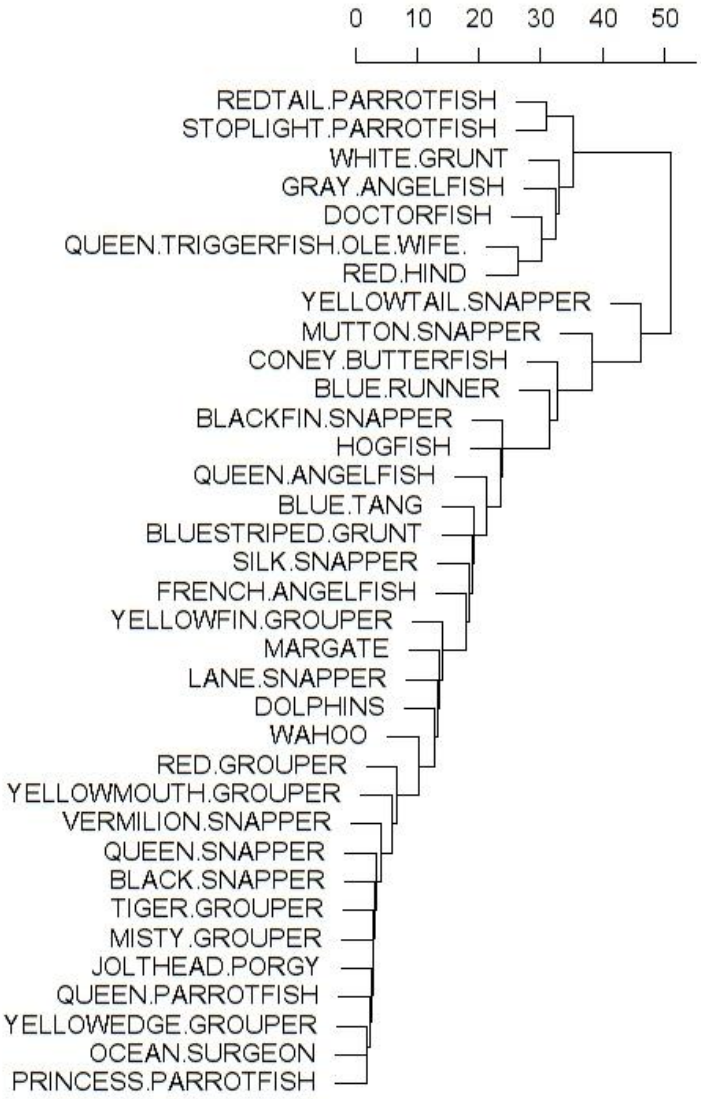

Figure 1. Dendrogram of fish species generated with a cluster analysis of the species chosen for management in St. Thomas/St. John (n = 5,117 trips). The Caribbean council chose 47 species however 2012 through 2014 landings only had land for 36 of the 47 species.

The fisher's catch report form only lists 24 of 47 species that the Council chose for management. The data was filtered to only include the 24 species that were both chosen for management and on the catch form. Landings were only available for 23 of the species because no landings were available for pluma. This resulted in 5,113 trips, and a cluster analysis result of these data is shown in Figure 2.

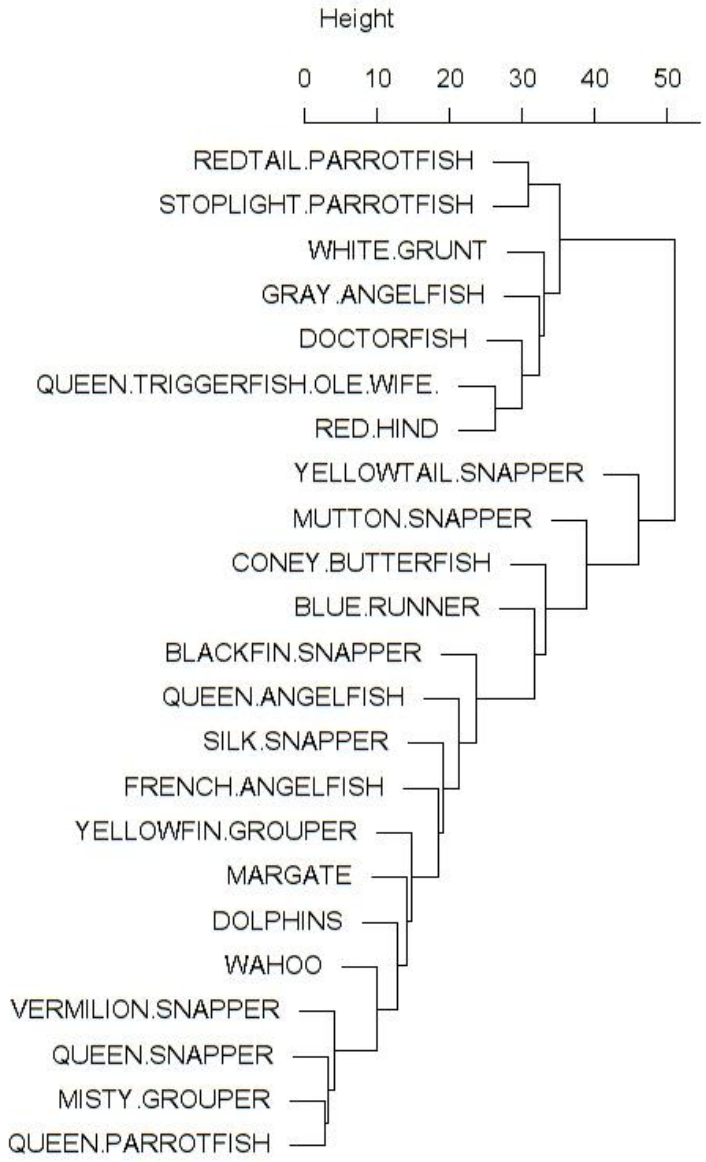

Figure 2. Dendrogram of fish species generated with a cluster analysis for the 24 species that were both chosen for management and on the catch form in St. Thomas/St. John (n = 5,113 trips). However, landings were only available for 23 of the 24 species.

The trips were separated by gear and included all (if landings were available) of the 47 species chosen for management. There were 1,497 hook & line, 3,299 trap, 97 diving, and 224 net trips. A cluster analysis was done for the hook & line and trap trips, and the results are shown in Figures 3 and 4. No cluster analysis was done for the diving and net gear trips because of the low number of trips.

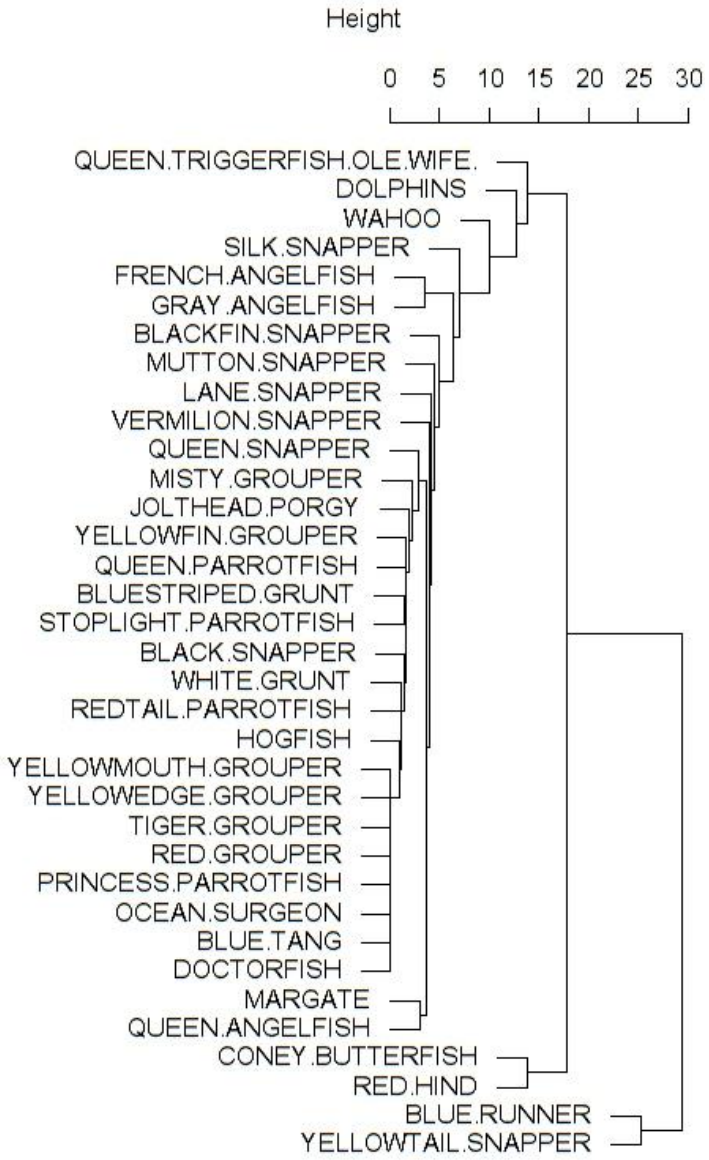

Figure 3. Dendrogram of fish species generated with a cluster analysis for only the hook and line gear trips (n = 1,497 trips). The dendogram includes all of the 47 species chosen for management, however landings are not available for all of the species.

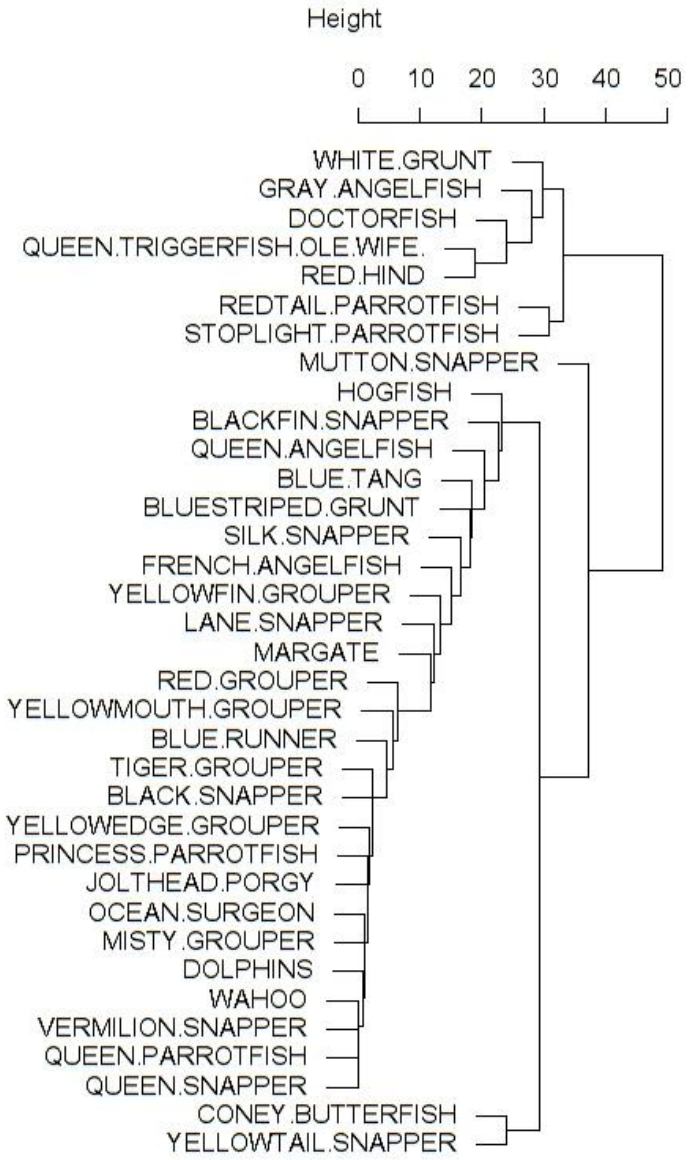

Figure 4. Dendrogram of fish species generated with a cluster analysis for only the trap gear trips (n = 3,299 trips). The dendogram includes all of the 47 species chosen for management, however landings are not available for all of the species.

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 47 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 = 540 trips, 10% 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 5 and 6.

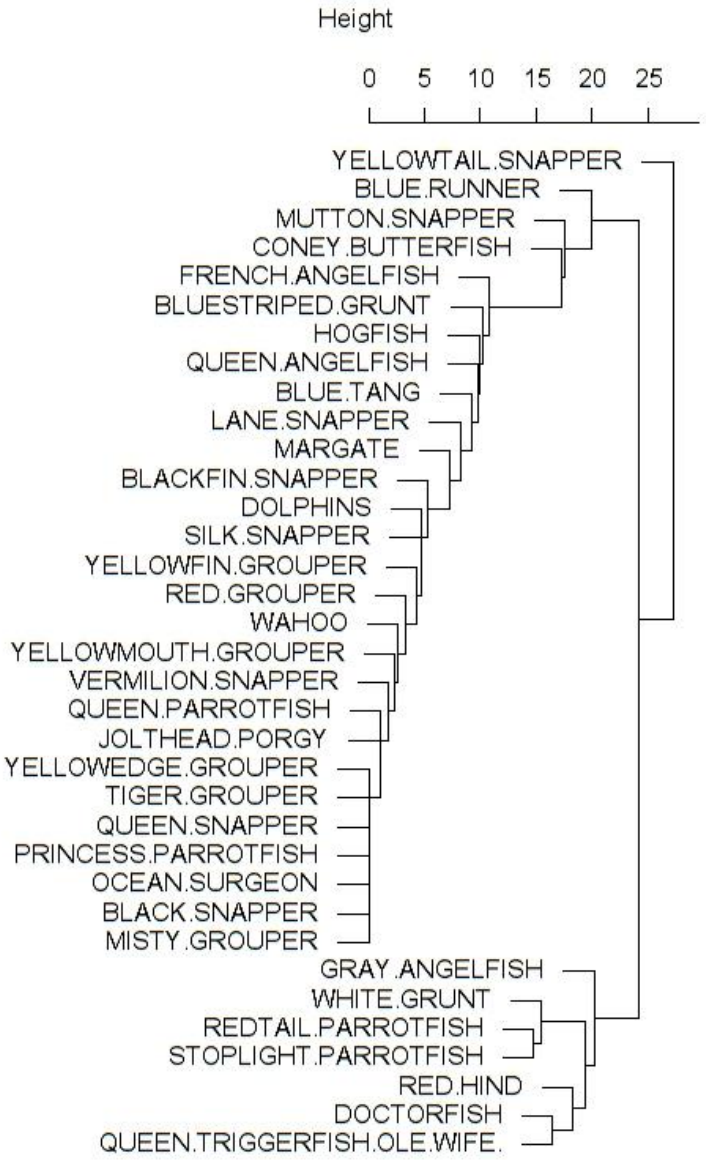

Figure 5. Dendrogram of fish species generated with a cluster analysis for only trips that occurred in depths of 100 feet or less (n = 1,539 trips). The dendogram includes all of the 47 species chosen for management, however landings are not available for all of the species.

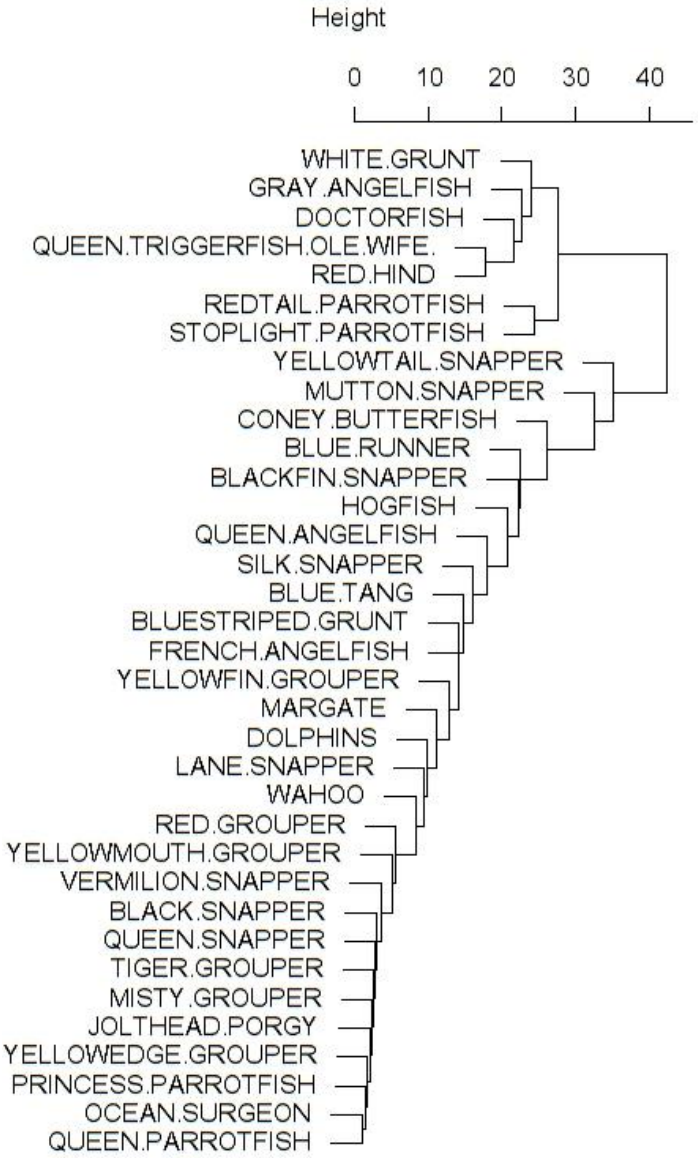

Figure 6. Dendrogram of fish species generated with a cluster analysis for trips that occurred in depths greater than 100 feet (n = 3,038 trips). The dendogram includes all of the 47 species chosen for management, however landings are not available for all of the species.

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 yellowedge grouper, ocean surgeon, and princess parrotfish were on a combined total of 6 trips. In Figure 1 these three species are shown at the bottom of the dendogram without a clearly defined cluster. In fact, Figure 1 has a stack of species on the bottom from vermilion snapper to princess parrotfish that do not have clear separation in the clusters, and this is because these species were landed

on a relative low number of trips. In contrast, the species that were frequently landed on trips did have clearly defined clusters. For example, redtail and stoplight parrotfish were each landed on over 1,900 trips. In Figure 1 there is a clear cluster of redtail and stoplight parrotfish.

The dendrogram was pruned using the cluster analysis for all available data (Figure 1) to provide a table of clusters (Table 1). Clusters were based on the height of the dendrogram branches. There were twenty-four 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 twenty-four species are Nassau grouper, goliath grouper, black grouper, blue parrotfish, midnight parrotfish, rainbow parrotfish, striped parrotfish, redfin parrotfish, redband parrotfish, sea bream, sheepshead porgy, pluma, red grouper, yellowmouth grouper, vermilion snapper, queen snapper, black snapper, tiger grouper, misty grouper, jolthead porgy, queen parrotfish, yellowedge grouper, ocean surgeon, and princess parrotfish. These twenty-four species were not included in the cluster table (Table 1).

Table 1. Species clusters generated from a cluster analysis of all 47 species chosen for management in St. Thomas/St. John (n = 5,117 trips). Only species with discernible clusters were included.

Cluster	Species
1	Redtail Parrotfish
	Stoplight Parrotfish
2	White Grunt
	Gray Angelfish
	Doctorfish
	Queen Triggerfish
	Red Hind
3	Yellowtail Snapper
	Mutton Snapper
	Coney
	Blue Runner
4	Blackfin Snapper
	Hogfish
	Queen Angelfish
5	Blue Tang
	Bluestriped Grunt
	Silk Snapper
	French Angelfish
6	Yellowfin Grouper
	Margate
	Lane Snapper
7	Dolphin
	Wahoo

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 these species 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 and 4) 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.