

An Investigation of Fishing Communities' Adaptation Strategies and Disappearances

Wenrui Zhao

Department of Mathematics and Geography, Rutgers University, Piscataway, New Jersey 08854

Abstract

Fishing is an integral part of many coastal communities and economies. In order to understand the response of fishing communities to regulation and/or climate change, we examined a database of every commercial fishing trip spanning 1995-2015 to understand the response of different communities. We believe that the fishing communities are adapting to species shifts by changing their location and/or changing species catch. We, also, believe that small boat ground-fishing communities are extremely vulnerable to changes in their environment.

To understand the adaptation strategy of communities, we are using a cluster analysis technique to understand the common traits amongst fishing communities in the northeast United States and to analyze the adaptation strategy of these communities. In order to gain insight into the different adaptive strategies of different community types, we examined the following variables over time for each community type: number of trips, average crew size, average diversity of catch, average distance traveled, and the average total catch per trip. Based on our current analysis, it appears that different types of communities are adapting to climate change in different ways. Our research will provide deeper insight into how these communities are adapting to their changing environment and how these communities are changing at a community level.

Background

From previous investigation, two of the possible reactions responding to fish species' movements are changing fishing locations and shrinkage or disappearing of the community (Young, et al., 2018, p. 99). The goal for this project is to see how communities from our datasets get used to fish species' movements and make a living. We are going to classify the communities with similar characteristics into the same cluster and then examine how each cluster behaves to response to the fish species' movements.

Method

Part 1 – Fishing Communities' Adaptation Strategies

We have two major steps to investigate how those communities adapt to the changing environment – group communities based on similar characteristics and then investigate how each group performs over time (20 years of data).

Pre-STEP: Determine the communities going to be used in the cluster analysis: vessel number ≥ 3 , trip per year >20 , and age > 5 .

STEP 1 – Cluster Analysis

1. Select Effective Characteristics and Summarize for each Community

Selected Characteristics

2. Find the Optimal Number of Clusters

fviz_nbclust() function in R programming gives the optimal number of clusters = 3.

kmeans() function in R assigns cluster number to each community

Number of crew, length of vessels, number of vessel, number of trips, trip per vessel, quantity kept, distance traveled, fishing days per trip (the labor force), total fishing days, duration (fishing day per trip), total fishing days, efficiency (quantity kept per fishing day), area (a buffer containing 75% of the trips within a community), richness (number of types of species), Shannon_H (fishing catch characteristics), and evenness (Shannon_H/log(richness))

K-means clustering is a popular tool for vector quantization, to make vectors close to each other into a group.

STEP 2 – Investigation

1. Summarize the characteristics of each cluster

2. Make conclusions about each cluster's variation.

Conclusion

From the bar graphs shown in the result section, we can see that different clusters contain distinct characters; and for those line graphs, each cluster performs differently when responding to the fish species' movements.

Cluster 1 – These are relatively small-scale fishing communities (few vessels, small vessels, few crew, lower catch, low mobility, dependent upon a variety of species). Other research suggests that these communities are among the most vulnerable to environmental change. While, in this cluster most characteristics are comparatively steady, we note the large decrease of the number of communities after 2000 and the increase in the number of trips per vessel (suggesting more trips are needed to sustain overall catch levels). While the remaining communities in this cluster appear stable, there is some evidence that they (like other communities) are harvesting less of a variety of species as see in the richness, Shannon H, and evenness indexes.

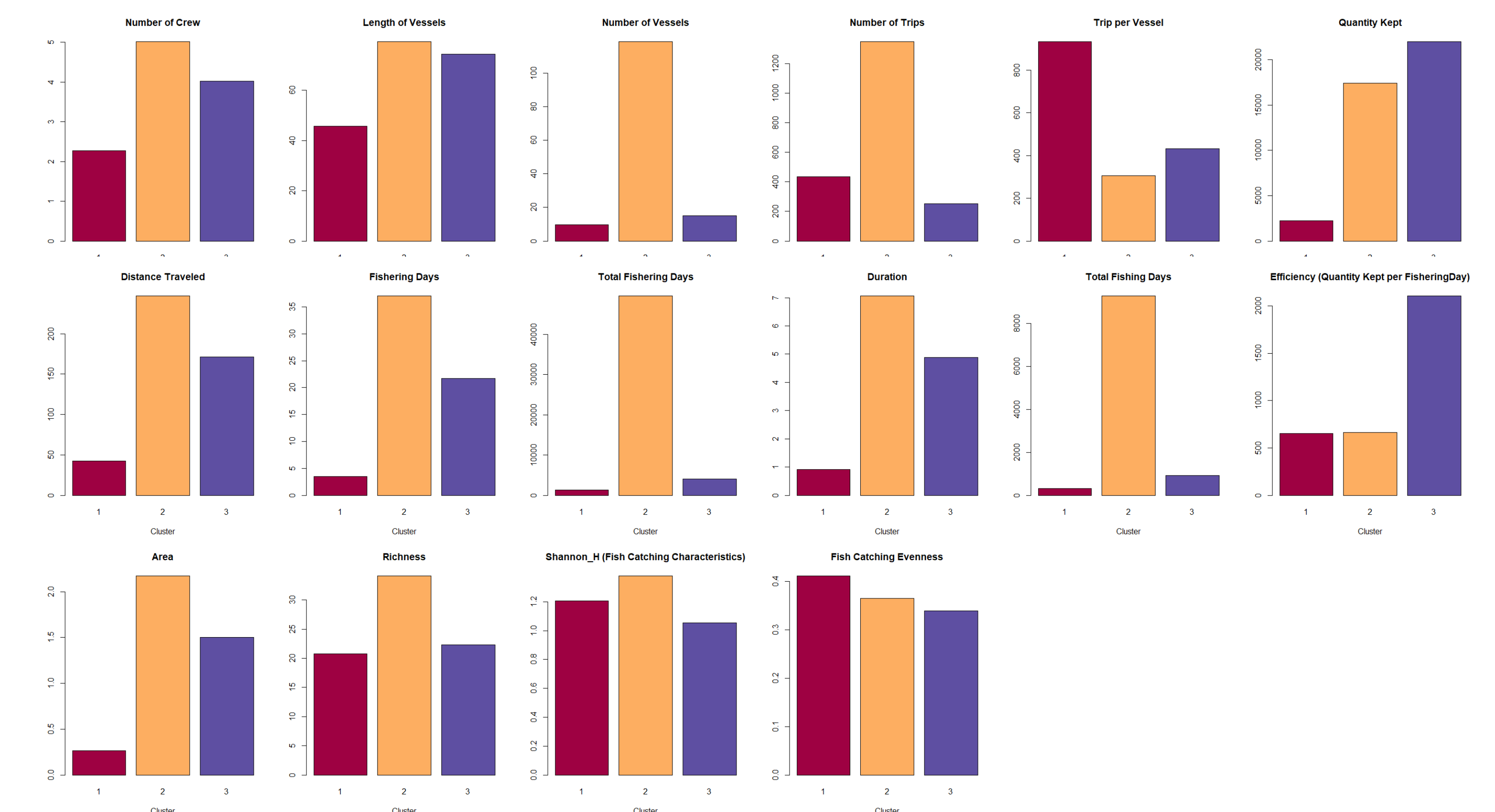
Cluster 2 – These are large fishing communities located in relatively large port cities (larger crew size, more and larger vessels, more trips, longer distance traveled, more fisher days (more labor force), longer duration (number of days for each trip), and larger area). Its number of communities is steady, but there is a clear increase in distance traveled (search for catch) as well as more trips for each vessel through these years, and what is more, its richness, Shannon H, and evenness keeps decreasing like the other two clusters (suggesting a narrowing of target species due to both management restrictions and species availability).

Cluster 3 – These are relatively small communities with gear types and target species similar to those in cluster 1 but with larger vessels traveling longer distances similar to cluster 2. The increase in mobility, fewer fisher days, and a rising efficiency indicates that these communities are increasing effort, however, quantity kept is unsteady throughout these years suggesting a level of precarity; moreover, its richness, Shannon H, and evenness, generally decreases throughout those years, which is an indication that those communities catch less fish species and they are more focusing on fewer of them.

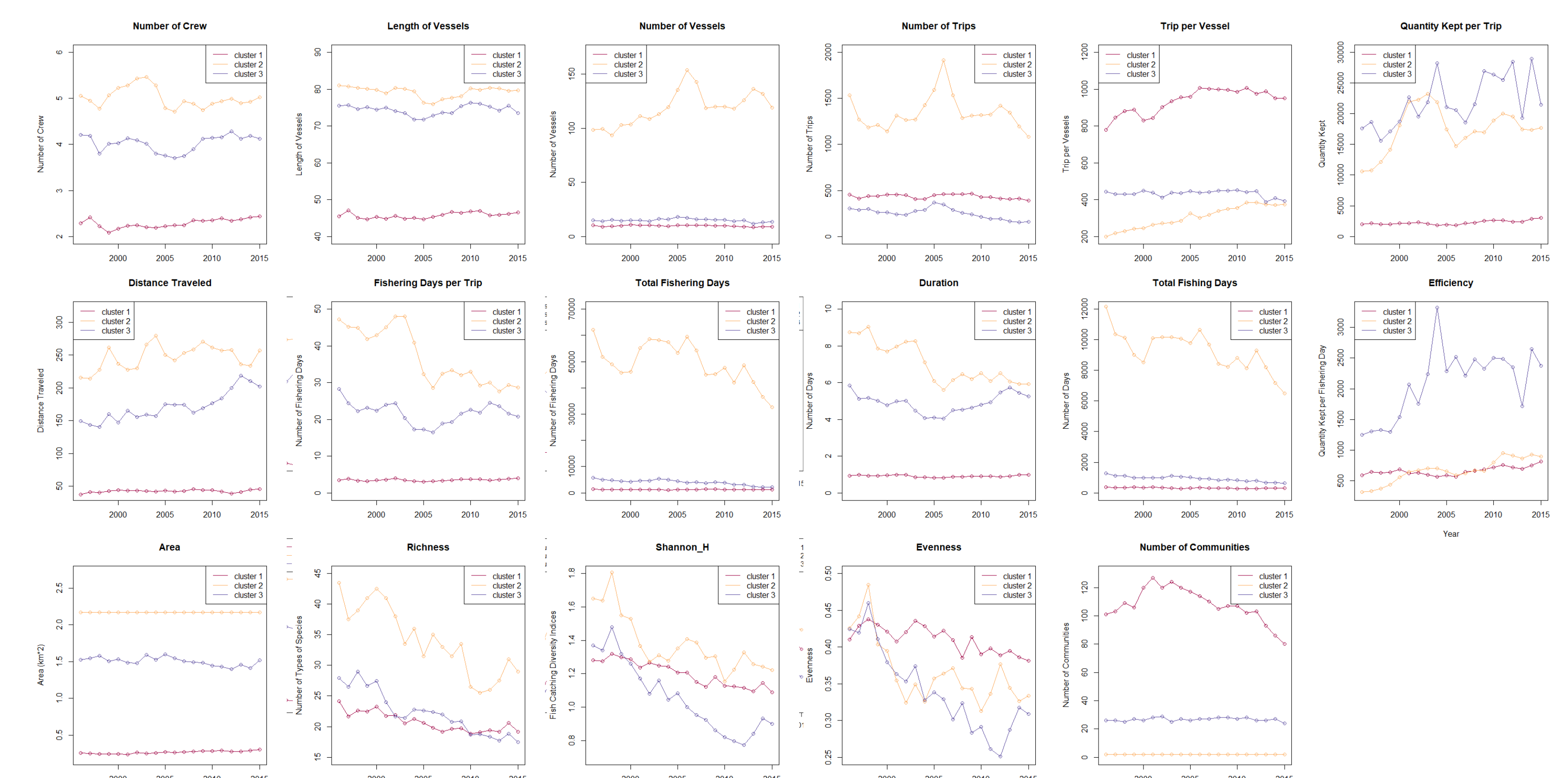
In conclusion, there are three types of adaptation strategies for the communities in the datasets we have, they are – disappearance of the community, traveling for longer distance (suitable for large communities), and putting more efforts on fishing (do the same or even more work with less labor force). But as you can see from those line graphs, all these three actions cannot stop the decrease in types of fish caught, and what is more, a focusing on fewer fish species may result in a threaten of their breeding, which may cause difficulties for future fishing.

Result

Cluster Characteristics



Cluster Variations (by Year)



References

Young, T., Fuller, E. C., Provost, M. M., Coleman, K. E., Martin, K. S., Mccay, B. J., & Pinsky, M. L. (2018). Adaptation strategies of coastal fishing communities as species shift poleward. *ICES Journal of Marine Science*, 76(1), 93–103. doi: 10.1093/icesjms/fsy140
The Fishshift Lab, Rutgers University.