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Impact of Increasing Biotic Habitat on Biodiversity

BIOL 310 Term Paper

I. Introduction

SeaTube is an effective technique which provide us with better observation of ocean ecosystem. By analyzing the SeaTube dataset, we can understand how the biodiversity of ocean ecosystem changes with different geographic or biotic conditions. Based on previous analysis of SeaTube data, we have realized the variation of location and bottom type can lead to the changes of biodiversity in substrates. Other than the abiotic factors, it's remained unknown that impact of biotic factors on the biodiversity of SeaTube substrates. Biotic factors are the living organisms and interaction among them within an ecosystem. According to data collected from the SeaTube, we don't know many specific information about each specie but abundance, so that we can consider the abundance of biotic habitat as an important variable to investigate. Biotic habitat is the biotic factor of the habitat where other living organisms with it as mutualism. (Buhl-Mortensen, 2010) Some common aquatic biotic habitats are sea pen and coral.

Sea pen is a type of octocoral which is usually related to the brittle stars. The present of sea pen provide brittle stars with potential habitat. According to the SeaTube data, many brittle stars are observed tangled on a sea pen. Coral is another common biotic habitat, which is a significant component of the coral reef ecosystem. Coral is a more complex biotic habitat than sea pen, and it can be the habitat for both vertebrates and invertebrates. (McNeil,2021) Based on

the observations of the SeaTube Videos, many living organisms such as fishes are found surrounding the coral.

Hence, I am wondering what is the difference between the substrate contains biotic habitat and the substrate without biotic habitat. Since biotic habitat can provide some living organisms with beneficial environment, I expected substrates containing biotic habitat have better biodiversity which can reflect on the higher alpha biodiversity index. Otherwise, the present of biotic habitats do not affect the overall biodiversity. Besides, I would like to ask how biodiversity changes as the biotic habitats increases if the first hypothesis is true. My hypothesis is that biodiversity is increasing as the number of biotic habitats increases. If the hypothesis is true, I expect to see the biodiversity index (species richness/Shannon's and Gini) has increasing trend as the biotic habitats increases. Lastly, sea pen is relatively simpler biotic habitat compared to coral. I am wondering if there is a difference of the biodiversity with simple biotic habitat and with complex biotic habitat. Since sea pen only plays the role of habitat for the brittle stars in the SeaTube data, I expected it can increase species richness by one specie. While coral can serve as habitat for multiple species, I expected substrates having coral can have higher species richness. What's more, coral usually has larger size than sea pens, so I expected corals have higher species abundance than sea pens. Generally, my hypothesis is that complex biotic habitat can have greater increasing in biodiversity than simple biotic habitat. An alternative hypothesis is that complexity of biotic habitat will not affect the biodiversity.

II. Method using R

According to previous analysis of SeaTube data, we have known that fine bottom type has relatively better biodiversity than others, and location Clayoquot slope also have general

higher biodiversity than others. To minizine the disturbing of abiotic factor, I only take the data with fine bottom type and in location of Clayoquot slope as the general dataset.

Biodiversity comparison between substrates with or without biotic habitat

To compare the biodiversity between substrates with or without biotic habitats, I made two subsets of the general dataset. For the first dataset, I chose the data instances with non-zero coral or non-zero sea pen (sea_pen!=0|coral!=0), and named it as my with_biotic data. Then, I chose the instances with zero coral and zero sea pen as my without_biotic data. (coral==0 & sea_pen==0) When two datasets are ready, I calculated the species richness, Shannon's diversity, and Gini-Simpson's index of both datasets. The Shannon's diversity was calculated by formula: $H = -\sum pi \times \ln(pi)$ where pi refers to the proportion of each species related to the total number of species. The Gini-Simpson's index is calculated based on the formula: $H = 1 - \sum pi$. Then I took the mean of all values and draw the box plot for comparison.

Biodiversity variation with increasing number of biotic habitats

To answering the questions about the trend of biodiversity with increasing biotic habitats, I will focus on the with_biotic data. I considered the number of biotic habitats as the summary of the abundance of coral and sea pens. Hence, I took the sum of both species in all data instances and ordering the data by the ascending number of sums. Then, I calculated species richness, Shannon's diversity, and Gini-Simpson's index of all sites. Base on the data I got, I draw the line plots for each biodiversity index related to the sum of biotic habitats. Form the trend of the line plot, the relationship between biodiversity and number of biotic habitats can be tell.

Biodiversity comparison with simple and complex biotic habitats

To explore how complexity of biotic habitats affect the biodiversity, I split the with_biotic data into two subsets. In the first dataset, I put data instances which contain coral but

not sea pen, and I named it as with_coral dataset. For the other dataset, I only put data instances which contain sea pen but not coral. Then, I calculated the species richness, Shannon's diversity and Gini-Simpson of each site for both datasets. Finally, I calculated the mean for each biodiversity index and comparing them between datasets.

III. Result

For the first part of data analysis, I found that substrates containing biotic habitat appear to have higher biodiversity than substrates without biotic habitat. According to the mean value of each biodiversity index in all qualified sites, species richness appears to have a great increase for the sites containing biotic habitats. However, Shannon's diversity and Gini-Simpsons of both situations are closely similar, but sites with biotic habitats are relatively higher in index. (Table.1) Compare the data distribution of species richness, the substrates with biotic habitats have average species richness 6.33, and data have boarder distribution. Substrates without biotic habitats with average species richness as 4.43 and data are close to the mean value. (Figure.1)

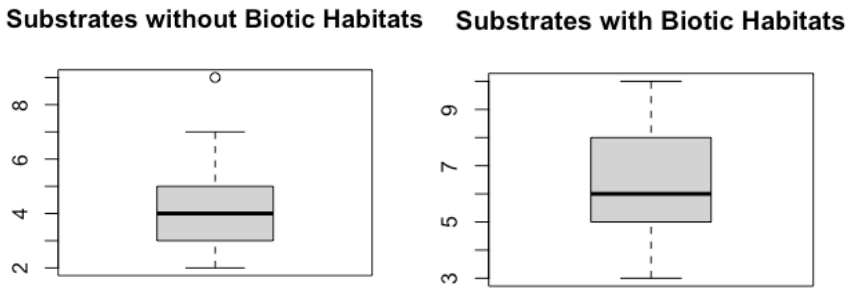

Figure 1. boxplot of species richness of substrates with and without biotic habitats.

	Richness	Shannon's	Gini-Simpson
With Biotic Habitat	6.33	1.16	0.57

Without Biotic Habitat	4.43	1.07	0.56

Table 1: mean value of species richness, Shannon's and Gini-Simpson of substrate with or without biotic habitat

For the relationship between biodiversity with increasing biotic habitat number, I got the result that line plot in three biodiversity indexes. Surprisingly, there is no conclusive trend shown for any of the biodiversity index. However, the plot of Shannon's diversity and Gini-Simpson's index have similar shape. All of three plots indicated that most sites having biotic habitat less than 50 individuals, and the highest value of each biodiversity index are found in sites with biotic habitats less or equal to 50 individuals. (Figure.2)

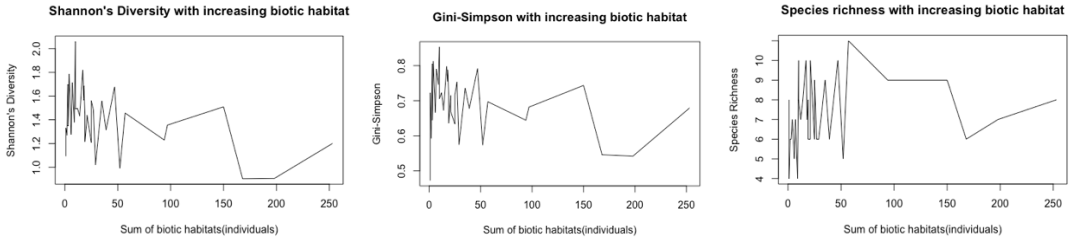

Figure.2: a. Shannon's Diversity with increasing biotic habitat; b. Gini-Simpson with increasing biotic habitat; c. Species richness with increasing biotic habitat.

For the comparison of biodiversity between biotic habitat with different complexity, the result showed that the sites which are only have sea pen as biotic habitats have slightly higher biodiversity index than site containing only coral as biotic habitats. (Table.2) However, the values of both datasets are close. Compare the data distribution of Gini-Simpson for both cases, most sites with coral have Gini-Simpson index lower than the mean value which is 0.53. For

sites with sea pens, more data are distributed above the mean value which is 0.60. (Figure.3)

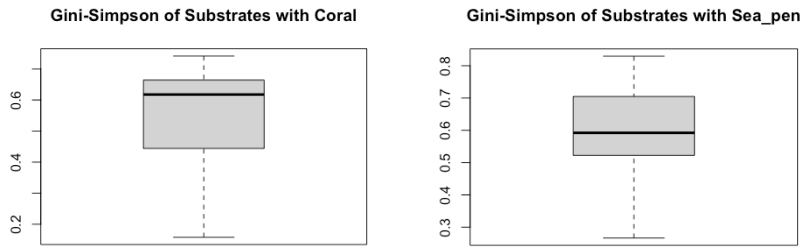

Figure.3: Gini-Simpson's index of substrate with only Coral biotic habitat and substrates with only sea pens as biotic habitat.

	Richness	Shannon's	Gini-Simpson
With Coral Only	6.00	1.06	0.53
With Sea Pen Only	6.47	1.24	0.60

Table.2: species richness, Shannon's and Gini-Simpson's index of sites contains only coral as biotic habitat and sites contains only sea pen as biotic habitats.

IV. Discussion

With the help of data analysis technique, I can conclude to my questions. Firstly, there is a difference between the substrates contain biotic habitat and the substrates without biotic habitat. According to my result, the substrates contain biotic habitats showed more alpha biodiversity than the substrates which don't have biotic habitats. There is a clearly increasing in biodiversity if the substrates containing biotic habitats. However, biodiversity index considering species abundance (Shannon's and Gini-Simpson's) are similar for both cases. Generally, the result confirms my hypothesis which is that substrates containing biotic habitat have better biodiversity which can reflect on the higher alpha biodiversity index. My second hypothesis is that biodiversity is increasing as the biotic habitat increases. However, my result is against to my

hypothesis which showed no general trend and highest value are found in sites with small amount of biotic habitat. My last hypothesis is that sites containing complex biotic habitat such as coral can have more biodiversity than those containing simpler biotic habitat such as sea pens. My result for this part of questions also showed against to my hypothesis. Biodiversity indexes of substrates containing only sea pens as biotic habitats are higher than those of substrates containing only coral as biotic habitats. Here I simply address the result of all three questions, but I will put discussion on the two results which against my hypothesis on next two paragraphs.

There is no general trend of biodiversity index with increasing biotic habitats

One of the most surprising results in my finding is that containing biotic habitats can increase the biodiversity of the substrates but not continuously increasing as number of biotic substrates increases. There is no clear pattern seen in the line plots for neither biodiversity index. I made my hypothesis based on the assumption that more biotic habitat can provide relevant living organisms with more proper living environment, so that there is higher survive rate for relevant species. However, the data results have shown that substrates with less amount of biotic habitat appear to have higher biodiversity, and there is a slightly increasing if the amount of biotic habitat increases to a larger number such as 250 individuals in total. One of the possible reasons is that lack of data for the sites with larger number of biotic habitats. Generally, the amount of biotic habitat seems not the main component lead to variation in the biodiversity.

Sites contains only sea pens have higher biodiversity than those only contains coral

Another interesting finding is that sites only contain sea pens as the biotic habitat appear to have more biodiversity than those only contains coral as the biotic habitat. This result is against both of my hypothesis and alternative hypothesis. I considered that coral can be potential habitat for multiple species while sea pens seem to be the biotic habitat only for brittle stars, so

that I think coral is a more complex biotic habitat. Even though my result told that sites with sea pens have more biodiversity, I do not think it concludes that simple biotic habitat can lead to more biodiversity in the sites. When we are observing the SeaTube videos, the brittle stars are easier to observed with sea pens since they have clearly different shape and colour with the biotic habitats (sea pens). However, I assume that some invertebrates living in the coral are harder to observe since the size and colour. Therefore, there are some data losses for the living organisms in coral which lead to the smaller biodiversity. Also, the difference between two cases too small to conclude any convictive evidence. Hence, I tend to conclude that complexity of biotic habitat does not affect the biodiversity of substrates. The alternative hypothesis is taken.

Caveats

When I was excluding the disturbing abiotic data, I only took off the effect of bottom type and location. There are still many abiotic factors such as latitude and temperature were not taken off, and they might affect the result I got. Besides, for summarizing the biotic habitat, there are only few data instances which containing large number of biotic habitats. Hence, the trend of biodiversity in sites with different number of biotic habitats is not concluded with sufficient datapoints. More data need to be collected for this case. Also, I mentioned that unclear observation can lead to the data loss which also largely affect the result. Finally, I did not exclude the effect of number of biotic habitat when I analyzed the biodiversity with different types of biotic habitat. With more accurate control of variables, we might be got more conclusive results.

Reference

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