Phytoplankton's Effect on Fish Populations

Abstract:

Plankton and fish surveys were conducted at four different artificial reef sites off the coast of Florida during summer and fall to investigate potential correlation. Surveys at Treasure Island Reef, St. Petersburg Reef, Veterans Reef, and Dunedin Reef showed that there was a positive correlation between the number of plankton and number of fish. Greater numbers of plankton and fish were observed in summer than during fall. Treasure Island Reef exhibited the greatest numbers of both fish and plankton. Of feeding types, the strongest positive correlation existed between the number of plankton and omnivorous feeders. Moving forward with this experiment, it may be useful to modify some of our original methodology to find a stronger correlation.

Introduction:

In the surface oceans, plankton makes up the base of the marine food pyramid. Fish rely both directly and indirectly on plankton as their main food source. They capture energy from the sun and convert it into a form for that can be eaten by other animals on the food pyramid such as zooplankton and fish. Carnivores and top predators are located at the top of the food pyramid and receive their energy by consuming other animals, like smaller fish and plankton. Based on this relationship, I hypothesized that the number of plankton will affect the number of fish in a particular area. If there is an increase in the number of plankton, then there may also be an increase in fish since a greater number of plankton would support a greater number of fish. Conducting an experiment comparing the number of plankton to the number of fish present at a dive location would allow us to support my hypothesis that there exists a positive correlation between the two.

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Methods:

Data was collected at of four different artificial coral reefs located in the Gulf of Mexico; Treasure Island Reef (27* 44.991, 082* 52.86’), St. Petersburg Reef (27* 40.692, 082* 51.850’), Veterans Reef (28* 02.850’, 083* 00.746’) and Dunedin Reef (28* 03.294’, 082* 54.593’). On each dive an, Reef Environmental Education Foundation (REEF) fish survey was completed underwater. During the surface intervals, a plankton sample was collected. A plastic, clear bottle was screwed into the plankton net. Ocean water was filled into the bottle before the net was towed behind the boat. Just skimming the surface of the water but fully immersed, the net was towed behind the boat for exactly five minutes at a speed between 2-4 knots. While the plankton was being collected, all the metadata was recorded down, including the beginning and ending coordinates for the reef sites, air temperature, water temperature, reef type (artificial or natural), weather, water depth and start and end time for net treading. After 5 minutes the plankton net was pulled up and then a picture was taken of the sample bottle. To analyze the plankton data, plankton was counted by looking at the picture and counting the numbers of plankton seen through the biggest circle of the collection bottle. The REEF fish survey includes categories that describe number of fish observed: single, few, many and abundant. To convert the categorical variables into quantifiable numbers, each category was assigned a number to help calculate an average number of the particular fish seen. Single was assigned 2, few was 4, many was 6 and abundant was 8. These numbers allowed us to analyze the number of fish seen that day. If there was more than one survey conducted per dive, fish totals were averaged to give us one numerical value. Four fish surveys and 4 plankton samples were conducted during summer months (July and August) and 2 fish surveys and 2 plankton samples were conducted during fall months (November).

Results:

Figure 1. Total plankton for versus total fish counted for each dive

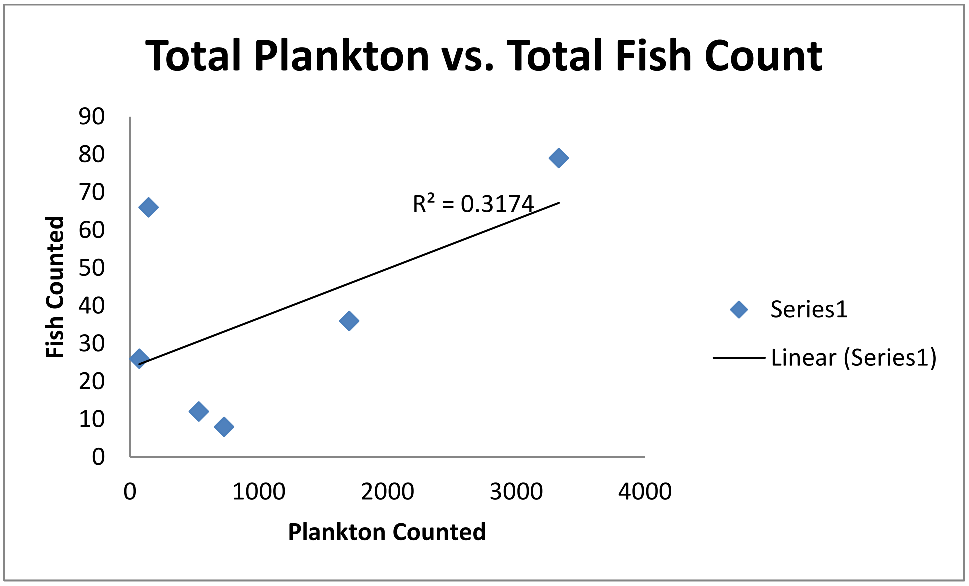

Figure 1 compares the total plankton counted for each dive plotted against the total number of fish counted. There is a 31% positive correlation between plankton and fish. This shows that although there isn't a strong correlation between the two, there is still a positive correlation that exists. Also, as the number of plankton increases, there is also an increase in the fish number. The first dive on July 30th, 2016 had the most fish and the most plankton compared to the other dives.

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Figure 2. Total plankton versus total fish counted by season. Summer- blue diamonds and Fall- red squares

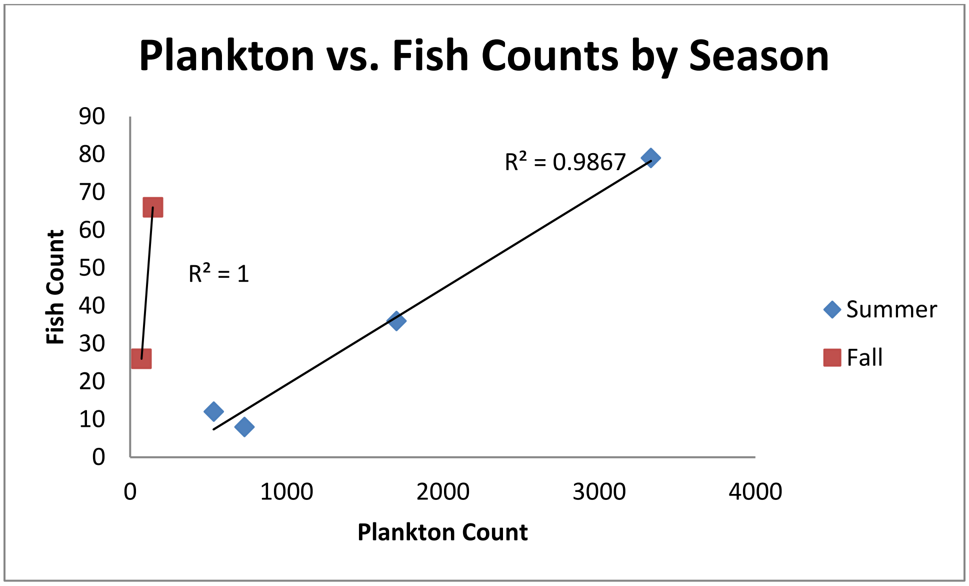

Figure 2 shows the relationship between the number of plankton and fish across different seasons (summer and fall). Although fish and plankton were present for both seasons, there was significantly more plankton during summer than fall. Fall's plot points remain slightly above zero for plankton, while summer is scattered from 500 to 3500 plankton counted. As for the fish counts, both fall and summer exhibited high fish counts from 25 to 68 and 8 to 80, respectively.

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Figure 3. Total plankton versus total fish counted by site. Treasure Island Reef- blue diamonds, St. Petersburg Reef- red squares, Veterans Reef- green triangle, and Dunedin Reef- grey X

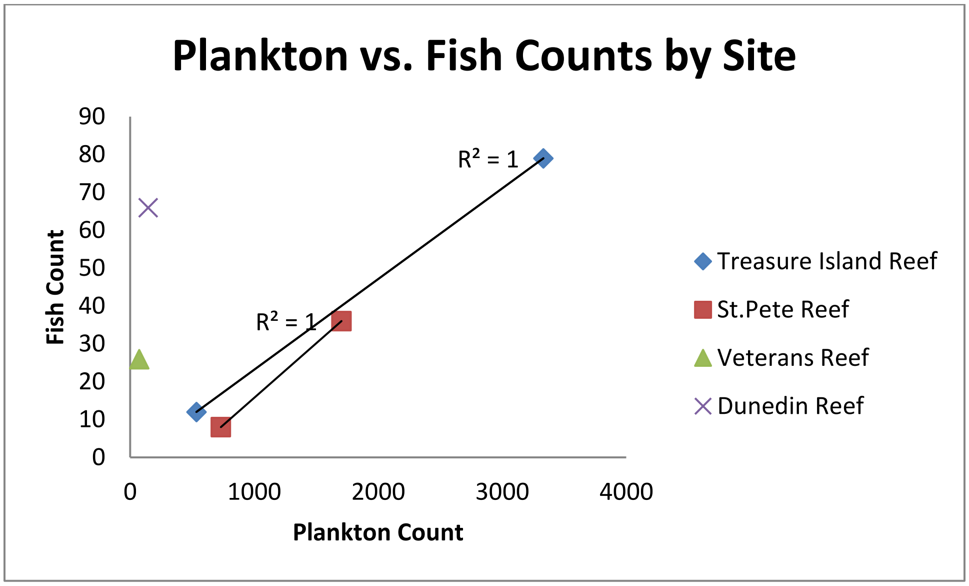

Figure 3 shows the correlation between the number of plankton and fish at the different dive sites. All 4 sites are located in the Gulf of Mexico and are close in proximity; they're all on similar lines of longitude and latitude. While 2 surveys were conducted at both St. Petersburg Reef and Treasure Island Reef, only 1 survey was collected at Veterans Reef and Dunedin Reef, which may impact these results. Treasure Island Reef and St. Petersburg Reef saw the most plankton and fish numbers while the least number of fish and plankton were seen at Veterans Reef and Dunedin Reef.

Figure 4. Total plankton versus total fish counts by feeding type. Carnivores- red squares, herbivores- blue triangles, and omnivores- green triangles

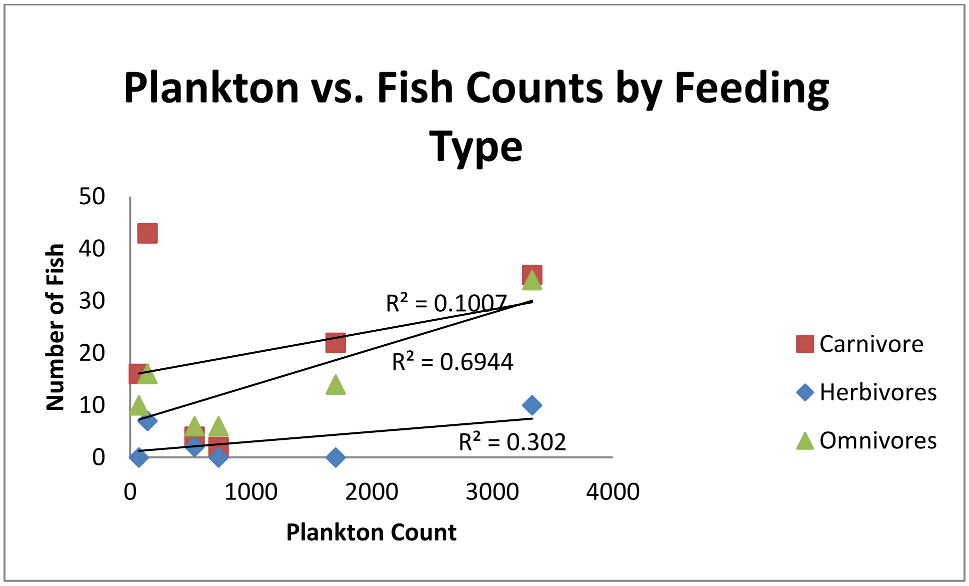

Figure 4 compares the correlation between the numbers of fish and plankton depending on fish feeding types: carnivorous, herbivorous, or omnivorous. The graph shows that the majority of fish that were counted were carnivores, while very few counted were herbivores. On both dives on July 30th, 2016 was an increase in phytoplankton numbers and also a greater number of carnivores compared to omnivores and herbivores. Dive 1 and 2 on August 13th, 2016 saw a greater number of omnivores compared to the number of carnivores. Excluding the dives in August, carnivores dominate over the other feeding types in July and November. The highest positive correlation between fish and plankton was with the omnivores, 69% correlation. Following that, herbivores had a 30% correlation and lastly carnivores had a 10% correlation.

Discussion:

The objective of this project was to determine the relationship between plankton and fish and how the number of plankton affects the number of fish. Figures 1 and 2 comparing total plankton to total fish and plankton to fish counts by season shows us that the greatest amount of plankton was collected in July .This was possibly influenced by the time of year (seasons) and also the location where the data was collected.

Seasons play a major role in numbers of plankton; most blooms occur in spring/summer. This explains why we saw more plankton in July compared to November. Also throughout the coastline of Florida there are different concentrations of nutrients. Water in the central Gulf of Mexico is more concentrated compared to the Florida Keys. The Florida Keys has crystal clear water which is a result of having fewer nutrients. As for the central Gulf of Mexico, where theses surveys occurred, water has more nutrients. This nutritious water attracts many bottom trophic level organisms, which due to the food pyramid will support more consumers including our fish. Since we collected our data in the Gulf of Mexico rather than the Florida Keys, it contributed to us having a higher plankton count and higher fish counts.

Figure 3 comparing plankton to fish by site shows that we had a strong correlation between plankton and fish at Treasure Island Reef and St. Petersburg Reef. This strong correlation maybe due to a small sample size. Conducting more dives at these sites is necessary to more conclusively identify a strong relationship. While Veterans Reef and Dunedin Reef had high fish numbers, they had the least plankton. These reefs may have had smaller numbers of phytoplankton because the data was collected in fall while St. Petersburg Reef and Treasure Island Reef's data was collected in summer.

Figure 4 comparing plankton to fish by feeding type shows that besides the month of July, carnivorous fish dominated herbivores and omnivores. If we look at the feeding ecology, this could be due to carnivorous fish potentially eating more herbivorous fish rather than other carnivorous fish, which releases a grazing pressure on the primary consumers, or zooplankton. An increase in plankton may increase the reef's population of herbivorous fish, resulting in a greater number of preys for carnivorous fish. Supplying plenty of food for carnivorous fish, they begin to feed on herbivorous species, which then decreases the herbivorous fish population. If this mechanism is at play, it could explain the larger population of carnivorous fish and a lacking population of herbivorous fish. Figure 4 also shows carnivorous fish have a less positive correlation to plankton compared to omnivores and herbivores. This may be because carnivorous fish have more interactions with other fish rather than plankton. As for herbivorous and omnivorous fish both directly interact and feed on plankton leaving them with a greater correlation to plankton. This evidence suggests that plankton does indeed play a role through the food pyramid and have possible effects on the populations of fish.

Conclusion:

By collecting fish and plankton counts on local reefs in the Gulf of Mexico to evaluate if there is a relationship between the two, we were able to interpret that plankton does have an effect on fish populations. Plankton makes up the foundation of the marine food pyramid which supports the rest of the life in the ocean's surface layers. Based on this relationship, it was hypothesized there exists a positive correlation between plankton and fish. Results from this project support the original hypothesis, although we had a small data set. By expanding our sample size, supporting evidence for this relationship may become more robust. With a larger data set, there may be a more reliable series, leading to a stronger correlation between plankton and fish. Moving forward with this experiment, it may be useful to modify some of our original methodology. For next time, it could be useful to sample under a microscope and identify the type of plankton to see if the fish have a greater correlation with a specific type of plankton. We could also use actual fish counts rather than categories so that the number will be more precise.

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