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A Comparison of Fish Growth Rates in a Pristine and an Urbanized Salt Marsh Estuary

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Abstract

Fish grow as they age, but not all fish grow at the same rate. Internal and external factors such as stress and food availability can change the growth rate. This study looks to see if the growth rates vary between North Inlet and Murrell's Inlet, SC for red drum and striped mullet. Red drum grew faster and showed a typical length-frequency graph in North Inlet. The cause of the difference in growth was not tested, but human influence on the estuaries was considered to be a possible factor.

Introduction

Fish grow indeterminately, indicating that the growth doesn't have a cutoff point; the fish continue to grow their entire lives. The energy put into growth may vary throughout the life cycle, for example less energy goes into growth during peak reproductive ages. The growth patterns of fish are never linear. The majority of the fish's growth is in the white muscle tissue. Growth is controlled by external factors, such as temperature, pressure, osmotic conditions and chemical stress, and by internal factors, such as hormones, tension, innervation and activity patterns (Mommsen 2001).

One factor affecting growth rate is salinity. Fish have the highest growth rate in brackish water because of osmoregulatory costs. This may have to do with the adaptations fish have for feeding in brackish water (Boeuf and Payan 2001). Another factor affecting growth rate is temperature. Handeland et al (2008) found the optimal growth rate of salmon to be 14 degrees Celsius, which will of course vary by species. This study found that the temperature for optimal growth rate increased with the size of the fish. A third factor affecting growth rate is food availability. Strelcheck et al. (2003)

found that juvenile fish provided with more food grew faster than fish with less food available to them.

The age of a fish is highly correlated to the length and sex of the fish (Bermejo 2007). This isn't saying that all fish of the same size are the same age, just that the two measurements are related. In fact, it has been seen in past studies, such as Joyeux et al. 1995, that growth rate varies by location. This study looked at two separate populations of closely related whiffs, sand whiffs and bay whiffs found in Puerto Rico and North Carolina respectively. These populations were found to have significantly different growth rates due to environmental factors, spawning grounds, and/or food sources.

The fish that were examined during this study include the red drum and striped mullet. These are fish that often spend their entire juvenile and much of their adult life in coastal areas and estuaries on the Eastern United States coast (Adams and Onorato 2005, Kucera et al 2002, and Labropoulou et al 1997). Since these fish have spent the majority of their lives in the studied estuaries, they are a good representation of the estuary and have little influence from other areas. The red drum (*Pogonias cromis*) is copper bronze in color and typically has one or more spots near its tail. It has a horizontal, downward opening mouth (Red Drum Fish Identification). The striped mullet (*Mugil cephalus*) is blue to green to gray on top and white to silver on bottom. It has a small mouth and a blunt nose (Striped (Black) Mullet Fish Identification).

The objective of this study is to see if the growth rate of red drum and striped mullet varies between North Inlet and Murrells Inlet. This study will provide preliminary

research, in the case that the growth rates do vary, for future projects to determine why the growth rates would vary.

Methods

Two estuaries were surveyed for this study. The first was North Inlet. North Inlet is fed mostly by direct exchange of water with the ocean, with a small input from Winyah Bay. This inlet is in South Carolina and is mostly pristine. Tides in North Inlet are semi-diurnal with a mean tidal height of 1.2 meters. North Inlet is shallow, and because of this is flushed out regularly (NERRS Reserves). North Inlet is ebb-dominated. The average temperature ranges from 9 to 27 degrees Celsius (Mwamba and Torres 2002). It is on average 3 meters deep and the salinity usually ranges from 15 to 35 ppt (White et al 2004). North Inlet is mostly undeveloped and pristine.

The second was Murrells Inlet. Murrells Inlet is physically very much like North Inlet. Murrells Inlet is shallow with an average depth of 1.5 meters. It is vertically well mixed and the average salinity is 31.4 ppt. The tides are semidiurnal and have an average height of 1.37 meters (White et al 2004). The average temperature is 20 degrees Celsius. Murrells Inlet is highly impacted by humans, especially when compared with North Inlet.

The fish used for this study were caught using trammel net surveys of North Inlet and Murrells Inlet as part of a graduate student research project done by Chris Smith. The fish were frozen. At a later date the fish were measured for length and weighed.

Length-frequency graphs were made. Length-frequency graphs show the number of times each particular length is found. When applied to fish collections, a general pattern is typically found: a series of peaks. The first peak is generally the

largest. Typically the first peak is looked at as the one year olds and each following peak is one year. Length-weight graphs were also made. The comparison of length and weight provides a condition factor for the fish. T-tests were used to compare these condition factors.

The birth date for the red drum was assumed to be September 1, so in order to have even sampling, data from June, July and August were used (Jenkins et al 2004). Standard lengths were used throughout this study.

Results

The length-frequency graph for the North Inlet red drum fell out according to the basic model for length-frequency graphs (Figure 1). There were two definite peaks; the first was at 20cm and the second was at 37cm. The Murrell's Inlet red drum, however, did not follow the normal distribution (Figure 2). The peaks did not resemble a typical length-frequency graph. Estimates of age cannot be made at all for these fish. The red drum caught in North Inlet had a maximum of 66cm, while the Murrell's Inlet maximum was 58cm.

Neither North Inlet nor Murrell's Inlet striped mullet showed a typical length-frequency graph (Figures 3 and 4). The striped mullet caught in North Inlet had a maximum of 32cm and those caught in Murrell's Inlet had a maximum of 29cm.

The North Inlet red drum had a mean condition factor of 1.08, and the Murrell's Inlet had a mean of 1.10 ($df=24$, $p=0.39$). The North Inlet striped Mullet had a mean condition factor of 0.997, and the Murrell's Inlet had a mean of 1.019 ($df=32$, $p=0.24$).

Figures

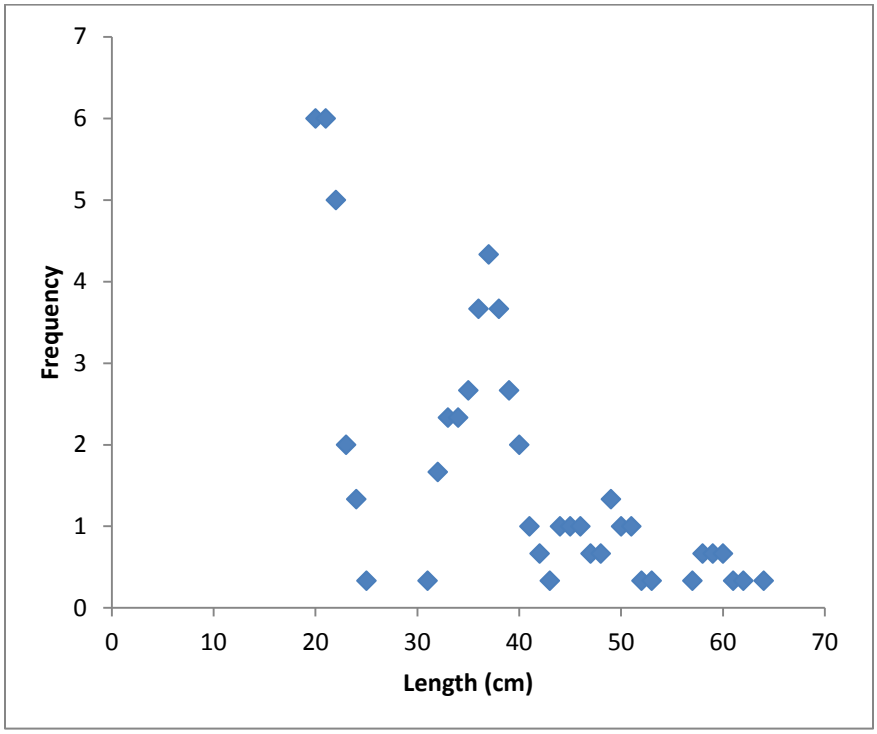

Figure 1. Length frequency for red drum in North Inlet during June, July and August 2010.

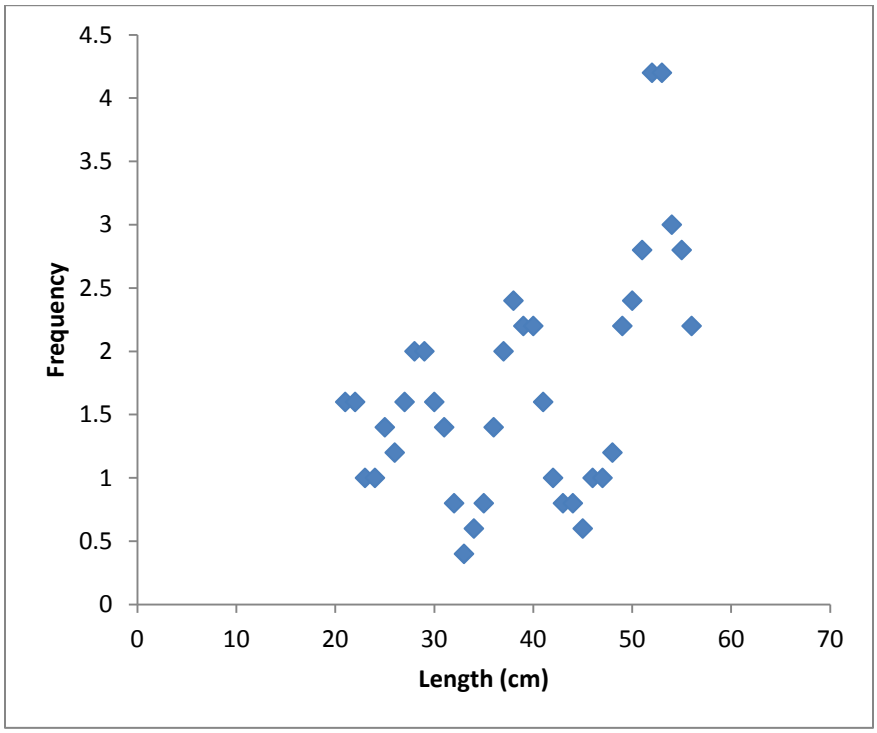

Figure 2. Length frequency for red drum in Murrell's Inlet during June, July and August 2010.

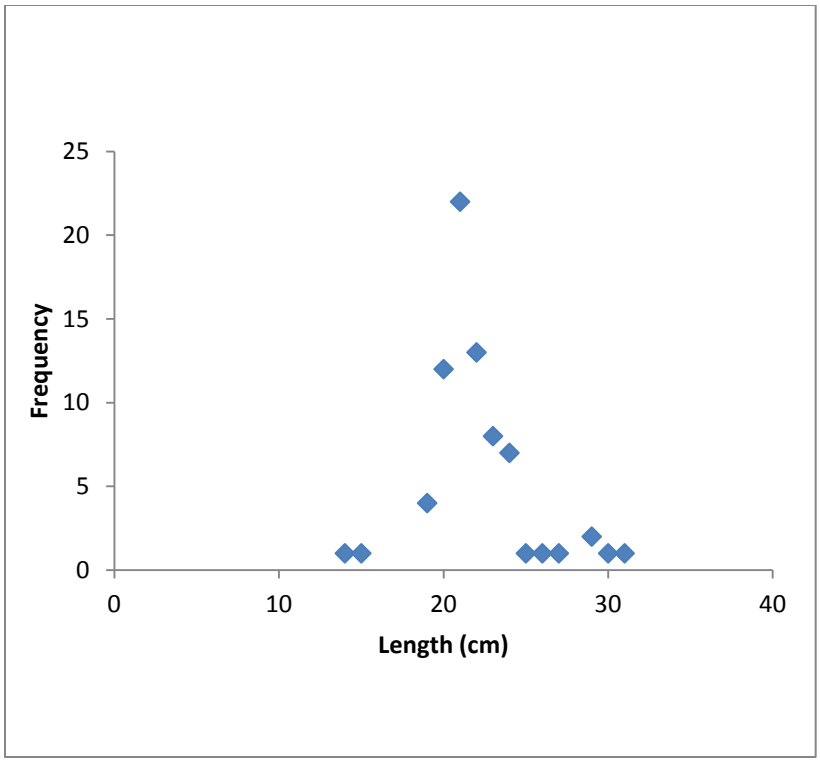

Figure 3. Length frequency for striped mullet in North Inlet from June, July, and August 2010.

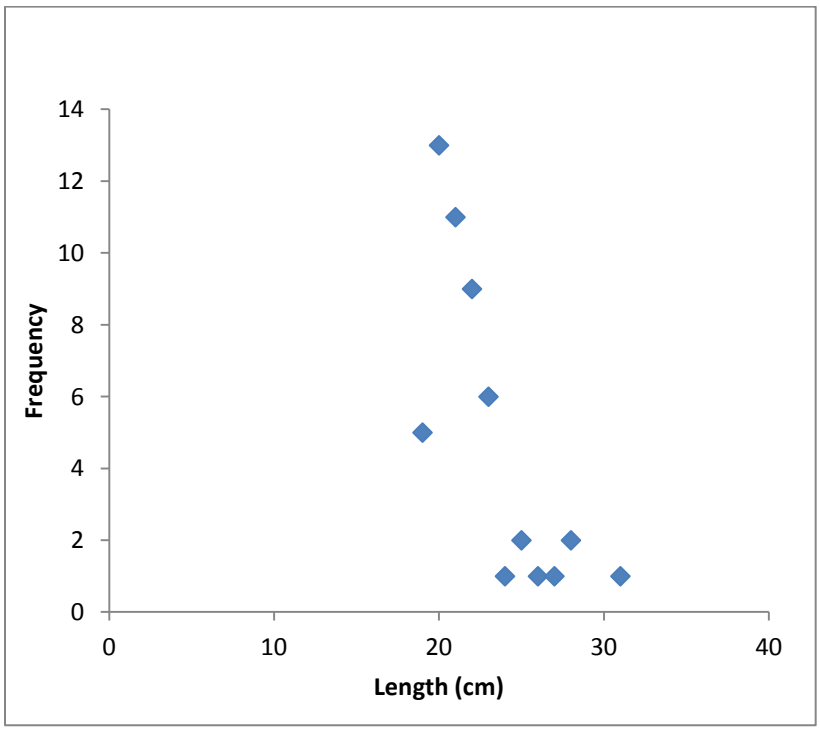

Figure 4. Length frequency for striped mullet in Murrell's Inlet from June, July, and August 2010.

Discussion

The length-frequency graph fell out typically for North Inlet red drum. Most likely, the first peak was the one year olds, the second was two year olds, and the remainder was the third year class. It is unlikely that the age classes were bumped up one year (though it is possible that the one year olds all fit through the net and the smallest fish were two year olds, shifting the pattern accordingly) or that the remainder of fish are a mixture of older fish because red drum typically do not stay in estuaries past three years old (Ramsey and Wakeman 1987).

The age distribution did not follow the pattern for a length-frequency graph for the Murrell's Inlet red drum. A possible reason is DNR has stocked this estuary with hatchery fish. Fish grown in a laboratory or hatchery tend to grow at different rates from fish growing in the wild due to differences in stressors and food (Strelcheck et al 2003). This would have caused the growth patterns to appear skewed.

The red drum caught in North Inlet had a longer maximum standard length than those caught in Murrell's Inlet. This indicates that growth is probably faster in North Inlet over the course of the years that the fish spend in the estuaries. Some factor affecting growth must be better in North Inlet. Joyeux et al (1995) found the difference in growth rate between two estuaries to be caused by factors such as temperature, distance between spawning area and settling ground, and food availability. These factors are not likely to be of importance in this study, with the exception of food availability. The Joyeux et al study was performed on two estuaries that were very different and had considerable distance between them. This was not the case in the current study. These estuaries were within miles of each other and had the same

environmental conditions, except for the level of human development on the area. Human influence may have changed factors affecting the growth of the red drum, such as the food availability.

The length-frequency graphs did not fall out typically for either North Inlet or Murrell's Inlet striped mullet. Most likely the youngest age classes were very small and slipped through the nets. This would have caused the graphs to show the little that they show.

The length and weight of select fish were used to determine condition factors. A high condition factor indicates more weight per length. This results in a fatter, better fed fish. There was no significant difference between the condition factors between Murrell's Inlet and North Inlet. This indicates that the health of the red drum in North Inlet is equal to that of the red drum in Murrell's Inlet.

For striped mullet, the condition factor is also not significantly different between Murrell's Inlet and North Inlet. The factors once again indicate that the striped mullet in Murrell's Inlet and North Inlet were equally fat and well fed.

One factor that seems important is the hatchery fish that were released in Murrell's Inlet. Their effects are not yet known for this inlet. The length-frequency graphs did not follow the normal pattern in Murrell's Inlet and the fish were growing slower there as well. While these effects cannot be absolutely determined to be from the hatchery fish, it is possible. Hatcheries have caused differences from nature in other estuaries, like causing lower survival in juveniles (Schultz and Clarke 1995). Jenkins et al (2004) found that some groups of hatchery released fish, though not all groups, grew slower than is typical for red drum in its early growth. They also found that this growth

did not affect the wild fish in the area. This same study found that a large difference in growth is found in the juvenile red drum released dependent on whether the fish are released in the spring or fall. These and other possible effects of the hatchery should be examined.

Overall, the differences that were seen between the inlets indicate North Inlet supported better growth. Red drum had longer maximum lengths in North Inlet than in Murrell's Inlet, suggesting faster growth in North Inlet. Significant differences were not seen in maximum length for striped mullet. The condition factors were also not significantly different. Red drum showed a normal length frequency graph in North Inlet, while the data for Murrell's Inlet did not fall out typically. Though there were several similarities between the estuaries, there were also significant differences to indicate that there is some factor that is different between the two affecting growth. No research was done to find out why there were differences, but the most obvious difference is the human influence. Murrell's Inlet has a much larger human presence and also has the hatchery fish released there. Other factors may have had an influence. Further research will be necessary to determine the actual causes for the difference in fish growth.

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