Condition Index for Georgia Oysters

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Abstract

Coastal fishermen are attempting to develop an oyster aquaculture industry for Georgia. Concerns over possible human deaths associated with the consumption of raw oysters contaminated with *Vibrio vulnificus*, a naturally occurring marine bacterium, during summer is of national concern. The FDA announced in October 2009 plans to ban interstate sale of raw Gulf of Mexico oysters (beginning May 2011) unless they are shucked or processed to reduce *Vibrio* bacteria to non-detectable levels. This paper examines the condition index of oysters in Georgia from February 2007 to February 2008. Results show that oysters have a low condition index during summer months. Georgia fisheries data show that few oysters are harvested during summer months as oysters are well into their spawning period. The spawning process partially explains the low condition index of oysters during summer in Georgia. As a result industry working with the Georgia Department of Natural Resources imposed a commercial ban on the harvesting of oysters during summer months from June 1 to September 30. Industry will use this ban as a mean of ensuring and marketing a “safe” oyster for human consumption for Georgia.

Introduction

During the turn of the 20Th century, the State of Georgia lead the nation in oyster, *Crassostrea virginica* (Gmelin, 1791) harvest (Harris 1980). In 1908 Georgia harvested a record 3.6 million kgs of oyster meats primarily sold as canned or shucked meat products which were produced in steam canneries or shucking houses and shipped by railroad across the nation. Due to demand, which was high, by the 1930's the oyster industry in Georgia was in major decline as intense overharvest and poor fishery management contributed to a rapid decrease in local oyster populations (Harris 1980; Ofiara and Stevens 1987). The only existing remnant of the historic Georgia oyster industry is a small sack trade for live wild oysters intended for roasts.

Currently there is considerable interest in developing an oyster aquaculture industry in Georgia. The price for high-quality raw-bar-grade oysters continues to rise nationally as a result of a decreasing supply and growth in the consumer market base. The greatest obstacle to the development of an oyster aquaculture program in Georgia is the high reproductive success of local oyster stocks as a result of a productive coastal ecosystem and extended reproductive season. Oysters generally start spawning in April/May and continue through October (Heffernan *et al*. 1989, O'Brien *et al.* 1996a,b,c, 1997) with young-of-the-year oysters becoming sexually mature and spawning approximately two months post settlement (O'Brien *et al*. 1996b). This results in high larval oyster densities in the water column with settlement rates as high as 204,000 spat per square meter per month (Thoresen *et al*. 2005).With limited hard substrate and chemical and biological cues indicating an optimal settlement environment, oyster larvae are observed to settle heavily upon adult oysters (Fitt and Coon 1992). The result is that oyster reefs are formed that are overcrowded with newly settling spat. Competition for space with other oysters results in long, narrow, and thin oyster shell growth with low meat yields (Galtsoff and Luce 1930). The single cupped-shaped oysters that the raw market wants are not easily produced on a commercial scale in Georgia yet.

Oysters from natural beds in Georgia generally require 18 months to obtain a legal harvest size of 76 cm which could create complications for a potential oyster-culture operation since spat fouling could occur prior to cultivated oysters attaining market size. Cultivation research focused on producing a marketable half-shell grade oyster using off-bottom techniques has yielded some success in achieving a legal-sized single oyster in a year or less (Manley 2007; Power *et al.* 2010), however this research was not conducted on a commercial scale. So though it is likely possible to consistently produce a nicely shaped single oyster within a year, there is not a well defined large scale commercial process to achieve this desired result. Thus, there is a high risk of oyster spat fouling of economically valuable single oysters during the second summer of growth resulting in an unsightly product for the half-shell oyster consumer. Also, product quality is critical to marketability and pricing. Consistent production of a superior half-shell oyster product with not only desirable shell characteristics but high meat quality is essential for growers to compete in other markets.

Vibrio vulnificus, a naturally occurring gram-negative bacterium occurring in brackish and salt waters, is a serious problem to oyster industries nationwide where eating raw oysters is promoted. During summer months consuming raw oysters contaminated with *Vibrio vulnificus* can lead to serious health issues for human consumers especially those individuals that are already at risk from other illness such as liver disease, diabetes, alcoholism, cancer, weakened immune systems, kidney disease or HIV/AIDS (Stivers 2008). In these high-risk individuals, symptoms can rapidly develop and cause death in only a few days if not properly diagnosed and treated. According to Bross *et al.* (2007), *Vibrio vulnificus* is the leading cause of death related to seafood consumption in the U.S. and the FDA wishes to ban the harvest and raw consumption of oysters from the Gulf of Mexico and southeastern U.S. during summer to prevent illnesses in humans. If an oyster aquaculture industry is to develop for Georgia, then the *Vibrio vulnificus* issue must be addressed to protect the consumer and economic growth of the industry.

This paper attempts to address the feasibility of a defined oyster harvest season in an attempt to prevent human illness attributed to *Vibrios vulnificus* via raw oyster consumption by examining the Condition Index of oysters which is also directly related to product quality. The condition index of an oyster is an expression of its overall nutritive status. Condition indices do not yield detailed information concerning amounts of proteins, carbohydrates, and fats. It is based on a quick and simple calculation that describes the space an oyster's body fills within its shell relative to the space available to be filled (Galtsoff 1964). By following monthly condition index values, one can observe the seasonal changes in the collective nutrient reserves and monitor an indication of the commercial quality in terms of the meat yield of the population. Oyster condition indices can be affected by a host of factors including reproduction, pollution, disease, or availability of food.

Materials and Methods

There are various methods for determining condition index valves for oysters; however, we used that of Lawrence and Scott (1982). Thus, condition index was determined by the following equation: Condition index = [dry soft tissue weight of oyster (grams) X 100]/ internal shell cavity capacity (grams).

Oysters (N=32 per month) were collected from the Skidaway River along the marsh in front of the Shellfish Research Laboratory (Figure 1) between February 2007 and February 2008. Oysters were cleaned of any attached organisms. Oysters were measured for shell length (umbo to lip) with Vernier calipers to the nearest 0.5 mm. Live oysters were weighed to determine total weight of shell and oyster meat. Oysters were opened and shucked. Individual oyster meat was placed into a pre-weighed aluminum pan and placed into a drying oven at 80°C for 48 hours. Dry soft tissue weight was determined by weighting the pan with oyster meat after drying for 48 hours at 80°C and subtracting the weight of the pan. Oyster shells were dried for 24 hours and individually weighed. Internal shell capacity was determined by subtracting the weight of the dried shell from the total weight of the shell plus organism. Monthly means and standard errors were generated for the 32 oysters.

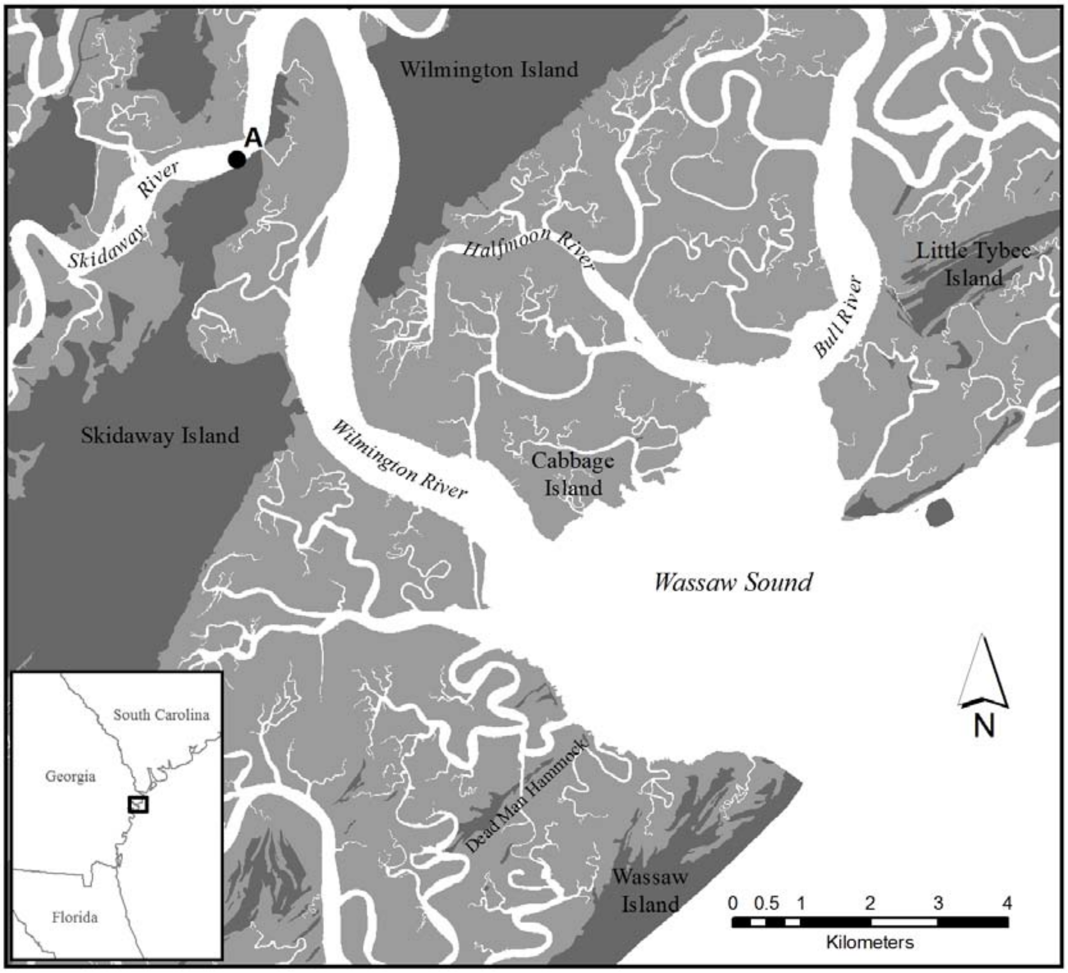

Figure 1. The study site (A) located on the Skidaway River, Skidaway Island, Georgia

Results

Physical Data

Water temperature reflected seasonal patterns with mean highs of 28.5 ± 0.02 (S.E.) ^{o}C in August 2007 and low temperatures reaching 11.8 ± 0.06^{o}C in January 2008 (Figure 2). Mean salinity reflected typical estuarine salinity and ranged from a high of 28.03 ± 0.04 PSU (December 2007) to a low of 18.7 ± 0.12 PSU (September 2007) (Figure 2).

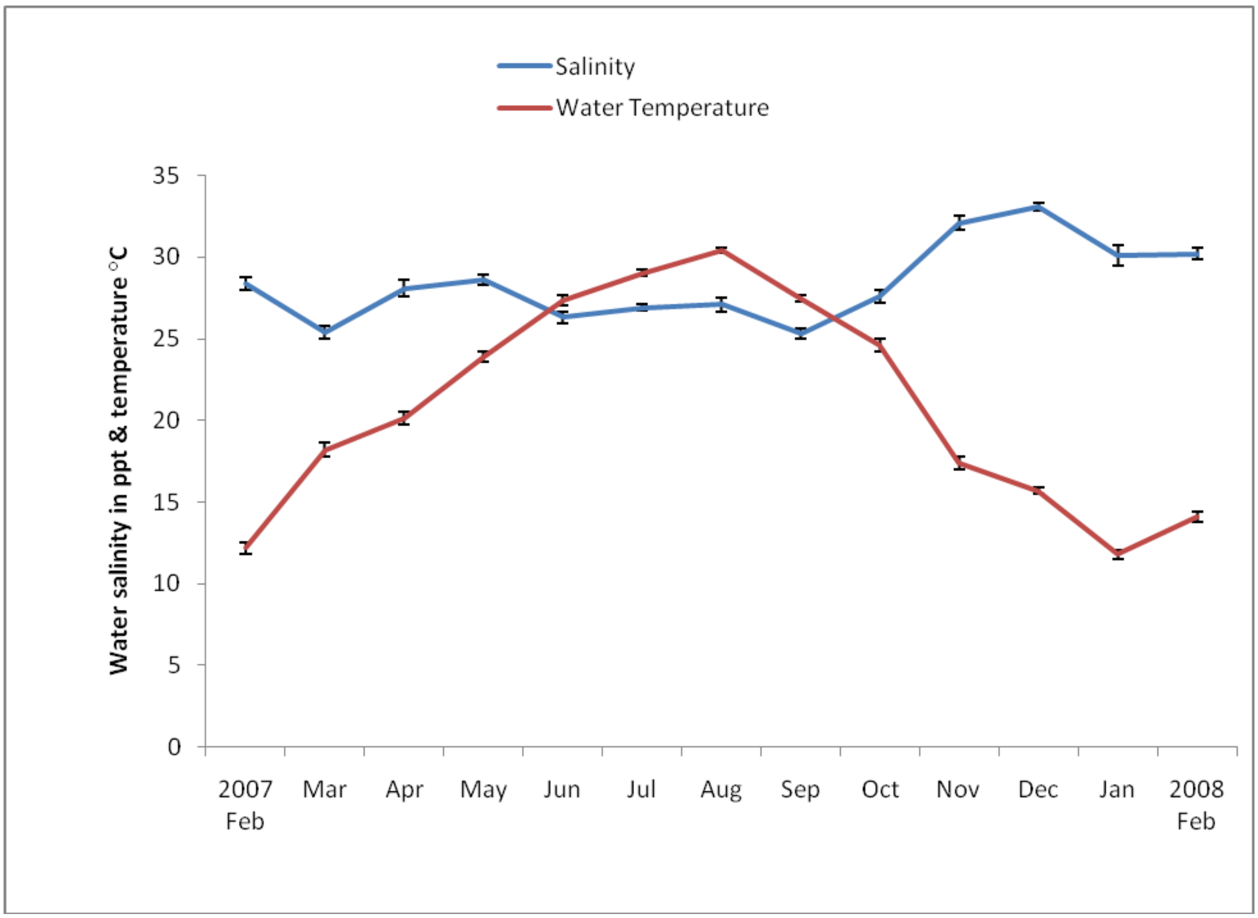

Figure 2. Monthly mean salinity (PSU ± S.E.) and temperature (^{o}C ± S.E.) recorded in the Skidaway River at Skidaway Island, Georgia from February 2007 to February 2008

The monthly mean sizes of oysters are given in Figure 3, while the monthly condition index is given in Figure 4. Individual oysters ranged in size from 22 mm to 145 mm. Monthly mean sizes ranged from 46.8 mm ± 2.07 (S.E.) in March 2007 to 93.7 mm ± 4.58 in May 2007 (Figure 3). Monthly mean condition index values ranged from a high of 16.17 ± 0.43 in March 2007 to a low of 8.3 for May, June and July 2007. T-tests performed on monthly means show that the low values for May to July were not significantly different from each other, but were significantly lower than all other monthly values.

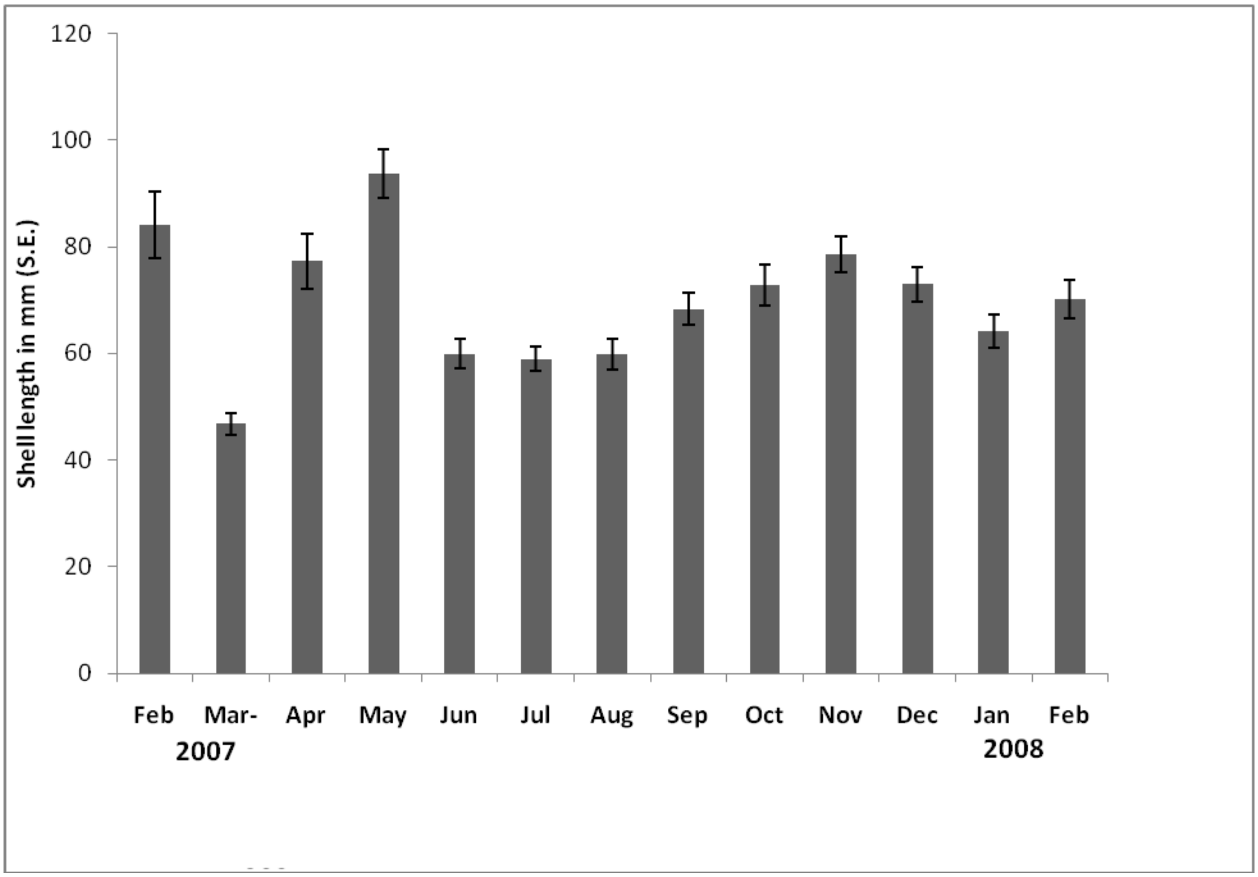

Figure 3. Monthly mean shell height (mm ± S.E.) of oysters collected for Condition Index analysis from February 2007 to February 2008

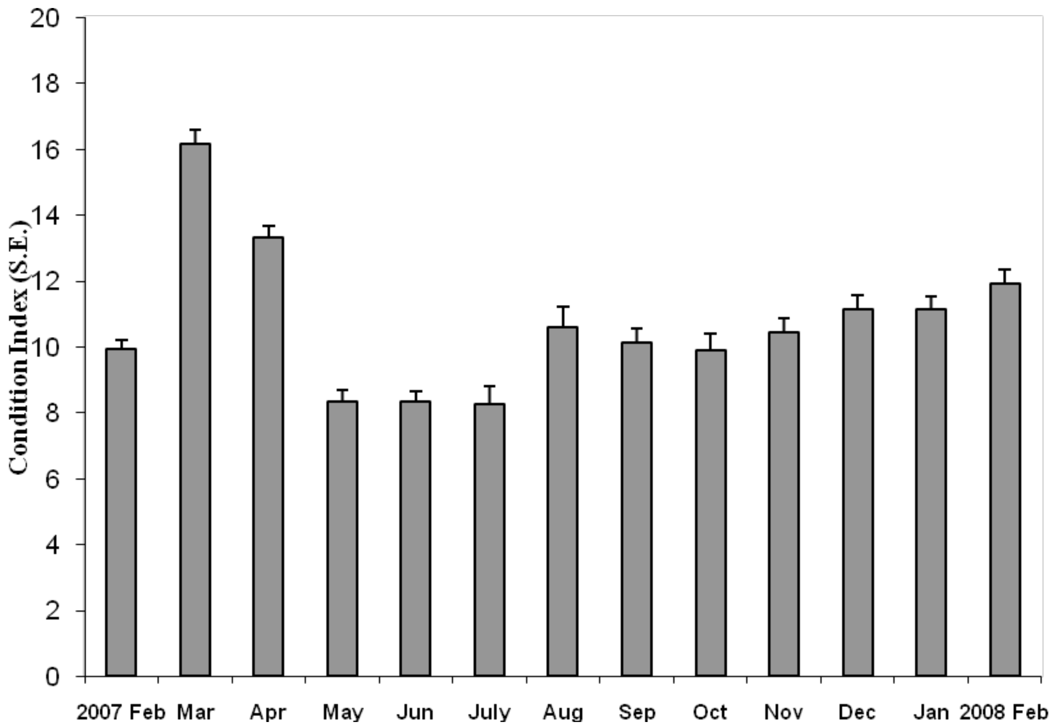

Figure 4. Monthly mean Condition Index ± S.E. for oysters collected from Skidaway River, Skidaway Island, Georgia from February 2007 to February 2008

Discussion

The condition index pattern for Georgia oysters closely follows the reproductive patterns of oysters in Georgia as determined from histological studies (Heffernan *et al*. 1989; O'Brien *et al*. 1996c, 1997). Highest values for the condition index were observed in March after the start of the reproductive process in January (Heffernan *et al*. 1989) and were lowest in summer during the peak spawning months. Oysters are ripe by March/April and spawning generally starts in April/May. The drop in the condition index values between March and April indicates spawning. In 2007 in the Duplin River, Sapelo Island, oyster recruitment was observed by May indicating that spawning had started in April (Sapelo Island National Estuarine Research Reserve oyster monitoring data, Walker unpublished).

As water temperatures start to increase from their winter lows in January or February (low of 12.2°C in February 2006 and 11.8°C in January 2008), oysters begin to shunt energy from growth to gamete production. Thus, in February/March most available energy goes into gametogenesis and this is reflected in the high condition index values seen in March and April. Spawning is triggered by rising water temperatures. Thus, the drop in the condition index values between April and May is likely correlated to oysters releasing their eggs and sperm.

Oyster recruitment in Georgia can be massive with recruitment rates as high as 204,000 oyster spat per meter square per month being recorded (Thoresen *et al*. 2005). Highest oyster larvae recruitment for sites monitored in the Duplin River, Sapelo Island, GA occurred during the May to June 2007 time period (Walker unpublished data). Likewise peak larval recruitment occurred in Sapelo Sound in April to May 2006 period (Manley *et al*. 2008). The oyster larval cycle may last from 10 to 30 days and is dependent upon factors such as water temperature, salinity and food availability (Kennedy 1996).

An increase in oyster condition index is generally associated with increased glycogen content stored within the tissue of the animal or the reproductive state (Galtsoff 1964). When ripe or full of eggs and/or sperm, the anterior body of the oyster is creamy white and a fairly solid mass that fills the shell cavity. As spawning occurs, this mass becomes clear with the discharge of eggs and sperm. After spawning, the anterior portion of the oysters becomes clear, flaccid, grayish looking, and appears emaciated. Upon completion of spawning, the condition index of an oyster usually drops to its lowest value which would significantly reduce meat yield from a commercial standpoint. During summer months, the commercial quality of oyster meats in Georgia is low as indicated by condition index and as mentioned previously is directly related to spawning. Adult oysters in Georgia continue to spawn throughout summer and into fall (Heffernan *et al*. 1989; O'Brien *et al*. 1996c, 1997). A second peak and often the major peak of recruitment may occur in July/August (Manley *et al.* 2008). Furthermore, physiological stress due to high water temperatures and diseases also affect the Condition Index of oysters in a negative manner. *Perkinsus marinus*, a protozoan disease of oysters, is prevalent throughout coastal Georgia's oyster population (Lewis *et al*. 1992, Power *et al*. 2006) and generally has its highest intensity during summer often followed by oyster mortalities in fall. It is generally not until fall and after spawning that adult oyster's return to allocating most of their energy into growth and glycogen storage which translates to higher condition index values.

During summer months few oysters (less than 2% of annual harvest according to Georgia Department of Natural Resources) are harvested in Georgia since meat yield is seasonally low for oysters post spawn. Since oyster harvest is traditionally low during summer months, the industry in collaboration with the Georgia Department of Natural Resources has agreed to ban the harvesting of oysters from June 1 to September 30. This is a critical aspect related to the public perception of Georgia oysters as a safe product as this closed season significantly reduces the probability of human illness from consuming raw oyster contaminated by *Vibrio vulnificus*.

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