Health Assessment of Clams Collected during the Summer at Cedar Key Lease Areas

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Purpose: The objective is to determine how environmental changes seen during summer impact clam health by employing bacterial and histological analysis. Temperature has a known impact on the proliferation of bacterial and parasitic diseases in clams, while salinity is a factor in the proliferation of parasitic diseases. High temperature and salinity and low dissolved oxygen, typically seen in the summer, increase stress and decrease immune response. This project takes an integrated approach by documenting the presence of bacterial and other disease-causing organisms in clams in response to environmental changes that occur during the summer months at the Gulf Jackson and Dog Island lease areas. In addition, physiological condition, and responses, such as changes in the digestive tract tubules and presence of food in the gut are evaluated.

Results: Harvest-size clams (n=20) were collected monthly at lease parcels that were sampled for sediments and at the same time the soils samples were collected. Clams were collected in June, July and August, but not in September due to Hurricane Helene, so an additional set of samples was collected in October. Due to limited numbers of clams at some leases which were severely impacted by Hurricane Idalia in 2023, clams were not available from all leases every month. Growers provided estimates of clam survival at harvest. Clam samples were shipped by overnight courier to Laramore for bacterial and histological analysis. In total 380 clams (80-120/month) were examined for the presence of general and Vibrio bacteria by swabbing mantle tissue. Clams were also processed and examined histologically for the presence of pathogens/parasites and other abnormalities, physiological and digestive tract condition (atrophy), and presence of food in the digestive tract. The microbiology, gross morphology (shell, mantle, gaping), histological condition (pathogens, dig tract, food), and size were evaluated.

Title: Growth of hard clams at leases at two use zones (Gulf Jackson GJ, Dog Island DI) during summer 2024
Relevance: Growth, as measured in increased size (length, width and weight), is correlated with optimal environmental conditions (temperature, salinity, dissolved oxygen) and the presence of disease-causing organisms, which may vary throughout the summer. Clams that reared in less than optimal environments may be stressed and susceptible to disease and would be expected to have slower growth.
Response: Twenty clams were collected from 3 leases within two Cedar Key aquaculture use zones (Dog Island, Gulf Jackson), N= 6 leases total, and length, width (thickness) and weight measured in July, August, and October. Temperature, salinity and dissolved oxygen measures were taken each month. Five different lease holders contributed clams for this project and estimated survival in bags from which clams were obtained. Lease location (inner, outer) differed within use zones.
Results: Clam lease holders benefit by knowing when highest and lowest growth occurs over the summer and whether lease site (inner, outer) or location (aquaculture zone) appears to be differentially affected. The impact of differing environmental and disease-causing organisms within the zones that may impact growth throughout the summer may provide some insight as to

what parameters are more significant to examine for improved growth and is applicable to southeast USA locations with similar conditions.
Recap: Growth was variable in both zones from July to October. Regardless of zone, size of clams on all leases decreased between July and August, indicating poor growth. Size increased at two leases, located in different zones by October, while size decreased or remained stagnant at two other leases, located in the same zone (DI). All clams collected in August were thicker and all size parameters (length, width, weight) were more variable.

Title: Gross signs of disease in hard clams at leases at two use zones (Gulf Jackson GJ, Dog Island DI) during summer 2024
Relevance: Gross clinical signs allow one to gauge clam health without using any specialized techniques. These signs may be associated with infections or noninfectious disease or adverse environmental conditions. It relies on evaluating external signs (shell deformities, gaping) and upon opening a clam, internal signs (mantle deformities, meat condition, and lesions. These observations can then be correlated with changes in environmental conditions and other tests that detect pathogens.
Response: Twenty clams were collected from 3 leases within two Cedar Key aquaculture use zones (Dog Island, Gulf Jackson), N= 6 leases total in June, July, August and October. Clams were examined externally for shell abnormalities (chipped, deformed lips), gaping (inability to close). They were opened and examined internally for mantle abnormalities (swelling, retraction) and meat condition (watery, fat). Five different lease holders contributed clams for this project and estimated survival in bags from which clams were obtained. Lease location (inner, outer) differed within use zones.
Results: Gross clinical signs of disease increased mid-summer regardless of site position or zone, and was correlated with high temperature, salinity and low dissolved oxygen. Gaping was the prime indicator of poor health status, followed by meat condition and mantle abnormalities, while shell abnormalities was a poor indicator. Knowing which gross signs of disease are most likely to indicate health status allows clam growers to quickly assess clam health and may offer an economic benefit. These results are applicable to clams grown throughout the USA.
Recap: Gross disease signs increased in July and August. Gaping was seen at most sites in July and continued through August. Mantle retraction increased over time at GJ, but not DI. Meat condition decreased in July at GJ and in August at DI and increased by October but was lower at GJ. Shell abnormalities increased at all sites over time but were predominately slight chipping. GJ sites had fewer gross clinical signs in June, while DI sites had fewer signs in October.

Title: Microbial populations present in hard clams at leases at two use zones (Gulf Jackson GJ, Dog Island DI) during summer 2024
Relevance: It was important to determine whether bacteria was responsible for mortality, poor growth and clinical signs of disease that increased mid-summer. Bacterial growth is typically associated with warmer temperatures. However, the higher temperatures and salinity and lower DO seen in July and August did not result in bacterial proliferation, but rather in a species shift, in which more pathogenic Vibrios were seen, along with a decrease in other bacterial species that might have helped to outcompete them.
Response: Twenty clams were collected from 3 leases within two Cedar Key aquaculture use zones (Dog Island, Gulf Jackson), N= 6 leases, in June, July, August and October. Mantle tissue was swabbed and plated onto Marine agar (general bacteria) and TCBS (Vibrio bacteria) and

counts recorded. Five lease holders contributed clams for this project and estimated survival in bags from which clams were obtained. Lease location (inner, outer) differed within use zones.
Results: It was determined that microbial populations shifted during mid-summer concurrent with high temperatures to being more pathogenic. This was more pronounced at DI sites where salinity was higher and DO levels lower. This stress may have made clams more susceptible to pathogenic bacteria, causing slow growth, gaping and mantle retraction. There was no difference between locations. This information is applicable to bivalve growers in other regions of the USA where similar environmental changes occur mid-summer (i.e., Southeast).
Recap: Bacterial counts (total, Vibrio) were highest in June and October, regardless of site location. Decreased total counts were accompanied by decreased bacterial diversity in July and August. In October counts again increased. Diversity increased, but not to the extent seen in June and a shift in microbial diversity was seen. Although Vibrio counts decreased in July there was a shift to more pathogenic colonies. This was more pronounced at DI sites. By October non-pathogenic colonies again dominated.

Title: Histological examination of hard clams at leases at two use zones (Gulf Jackson GJ, Dog Island DI) during summer 2024
Relevance: Histology is used to visualize internal health (i.e. condition of tissues and organs). This can be driven by both negative environmental conditions, pathogenic organisms or both. High temperature is known to affect bacterial proliferation, while both high temperature and high salinity can increase pathogen prevalence. Digestive tissue disintegration and tubule atrophy is typically due to poor environmental conditions and/or an increase in toxic algae, that in turn impacts feeding, and growth.
Response: Twenty clams were collected from 3 leases within two Cedar Key aquaculture use zones (Dog Island, Gulf Jackson), N= 6 leases, in June, July, August and October and examined histologically for the presence of food in their digestive tract (feeding), parasites (predominately cestodes), bacterial infiltration of tissues, hemocytic infiltration and tissue disintegration (low, moderate or high). Digestive tubule atrophy was evaluated on a scale of 0-4 (0 = no atrophy (optimal).
Results: Digestive condition decreased in July, resulting in decreased feeding at all but one lease, concurrent with high temperatures. Bacterial numbers increased, but not parasites. Clams at GJ, where salinity was lower and DO was higher were less impacted. Clams at DI outer lease were not affected, yet lease placement had no effect at GJ. This information is applicable to bivalve growers in regions of the USA where similar environmental changes occur mid-summer (i.e. Southeast).
Recap: The health of clams decreased in at all sites in July. Some sites begin to experience decreases in June (DI 813) and others continued to experience issues into August (GJ 6027). By October clam health had recovered. The most definitive signs of poor health were a decrease in feeding, an increase in digestive tubule atrophy and the presence of bacteria. This was accompanied by an increase in hemocytes, disintegration of digestive tubules and digestive tract tissues. Although clams appeared overall healthier at GJ, this was driven by one site in which clam health high throughout the summer.

Title: Health of hard clams at leases at two use zones (Gulf Jackson GJ, Dog Island DI) during summer 2024: impacts of environment and lease position

Relevance: Growth, as measured in increased size (length, width, weight), is known to be impacted by both the environment and disease-causing organisms. External (shell deformities, gaping) and internal (mantle deformities, meat condition) gross clinical signs are likewise indicators of less than optimal environmental conditions and disease causing organisms. Use of microbiology and histological techniques to evaluate bacteria, parasites, and tissue condition assist in determining whether the environment or pathogenic organisms are more important determinants of poor health status. (78/75)
Response: Twenty clams were collected from 3 leases, that differed in position, within two Cedar Key aquaculture use zones (Dog Island, Gulf Jackson) in June, July, August and October. Size (length, width, weight) was recorded. Clams were then examined externally and internally for abnormalities and meat condition. Microbiological and histological techniques were employed to assess the presence of disease causing organisms and tissue condition. Five lease holders, with different lease placements (outer, inner) contributed clams for this project and estimated bag survival.
Results: Decreased growth, feeding, meat condition, digestive tubule and tract condition and bacterial diversity and increased mantle retraction, gaping, and pathogenic Vibrios proved to be good indicators of poor health. High temperature appeared to be the driving force and this was consistent at both use zones. Clams fared better at GJ due to the higher DO and slightly lower salinity. Lease position did not matter. Knowing which health parameters should be assessed and what environmental conditions are most likely to impact health is applicable to all clam growers, regardless of location.
Recap: All health parameters examined: growth, gross clinical signs, bacterial diversity, and internal tissue integrity decreased from June to July, regardless of use zone, concurrent with high temperature. Clam health improved in October in surviving clams. Clam health was less impacted at GJ where salinities were lower and DO was higher. Lease placement had little effect. Despite the health improvement seen in clams in October, overall survival decreased sharply from August to October, perhaps due to the impact of two back to back hurricanes during this period.