Parasite Treatments on Marine Worm Infestations in Pacific Oysters (*Crassotrea gigas)* at K’awat’si Shellfish Aquaculture Site

Treadwell Bay, British Columbia

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Disclaimer

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Introduction

The purpose of this study is to determine whether there is a treatment method that will inhibit marine worm growth in oyster shells at K’awat’si Shellfish in Treadwell Bay, British Columbia (BC). Economic and physical issues caused by the marine worms are directed at a decrease in the financial value of the oysters when they are served on half shell, as the blisters are negatively impacting the visual aspect. Due to K’awat’si Shellfish being a relatively young shellfish operation, the economic challenges posed by marine worms are particularly damaging. In this introduction I will highlight the specific challenges the farm has, the methods of oyster culturing, and the negative effects posed by the worms.

The K’awat’si Shellfish Aquaculture Site is located on the mainland coast of British Columbia, north of the northern end of Vancouver Island, at 51°6'3.01"N and 127°32'25.97"W (Figure 1). The shellfish farm, on the traditional territory of the Gwa'sala-'Nakwaxda'xw First Nations, is operated under the K’awat’si Economic Development Corporation (KEDC). KEDC was developed in 2014 to develop opportunities for the Gwa'sala-'Nakwaxda'xw community (KEDC 2020). The oysters grown at the shellfish farm are Pacific Oysters (*Crassotrea gigas*) and they have been named *GwiGwi* oysters after the *Baḱwam* (Kwak̓wala word for First Nations) word for the oyster catcher bird **(**KEDC 2020). The intent is for K’awat’si Shellfish to create a sustainable aquaculture program and develop economic benefits for the community (KEDC 2020).

Figure 1. K'awat'si Shellfish Aquaculture location, November 30, 2019 (Google Earth 2020).

At K'awat'si Shellfish, the method of culturing oysters is with an off-bottom raft system to increase the growth rates of the oysters (OO and OO 2016). An off-bottom system entails that the oysters are placed in trays that are stacked vertically (approximately 14 trays for a stack) (Oyster Grow-out 2016). These stacks are then attached to the rafts by rope that is varied in depth; there can be approximately 110 stacks descending from a raft. Where an off-bottom culture is beneficial for maximizing growth periods, it also has the problem of increased levels of parasites, such as worms, within the oysters (OO and OO 2016). This is due to both the buildup of detritus below the site (OO and OO 2016), as well as not having exposure to air through regular tides (Ronel et al. 1996). However, due to the economic benefits outweighing the ecological challenges, the method of off-bottom culture is ideal for K'awat'si Shellfish, which is why they are pursuing treatment methods for the worms.

The two main species of marine worms that are suspected to infect *GwiGwi* oysters are *Polydora* spp. and *Polychaete* spp., determined through visual analysis on site. These worms cause blisters in the oyster shell which trap mud, fecal matter, and detritus and greatly reduces the value of oysters that are served as half shell products (Morse et al. 2015). The blisters can also vary in size on the oyster from very small, to encompassing almost the entire shell, and worms have the potential to lead to oyster mortality (Chambon et al. 2007). Additionally, parasitic worms in oysters cause oxidative stress, which then limits the growth in shellfish (Chambon et al. 2007). Based on other previously attempted methods to mitigate worm populations, this study will repeat and attempt new methods to treat worm infected oysters.

Materials and Methods

I created this project as a summer student at K'awat'si Shellfish when I discovered that there was an issue posed by the presence of marine worms. After completing an initial research review to familiarize myself with the issue, I created a sampling plan to mitigate worm populations in the *GwiGwi* oysters.

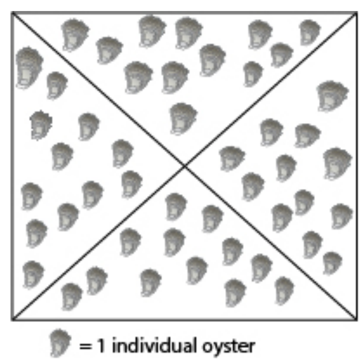

Figure 2. Diagram of a single oyster tray, 48 oysters per tray is standard for the size of oysters that were used (Ankenmann 2019).

Materials

The oysters used for the sampling were at the size category of double extra small (around 40 mm). Oyster dimensions (length, width, depth), the weight of the meat, along with worm variables (inside, outside, rank) were all recorded with the aid of the listed equipment below. Each sampling day there were a total of 30 oysters that were sampled from each method. There were XX days in total.

Equipment

The following equipment were needed for data collection at Treadwell Bay:

- Flagging Tape – to differentiate the different treatment methods
- Caliper – determine the length (mm), width (mm), and depth (mm) of each oyster
- Scale – determine weight (g) of oyster meat, only tuned to the gram.
- Data collection sheets – record data collected about each oyster
- Salt – for brine, usually industrial salt
- Electric Conductivity Measure – measure salinity for brine conditions

Methods

Methods were chosen to ensure as much consistency as possible in the research design. The oysters used in this study were all the same species and size classification. Each sampling method had 332 oysters that were divided among 7 trays (Figure 2). This equated to two treatments (A and B) for each stack (Figure 3). The stacks were all placed on the same raft and at the depth of approximately 3 meters (10 feet). Throughout the data collection period sampling was done to determine whether there were worms present inside or outside of the oyster shells.

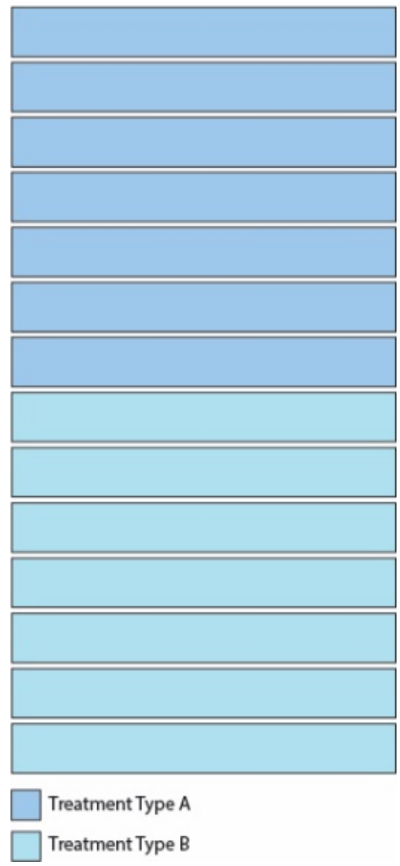

Figure 3 - Diagram of oyster stack. Each rectangle represents one tray, and the treatment types represent how there would be 2 treatments per stack. (Ankenmann 2019).

Treatment Methods

All treatment methods began with the initial tumble and rinse of the oysters to remove any new frail (new growth). The treatments were applied after this initial step, which included pulling the stacks up, tumbling to remove the frail, and rinsing the oysters. Following each treatment, there were 30 samples collected from each treatment method (excluding Base Line Conditions on the first and last sample day).

Base Line Conditions

The process of tumbling and rinsing the oysters replicates the normal actions taken by workers in the farm. Therefore, this method allowed for a standard that future oyster samples from other treatments will be compared to. These oysters were left in the trays for the duration of the summer, as airtime may potentially affect the infestation rates of the oysters. At the end of the summer these oysters were sampled to observe infestation rates.

Vigorous Clean

The oysters were individually hand scrubbed, which involves paying special attention to the mud that may become compact within the different layers of the shells. The oysters are then placed in a bucket where the water is agitated. The oysters were placed on the table and subjected to another rinse before they were placed back into their trays.

Salt Brine - 60 ppt, no dry

The oysters were placed in a tote with a brine of ocean water and added salt to have a salinity of around 60 ppt. Following the treatment in the salt brine the oysters were then placed in a tote/bucket with seawater until they were ready to be placed back in their trays, as they were on the same stack as the Salt Brine with an hour dry.

Salt Brine - 60 ppt, 1-hour dry

Oysters were placed into a tote of the brine, with 60 ppt saline solution for 20 minutes. When the brining was completed, they were sorted back into their stacks, where the oysters will sit in their trays for approximately 1 hour while they dry. This amount of time was determined through research, and also as an amount of time that would not significantly delay production.

Control Tray

This treatment method observed the infestation rates and severity given the standard actions taken for animal husbandry at the farm. The method of this treatment was to tumble the oysters to remove frail, then rinse, and finally return them to their trays. The trays were cleaned to maintain normality with the condition's harvestable oysters experience. These oysters were sampled throughout the summer and were pulled up on a regular schedule with the other treatments.

Results

Most oysters found at K'awat'si Shellfish had a presence of marine worms. I had broken the severity of the oyster's infestation into groups and averaged them on a scale of 0-5 with 0 being no worms present, and 5 being a severe blister that generally encompassed the entire oyster shell. The ranks of the oysters were collected throughout the entire sampling period were then averaged (Figure 4).

Data was collected with a simple yes or no to whether the worms were present, and the total number of worms is out of a total of 30 samples. For the worms on the outside of the shell of the oysters the treatments of a salt brine with a one-hour dry, and the vigorous clean had the most effective treatments regarding the lowest final numbers (Figure 5). With the worms that were found on the inside of the oysters the salt brine with one-hour dry shows an improvement of 10 worms present within the shell on the last sampling day (Figure 6).

A comparison of the internal and external worm presence combined with the rank resulted in a comparison of the initial numbers to the last sample date (Figure 7). For all the treatments the severity of the rank decreased for the duration of the season. With the Control Tray (CSRC) there was no data collected regarding whether worms were found inside and outside at the beginning of the sampling period. The Salt Brine with one-hour dry is the only method that shows an overall decrease in worms inside and outside of the shell over the period of the summer.

The other main considerations of this study were with the growth period of the oysters over time, and whether a method benefited the growth of an oyster over time. Comparisons were made through utilizing the averages of weight based on treatment throughout the duration of the summer (Figure 8). Vigorous Clean displayed the greatest impact on benefiting the weight of the oysters over the summer. The final display of data was to plot the length by width and separate them by treatment (Figure 9). Linear lines were then attached to each of the treatments to show a trend over time based on treatment.

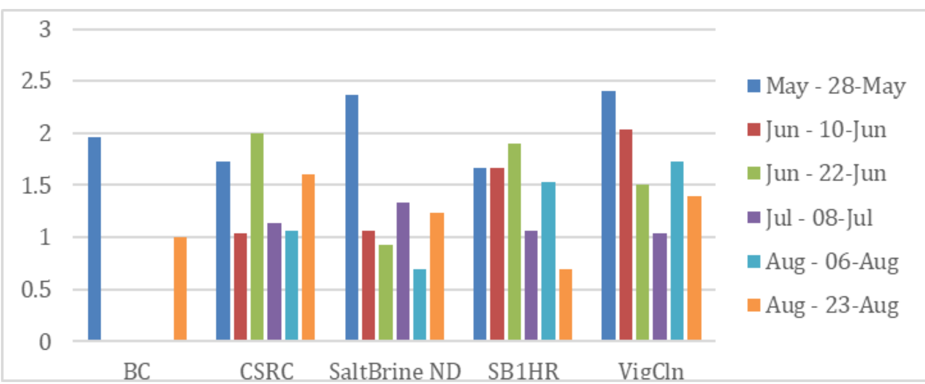

Figure 4 - Average rank of worms found in the oysters at K'awat'si Shellfish broken down by date. BC – Base Clean, CSRC – Control Tray, SaltBrine ND – Salt Brine with No Dry, SB1HR – Salt Brine with 1 hour dry, VigCln – Vigorous Clean.

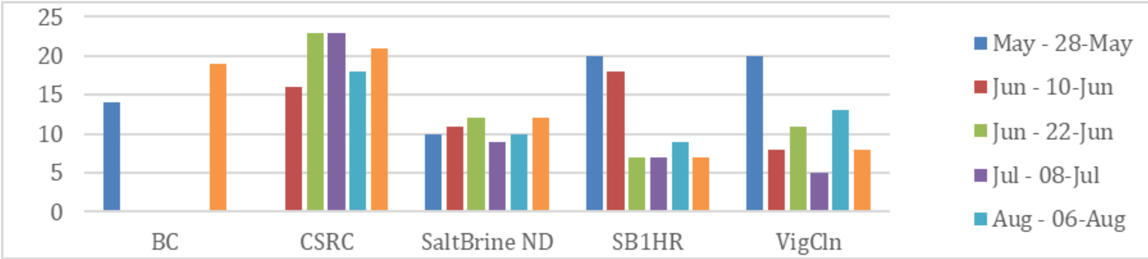

Figure 5 - Sum of worms present on the outside of oysters at K'awat'si Shellfish in 2019.

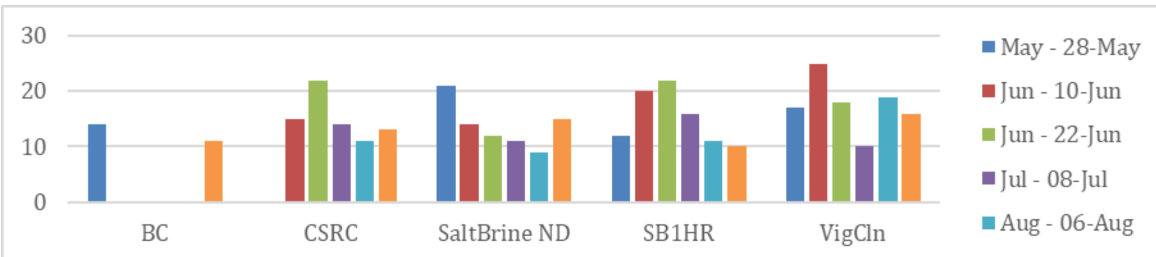

Figure 6 - Sum of worms present on the inside of oyster shells at K'awat'si Shellfish in 2019.

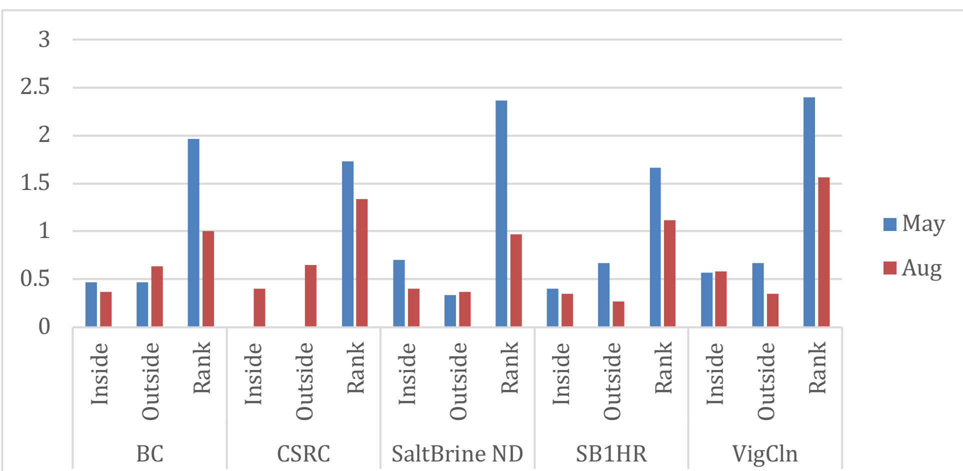

Figure 7 – Comparison of worm presence inside and outside with the rank of oysters from the first and last sampling date, K'awat'si Shellfish, 2019.

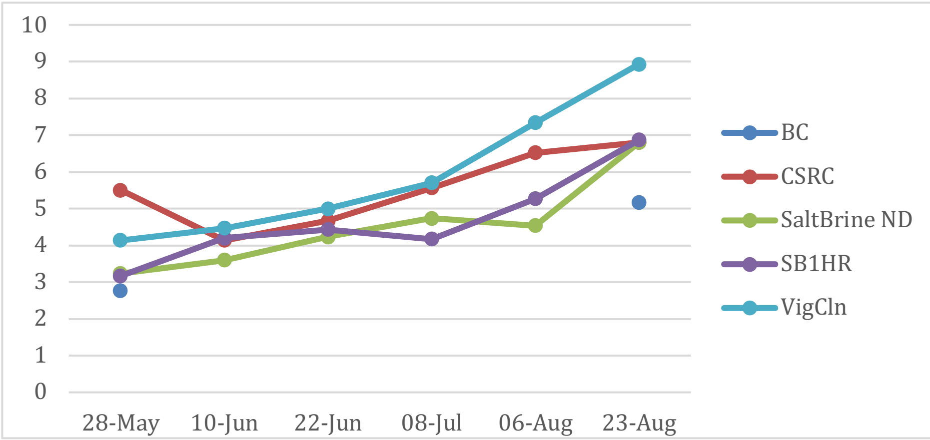

Figure 9 - Average of weight by treatment over the sampling period at K'awat'si Shellfish, 2019.

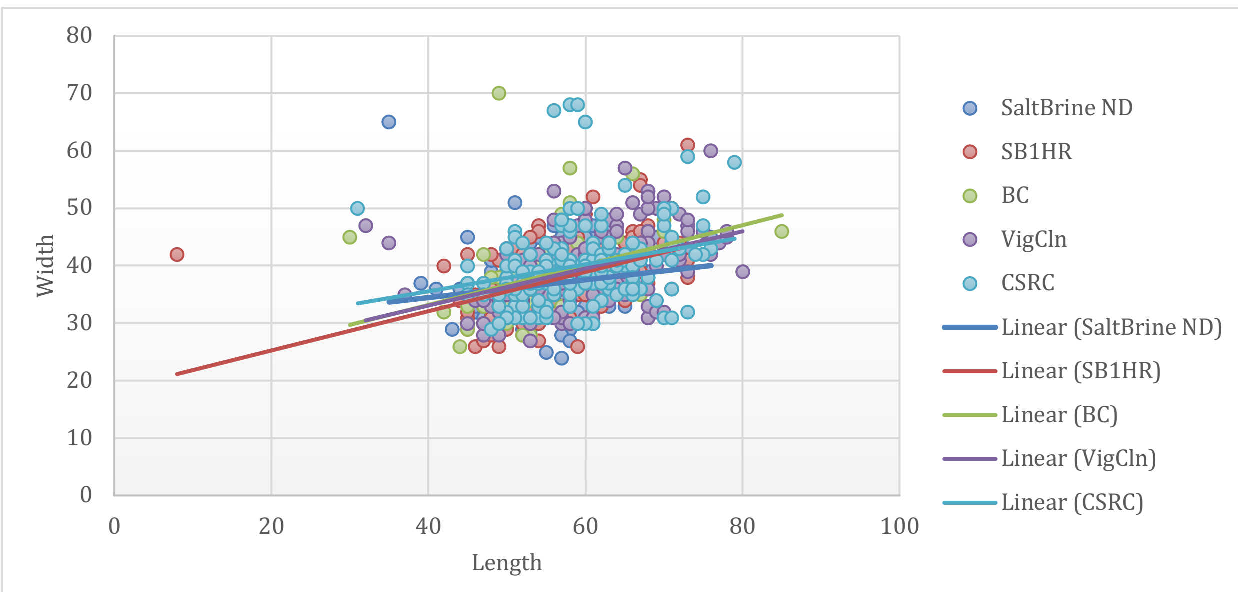

Figure 8 - Length by width by treatment scatter plot with linear trend lines for the entire duration of the sampling period, at K'awat'si Shellfish, 2019.

Discussion

According to my analysis, the most effective method to decrease the severity and presence of worms on the inside and outside of the oysters is a salt brine treatment followed by a one hour drying period. An unexpected result of this work was the growth rates of the oysters that were treated with the vigorous clean treatments were higher than the growth rates of other treatments.

The effectiveness of the Salt Brine with a one-hour dry treatment method seen in my work is supported in other research (Managing an Oyster Parasite - Cooperative Extension, 2020). The rank of worms in the shellfish at K'awat'si with this treatment fell from 1.67 to 0.7 (Figure 4), which displays a successful treatment. I believe the combination of the increased salinity and the exposure to air following the treatment negatively affected the worms because they thrive in low oxygen areas. Through my work with the worms I observed that many have a slimy coating. I speculate that the Salt Brine and Drying treatment may have dehydrated them for long enough to cause mortality. Overall, this treatment is relatively accessible to smaller farms, as the salt is not as high of a cost as the other treatments and it is not a labor-intensive process.

An additional notable treatment was the vigorous clean, a method I created partly due to the high levels of sediment deposit within Treadwell Bay primarily coming from Seymour Inlet. This treatment had little effect on overall oyster abundance and their presence inside the shells; however, the number of worms present on the outside of the shells notably decreased (Figure 2). Based on my research and experience, I believe this decrease in worms was partly due to the decrease of buildup between layers of the shell that allowed for weakness spots that the worms used for access. The interesting aspect of these data are that the final average of weight was notably higher than the other treatments at 8.9 grams on the last date, versus the other samples being listed at around 6.9 grams (Figure 5). Although this treatment approach has some merit and can result in heavier oysters that likely have more commercial value it is a labor intensive and time-consuming process. A potential integration of this treatment method may be to find a system in the tumbling process that also allows for high velocity water to clean the oysters.

Through my project I had found circumstances that affected my research and were sources of, or contributed to, error include inconsistent sampling, faulty equipment, and the introduction of an oyster predator. Ideally, I would have sampled on weekly or biweekly intervals to maintain consistency of data. An additional challenge the salinity meter being damaged during the beginning of the study. This led to the salt brine concentration to being estimates throughout the duration of the study based upon quantities that were measured when the probe was working. Additionally, there had been a situation where a starfish had entered one of the treatment methods and caused unforeseen mortalities that could have skewed the data on the study.

Throughout this study it became apparent that there is a need for more research to be completed on these topics. This study led to some interesting and informative results, and more research should be conducted. A future study should occur for longer term and include constant collection dates, as it would allow for more consistent data to be collected. An option would be a study over a year with 12-24 sample dates to determine whether there are long term effects to the oysters due to the study, ie based upon the weight or rank of worms. More information sharing between aquaculture sites would be beneficial to determine whether there are methods that are actively working for these sites as this information is currently seen as a slight industry secret.

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