# Feasibility of harvesting, holding and culturing *Donax spp.* for resource enhancement aquaculture

## 2nd Quarterly Report
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**Objective A: Develop and document efficiency of various mass-harvesting techniques.**

The main goal of the second quarter was to complete the harvest tests using the harvester prototype. Determining the most efficient harvest depth and mesh will allow us to mass harvest during the late summer to early fall months in order to provide enough *Donax* for the holding tests.

Intensive harvest testing began in May on the shores of Bogue Banks. After several tests were completed we made several changes to the prototype to improve efficiency. The size of the pump was increased to 5 horsepower and placed in a four wheel beach cart. Additional spray nozzles were mounted in order to convey to material to the mesh baskets quicker. Last, the removal of the pump from the harvester required the addition of three five pound weights positioned between the mesh baskets and the blade apparatus. Also, we conducted a survey of Bogue Banks to find an average depth of 90% shell material. This shell layer was found at a depth of 4.5cm. We decided that a harvest depth of 6cm would catch a significant volume of bycatch and was eliminated.

The harvester modifications and the abundance of *Donax* harvested prompted changes to the data analysis techniques. Samples taken during the month of May contained greater than 1,000 *Donax* along with shell bycatch and *Emerita* bycatch. The time and labor that was required to sort, count, and volumetrically measure each was too intensive. After consulting with several field biologists, we found that this project needed to develop and justify a sub sampling technique that would be a representative of the total. The main objective of the sub sampling was to decrease the time it takes analysis a sample by ~75%.

Through rigorous sub sampling tests we found a simple technique that worked for this project. Step one required taking the total sample and sieving the total through a 10mm sieve in order to remove large shell bycatch. This step allows for improved homogenization of the sample. Step two is placing the sample in the Folsom plankton splitter (Figure 1) for homogenization and sub sampling. This wheel divides the sample in halves each time it is fully rotated. This division continues until the remaining sample is small enough for a timely analysis. Justification data of the sub sampling techniques are attached.


Figure 1: Folsom Plankton Splitter

Five mechanical harvest tests were completed and analyzed during the second quarter of the project. A T-test comparing the means of the five tests was conducted to test for any significant differences. We currently use 0.1 as the level of significance because of its suitability for this project's harvest tests.

The results show that shell bycatch volume is significantly greater at a depth of 4cm compared to 2cm. However, there is no significant difference between these depths in terms of volume, weight, average length, and total number of *Donax*.

When a T-test was conducted comparing the mesh sizes, significant differences were evident with the total number of *Donax*. As suspected the 3mm mesh harvested more *Donax* than the 5mm mesh. The 5mm mesh also collected a greater number of *Donax* that the 7mm mesh. There are not any significant differences between the shell bycatch volumes, yet when comparing the means of shell bycatch volumes we see the opposite. The 7mm mesh caught less bycatch than the 5mm mesh and the 3mm mesh harvested the greatest volume of bycatch.

The results also show a significant difference of the average lengths of the *Donax* between 3mm and 7mm mesh and among 5mm and 7mm mesh. There is no significance between 3mm and 5mm mesh sizes. This indicates that the 3mm and 5mm mesh sizes are catching the same size of *Donax*.

Harvesting tests will continue through the 3$^{rd}$ quarter of the project. Comparisons such as *Donax* volume and bycatch volume have p-values which are approaching significance.

**Objective B: Compare and refine feasibility of two long-term holding methods.**

The long-term holding tests will take place in the fall of 2005. We are in the process of refining an upweller that is better suited for this project's purpose. The planning and designing of the systems are currently being analyzed for efficiency and various operation requirements.

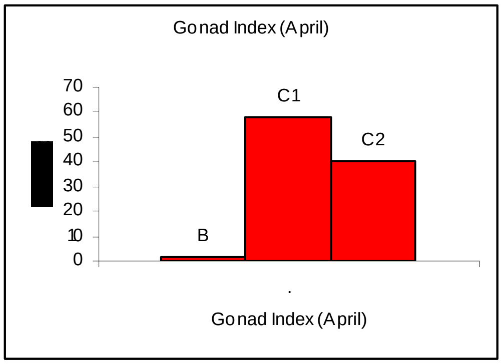
**Objective C: Test and improve techniques for aquaculture propagation of *Donax*.**

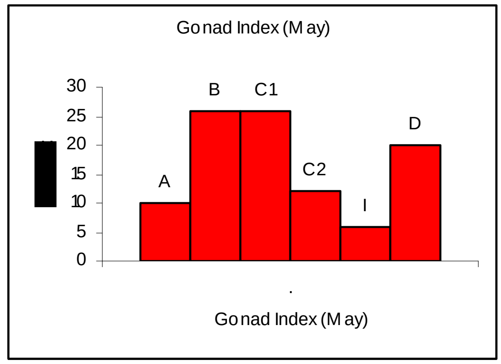
Monthly gonad investigations are continuing to provide information about the maturity of the *Donax* clam. We have used this information to successfully strip spawn the clams at a time of peak gonad maturity. Natural spawns have been attempted in lab during the months of April and May which has yielded limited success. Further natural spawning attempts will take place on known months of gonad maturity.

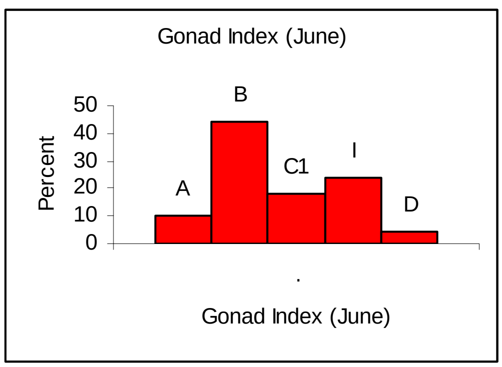
Gonad data collected for April shows that a significant percentage of *Donax* have gonads that are ripened or almost ripe. The indexes for the months of May and June show that there was possibly a major spawn taking place and a majority of the gonads are empty. For the months April, May and June we have seen a decline in the C1, C2 categories from 98%, 38% and 18% respectively. There is evidence that a trickle spawn has occurred from December to April. During the months of May and June the gonads



are very small and show signs of recovery which indicate a period of natural spawn between April and May. The sudden release of the gametes during this period may be due to factors such as temperature change, algae bloom and/or other environmental changes. We will simulate these parameters in the lab to pinpoint which factor or a combination thereof signaled the release of gametes.




We are conducting strip spawns according to the gonad indexes. We are using this method of spawning to pictorially catalog the growth and development of the *Donax* larvae. Several natural spawns have been attempted by the simulating temperature changes as well as static conditions. Two additional tests were also run with the same conditions but with the introduction of sperm. These four trials ran for a period of 6 hours and only produced an average of 100 eggs. Natural spawns will continue using the before mentioned techniques along with other experimental parameters.



## Attachment

### *Donax* Hypothesis Tests

# *Donax* Hypothesis Tests (Spring)

**The first mechanical harvest test was accomplished April 11, 2005. Mechanical harvest test 4, 5, 6, and 7 were accomplished on May 25, 2005, June 8, 2005, June 16, 2005, and June 22, 2005 respectively. Data for mechanical test 2 and 3 was invalid. The goal is to determine the mesh size 3mm, 5mm, and 7mm, as well as the depth 2cm or 4cm is most efficient for harvesting *Donax* clams. The following is a comparison between the mesh sizes and depths for average Donax volume, the average bycatch volume, number of *Donax* spp. harvested and the average length of *Donax* spp. harvested as well.**

(Note: In order to reject the null hypothesis $(H_o)$, the means are equal; the p-value must be less than .10)

$$H_o : \mu_{DVM3} = \mu_{DVM5}$$

$$H_a : \mu_{DVM3} \neq \mu_{DVM5}$$

The mean *Donax* volume for mechanical harvest test 1, 4, 5, 6, and 7 for the 3mm mesh and the 5mm mesh were 215.7 ml and 127.7 ml respectively, with standard deviations of 231.0 ml and 117.7 ml respectively. However, the **p-value = .278** which is greater than .10 indicating that there was not a statistically significant difference in the volume of *Donax* harvested between the 3mm and 5mm mesh sizes for mechanical harvest test 1, 4, 5, 6, and 7.

$$H_o : \mu_{DVM3} = \mu_{DVM7}$$

$$H_a : \mu_{DVM3} \neq \mu_{DVM7}$$

The mean *Donax* volume for mechanical harvest test 1, 4, 5, 6, and 7 for the 3mm mesh and the 7mm mesh were 215.7 ml and 86.6 ml respectively, with standard deviations of 231.0 ml and 107.0 ml respectively. However, the **p-value = .114** which is greater than .10 indicating that there was not a statistically significant difference in the volume of *Donax* harvested between the 3mm and 7mm mesh sizes for mechanical harvest test 1, 4, 5, 6, and 7.

$$H_o : \mu_{DVM5} = \mu_{DVM7}$$

$$H_a : \mu_{DVM5} \neq \mu_{DVM7}$$

The mean *Donax* volume for mechanical harvest test 1, 4, 5, 6, and 7 for the 5mm mesh and the 7mm mesh were 127.7 ml and 86.6 ml respectively, with standard deviations of 117.7 ml and 107.0 ml respectively. However, the **p-value = .402** which is greater than .10 indicating that there was not a statistically significant difference in the volume of *Donax* harvested between the 5mm and 7mm mesh sizes for mechanical harvest test 1, 4, 5, 6, and 7.

$$H_o : \mu_{BVM3} = \mu_{BVM5}$$

$$H_a : \mu_{BVM3} \neq \mu_{BVM5}$$

The mean shell bycatch volume for mechanical harvest test 1, 4, 5, 6, and 7 for the 3mm mesh and the 5mm mesh were 269.0 ml and 184.0 ml respectively, with standard deviations of 253.2 ml and 192.2 ml respectively. However, the **p-value = .385** which is greater than .10 indicating that there was not a statistically significant difference in the volume of shell bycatch harvested between the 3mm and 5mm mesh sizes for mechanical harvest test 1, 4, 5, 6, and 7.

$$H_o : \mu_{BVM3} = \mu_{BVM7}$$

$$H_a : \mu_{BVM3} \neq \mu_{BVM7}$$

The mean shell bycatch volume for mechanical harvest test 1, 4, 5, 6, and 7 for the 3mm mesh and the 7mm mesh were 269.0 ml and 145.8 ml respectively, with standard deviations of 253.2 ml and 155.9 ml respectively. However, the **p-value = .188** which is greater than .10 indicating that there was not a statistically significant difference in the volume of shell bycatch harvested between the 3mm and 7mm mesh sizes for mechanical harvest test 1, 4, 5, 6, and 7.

$$H_o : \mu_{BVM5} = \mu_{BVM7}$$

$$H_a : \mu_{BVM5} \neq \mu_{BVM7}$$

The mean shell bycatch volume for mechanical harvest test 1, 4, 5, 6, and 7 for the 5mm mesh and the 7mm mesh were 184.0 ml and 145.8 ml respectively, with standard deviations of 192.2 ml and 155.9 ml respectively. However, the **p-value = .615** which is greater than .10 indicating that there was not a statistically significant difference in the volume of shell bycatch harvested between the 5mm and 7mm mesh sizes for mechanical harvest test 1, 4, 5, 6, and 7.



$$H_o : \mu_{DNM3} = \mu_{DNM5}$$

$$H_a : \mu_{DNM3} \neq \mu_{DNM5}$$

The mean number for *Donax* harvested for mechanical harvest test 1, 4, 5, 6, and 7 for the 3mm mesh and the 5mm mesh were 3065.7 and 1905.9 respectively, with standard deviations of 3053.2 and 1893.1 respectively. However, the **p-value = .300** which is greater than .10 indicating that there was not a statistically significant difference in the number of *Donax* harvested between the 3mm and 5mm mesh sizes for mechanical harvest test 1, 4, 5, 6, and 7.

$$H_o : \mu_{DNM3} = \mu_{DNM7}$$

$$H_a : \mu_{DNM3} \neq \mu_{DNM7}$$

The mean number for *Donax* harvested for mechanical harvest test 1, 4, 5, 6, and 7 for the 3mm mesh and the 7mm mesh were 3065.7 and 518.4 respectively, with standard deviations of 3053.2 and 612.3 respectively. The **p-value = .020** which is less than .10 indicating that there is a statistically significant difference in the number of *Donax* harvested between the 3mm and 7mm mesh sizes for mechanical harvest test 1, 4, 5, 6, and 7.

$$H_o : \mu_{DNM5} = \mu_{DNM7}$$

$$H_a : \mu_{DNM5} \neq \mu_{DNM7}$$

The mean number for *Donax* harvested for mechanical harvest test 1, 4, 5, 6, and 7 for the 5mm mesh and the 7mm mesh were 1905.9 and 518.4 respectively, with standard deviations of 1893.1 and 612.3 respectively. The **p-value = .039** which is less than .10 indicating that there is a statistically significant difference in the number of *Donax* harvested between the 5mm and 7mm mesh sizes for mechanical harvest test 1, 4, 5, 6, and 7.

$$H_o : \mu_{DLM3} = \mu_{DLM5}$$

$$H_a : \mu_{DLM3} \neq \mu_{DLM5}$$

The mean average length of *Donax* harvested for mechanical harvest test 1, 4, 5, 6, and 7 for the 3mm mesh and the 5mm mesh were 8.9mm and 9.1mm respectively, with standard deviations of 1.6mm and 1.7mm respectively. However, the **p-value = .774** which is greater than .10 indicating that there was not a statistically significant difference in the average length of *Donax* harvested between the 3mm and 5mm mesh sizes for mechanical harvest test 1, 4, 5, 6, and 7.



$H_o : \mu_{1DLM3} = \mu_{1DLM7}$

$H_a : \mu_{1DLM3} \neq \mu_{1DLM7}$

The mean average length of *Donax* harvested for mechanical harvest test 1, 4, 5, 6, and 7 for the 3mm mesh and the 7mm mesh were 8.9mm and 12.0mm respectively, with standard deviations of 1.6mm and 1.3mm respectively. The **p-value = .000** which is less than .10 indicating that there was a statistically significant difference in the average length of *Donax* harvested between the 3mm and 7mm mesh sizes for mechanical harvest test 1, 4, 5, 6, and 7.

$H_o : \mu_{DLM5} = \mu_{DLM7}$

$H_a : \mu_{DLM5} \neq \mu_{DLM7}$

The mean average length of *Donax* harvested for mechanical harvest test 1, 4, 5, 6, and 7 for the 5mm mesh and the 7mm mesh were 9.1mm and 12.0mm respectively, with standard deviations of 1.7mm and 1.3mm respectively. The **p-value = .000** which is less than .10 indicating that there was a statistically significant difference in the average length of *Donax* harvested between the 5mm and 7mm mesh sizes for mechanical harvest test 1, 4, 5, 6, and 7.

$H_o : \mu_{DVd2} = \mu_{DVd4}$

$H_a : \mu_{DVd2} \neq \mu_{DVd4}$

The mean volume of *Donax* harvested for mechanical harvest test 1, 4, 5, 6, and 7 for the 2cm and the 4cm depths were 158.9ml and 155.1ml respectively, with standard deviations of 160.5ml and 181.1ml respectively. However, the **p-value = .953** which is greater than .10 indicating that there was not a statistically significant difference in the volume of *Donax* harvested between the 2cm and 4cm depths for mechanical harvest test 1, 4, 5, 6, and 7.

$H_o : \mu_{BVd2} = \mu_{BVd4}$

$H_a : \mu_{BVd2} \neq \mu_{BVd4}$

The mean shell bycatch volume of *Donax* harvested for mechanical harvest test 1, 4, 5, 6, and 7 for the 2cm and the 4cm depths were 97.0ml and 241.9ml respectively, with standard deviations of 125.7ml and 216.7ml respectively. The **p-value = .035** which is less than .10 indicating that there was a statistically significant difference in the volume of shell bycatch harvested between the 2cm and 4cm depths for mechanical harvest test 1, 4, 5, 6, and 7.



$H_o : \mu_{DNd2} = \mu_{DNd4}$

$H_a : \mu_{DNd2} \neq \mu_{DNd4}$

The mean number of *Donax* harvested for mechanical harvest test 1, 4, 5, 6, and 7 for the 2cm and the 4cm depths were 2099.7 and 1920.9 respectively, with standard deviations of 2429.7 and 2314.1 respectively. However, the **p-value = .838** which is greater than .10 indicating that there was not a statistically significant difference in the number of *Donax* harvested between the 2cm and 4cm depths for mechanical harvest test 1, 4, 5, 6, and 7.

$H_o : \mu_{DLd2} = \mu_{DLd4}$

$H_a : \mu_{DLd2} \neq \mu_{DLd4}$

The mean average length of *Donax* harvested for mechanical harvest test 1, 4, 5, 6, and 7 for the 2cm and the 4cm depths were 9.2mm and 10.2mm respectively, with standard deviations of 1.7mm and 2.2mm respectively. However, the **p-value = .180** which is greater than .10 indicating that there was not a statistically significant difference in the average length of *Donax* harvested between the 2cm and 4cm depths for mechanical harvest test 1, 4, 5, 6, and 7.

# Gonad Development

Notes:
1) Gonad indices for **April** are B, C1, and C2 only (no A, D, or I)
2) Gonad indices for **May** are A, B, C1, C2, D, and I
3) Gonad indices for **June** are A,B, C1, D, and I (no C2)

Subscripts: First letter is the first letter of the month followed by the index.

$H_o : p_{AB} < p_{MB}$
$H_a : p_{AB} \geq p_{MB}$
**p-value = .0003** (The percent of index B's for April are significantly less than for May)

$H_o : p_{AB} < p_{JB}$
$H_a : p_{AB} \geq p_{JB}$
**p-value** $\approx$ **0** (The percent of index B's for April are significantly less than for June)

$H_o : p_{AC1} > p_{MC1}$
$H_a : p_{AC1} \leq p_{MC1}$
**p-value = .0006** (The percent of index C1's for April are significantly greater than for May)



$H_o : p_{AC1} > p_{JC1}$
$H_a : p_{AC1} \leq p_{JC1}$
**p-value = .00002** (The percent of index C1's for April are significantly greater than for June)

$H_o : p_{AC2} > p_{MC2}$
$H_a : p_{AC2} \leq p_{MC2}$
**p-value = .0007** (The percent of index C2's for April are significantly greater than for May)

$H_o : p_{MA} = p_{JA}$
$H_a : p_{MA} \neq p_{JA}$
**p-value = 1** (The percent of index A's for May are not significantly different than for May)
In fact both percentages are 10%.

$H_o : p_{MB} < p_{JB}$
$H_a : p_{MB} \geq p_{JB}$
**p-value = .03** (The percent of index B's for May are significantly less than for June)

$H_o : p_{MC1} = p_{JC1}$
$H_a : p_{MC1} \neq p_{JC1}$
**p-value = .33** (The percent of index C1's for May are not significantly different than for June)

$H_o : p_{MD} > p_{JD}$
$H_a : p_{MD} \leq p_{JD}$
**p-value = .04** (The percent of index D's for May are significantly greater than for June)

$H_o : p_{MI} < p_{JI}$
$H_a : p_{MI} \geq p_{JI}$
**p-value = .006** (The percent of index I's for May are significantly less than for June)

What this is telling us is that most *Donax* spp. in April are either ready to spawn or almost ready to spawn (98% of the April sample *Donax* spp. were either C2 or C1) which is considerably more than in May or June.



# Subsample Justification

Variables Entered/Removed

| Model | Variables Entered | Variables Removed | Method |
|---|---|---|---|
| 1 | Predicted Donax Volume | . | Enter |

a All requested variables entered.
b Dependent Variable: Actual Donax Volume

Model Summary

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | 1.000 | 1.000 | .999 | 2.03205 |

a Predictors: (Constant), Predicted Donax Volume

ANOVA

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 11218.037 | 1 | 11218.037 | 2716.743 | .012 |
| | Residual | 4.129 | 1 | 4.129 | | |
| | Total | 11222.167 | 2 | | | |

a Predictors: (Constant), Predicted Donax Volume
b Dependent Variable: Actual Donax Volume

Coefficients

| | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|---|
| Model | | B | Std. Error | Beta | | |
| 1 | (Constant) | 5.158 | 2.009 | | 2.568 | .236 |
| | Predicted Donax Volume | .939 | .018 | 1.000 | 52.122 | .012 |

a Dependent Variable: Actual Donax Volume

Variables Entered/Removed

| Model | Variables Entered | Variables Removed | Method |
|---|---|---|---|
| 1 | Predicted Donax Weight | . | Enter |

a  All requested variables entered.
b  Dependent Variable: Actual Donax Weight

Model Summary

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | 1.000 | 1.000 | 1.000 | .81845 |

a  Predictors: (Constant), Predicted Donax Weight

ANOVA

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 33792.685 | 1 | 33792.685 | 50446.786 | .003 |
| | Residual | .670 | 1 | .670 | | |
| | Total | 33793.354 | 2 | | | |

a  Predictors: (Constant), Predicted Donax Weight
b  Dependent Variable: Actual Donax Weight

Coefficients

| | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|---|
| Model | | B | Std. Error | Beta | | |
| 1 | (Constant) | 2.963 | .826 | | 3.585 | .173 |
| | Predicted Donax Weight | .971 | .004 | 1.000 | 224.604 | .003 |

a  Dependent Variable: Actual Donax Weight

Variables Entered/Removed

| Model | Variables Entered | Variables Removed | Method |
|---|---|---|---|
| 1 | Predicted Donax Count | . | Enter |

a  All requested variables entered.
b  Dependent Variable: Actual Donax Count



Model Summary

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | 1.000 | 1.000 | 1.000 | 22.94696 |

a Predictors: (Constant), Predicted Donax Count

ANOVA

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 5502948.104 | 1 | 5502948.104 | 10450.697 | .006 |
| | Residual | 526.563 | 1 | 526.563 | | |
| | Total | 5503474.667 | 2 | | | |

a Predictors: (Constant), Predicted Donax Count
b Dependent Variable: Actual Donax Count

Coefficients

| | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|---|
| Model | | B | Std. Error | Beta | | |
| 1 | (Constant) | 11.769 | 17.687 | | .665 | .626 |
| | Predicted Donax Count | 1.021 | .010 | 1.000 | 102.229 | .006 |

a Dependent Variable: Actual Donax Count

Variables Entered/Removed

| Model | Variables Entered | Variables Removed | Method |
|---|---|---|---|
| 1 | Predicted Bycatch Volume | . | Enter |

a All requested variables entered.
b Dependent Variable: Actual Bycatch Volume

Model Summary

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | 1.000 | 1.000 | 1.000 | 1.04916 |

a Predictors: (Constant), Predicted Bycatch Volume



ANOVA

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 63096.899 | 1 | 63096.899 | 57321.958 | .003 |
| | Residual | 1.101 | 1 | 1.101 | | |
| | Total | 63098.000 | 2 | | | |

a Predictors: (Constant), Predicted Bycatch Volume
b Dependent Variable: Actual Bycatch Volume

Coefficients

| | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|---|
| Model | | B | Std. Error | Beta | | |
| 1 | (Constant) | .955 | .808 | | 1.182 | .447 |
| | Predicted Bycatch Volume | 1.001 | .004 | 1.000 | 239.420 | .003 |

a Dependent Variable: Actual Bycatch Volume

Variables Entered/Removed

| Model | Variables Entered | Variables Removed | Method |
|---|---|---|---|
| 1 | Predicted | . | Enter |

a All requested variables entered.
b Dependent Variable: Actual

Model Summary

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | 1.000 | 1.000 | 1.000 | 10.56170 |

a Predictors: (Constant), Predicted

ANOVA

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 8265027.133 | 1 | 8265027.133 | 74092.924 | .000 |
| | Residual | 1115.495 | 10 | 111.549 | | |
| | Total | 8266142.627 | 11 | | | |

a Predictors: (Constant), Predicted
b Dependent Variable: Actual



Coefficients

| | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|---|
| Model | | B | Std. Error | Beta | | |
| 1 | (Constant) | -.713 | 3.379 | | -.211 | .837 |
| | Predicted | 1.025 | .004 | 1.000 | 272.200 | .000 |

a Dependent Variable: Actual



## **Appendix**

# Mechanical Harvest Mean Comparison (Spring)

**Note: Subscripts** 1,4,5,6,7, and A indicate the Mechanical Test and A being all 1-7 except 2 &3; DV is *Donax* Volume, BV is Bycatch Volume, DN is the number of Donax, DW is the *Donax* total weight, and DL is the average length of the *Donax* clams; M3, M5, and M7 are 3mm, 5mm, and 7mm mesh sizes respectively; d2, d4, and d6 are 2cm, 4cm, and 6cm depths of pulls respectively.

$H_o : \mu_{1DVM3} = \mu_{1DVM5}$

**p-value = .48**

$H_a : \mu_{1DVM3} \neq \mu_{1DVM5}$

$H_o : \mu_{1DVM3} = \mu_{1DVM7}$

**p-value = .89**

$H_a : \mu_{1DVM3} \neq \mu_{1DVM7}$

$H_o : \mu_{1DVM5} = \mu_{1DVM7}$

**p-value = .43**

$H_a : \mu_{1DVM5} \neq \mu_{1DVM7}$

$H_o : \mu_{1BVM3} = \mu_{1BVM5}$

**p-value = .67**

$H_a : \mu_{1BVM3} \neq \mu_{1BVM5}$

$H_o : \mu_{1BVM3} = \mu_{1BVM7}$

**p-value = .49**

$H_a : \mu_{1BVM3} \neq \mu_{1BVM7}$

$H_o : \mu_{1BVM5} = \mu_{1BVM7}$

**p-value = .74**

$H_a : \mu_{1BVM5} \neq \mu_{1BVM7}$

$$H_o : \mu_{1DNM3} = \mu_{1DNM5}$$
$$H_a : \mu_{1DNM3} \neq \mu_{1DNM5}$$

**p-value = .55**

$$H_o : \mu_{1DNM3} = \mu_{1DNM7}$$
$$H_a : \mu_{1DNM3} \neq \mu_{1DNM7}$$

**p-value = .43**

$$H_o : \mu_{1DNM5} = \mu_{1DNM7}$$
$$H_a : \mu_{1DNM5} \neq \mu_{1DNM7}$$

**p-value = .30**

$$H_o : \mu_{1DWM3} = \mu_{1DWM5}$$
$$H_a : \mu_{1DWM3} \neq \mu_{1DWM5}$$

**p-value = .51**

$$H_o : \mu_{1DWM3} = \mu_{1DWM7}$$
$$H_a : \mu_{1DWM3} \neq \mu_{1DWM7}$$

**p-value = .88**

$$H_o : \mu_{1DWM5} = \mu_{1DWM7}$$
$$H_a : \mu_{1DWM5} \neq \mu_{1DWM7}$$

**p-value = .59**

$$H_o : \mu_{1DLM3} = \mu_{1DLM5}$$
$$H_a : \mu_{1DLM3} \neq \mu_{1DLM5}$$

**p-value = .79**

$$H_o : \mu_{1DLM3} = \mu_{1DLM7}$$
$$H_a : \mu_{1DLM3} \neq \mu_{1DLM7}$$

**p-value = .15**

$H_o : \mu_{1DLM5} = \mu_{1DLM7}$

**p-value = .16**

$H_a : \mu_{1DLM5} \neq \mu_{1DLM7}$

$H_o : \mu_{1DVd2} = \mu_{1DVd4}$

**p-value = .55**

$H_a : \mu_{1DVd2} \neq \mu_{1DVd4}$

$H_o : \mu_{1DVd2} = \mu_{1DVd6}$

**p-value = .31**

$H_a : \mu_{1DVd2} \neq \mu_{1DVd6}$

$H_o : \mu_{1DVd4} = \mu_{1DVd6}$

**p-value = .02 (The mean volume of Donax at the 4 cm depth is greater than that at the 6 cm depth)**

$H_a : \mu_{1DVd4} \neq \mu_{1DVd6}$

$H_o : \mu_{1BVd2} = \mu_{1BVd4}$

**p-value = .08 (The mean volume of bycatch at the 2 cm depth is less than that at the 4 cm depth)**

$H_a : \mu_{1BVd2} \neq \mu_{1BVd4}$

$H_o : \mu_{1BVd2} = \mu_{1BVd6}$

**p-value $\approx 0$ (The mean volume of bycatch at the 2 cm depth is less than that at the 6 cm depth)**

$H_a : \mu_{1BVd2} \neq \mu_{1BVd6}$

$H_o : \mu_{1BVd4} = \mu_{1BVd6}$

**p-value = .80**

$H_a : \mu_{1BVd4} = \mu_{1BVd6}$



$$H_o : \mu_{1DNd2} = \mu_{1DNd4}$$

$$H_a : \mu_{1DNd2} \neq \mu_{1DNd4}$$

**p-value = .40**

$$H_o : \mu_{1DNd2} = \mu_{1DNd6}$$

$$H_a : \mu_{1DNd2} \neq \mu_{1DNd6}$$

**p-value = .31**

$$H_o : \mu_{1DNd4} = \mu_{1DNd6}$$

$$H_a : \mu_{1DNd4} \neq \mu_{1DNd6}$$

**p-value = .003 (The mean number of Donax at the 4 cm depth is greater than that at the 6 cm depth)**

$$H_o : \mu_{1DWd2} = \mu_{1DWd4}$$

$$H_a : \mu_{1DWd2} \neq \mu_{1DWd4}$$

**p-value = .51**

$$H_o : \mu_{1DWd2} = \mu_{1DWd6}$$

$$H_a : \mu_{1DWd2} \neq \mu_{1DWd6}$$

**p-value = .44**

$$H_o : \mu_{1DWd4} = \mu_{1DWd6}$$

$$H_a : \mu_{1DWd4} \neq \mu_{1DWd6}$$

**p-value = .045 (The mean weight of Donax harvested at 4 cm is greater than that at the 6 cm depth)**



$H_o : \mu_{1DLd2} = \mu_{1DLd4}$

$H_a : \mu_{1DLd2} \neq \mu_{1DLd4}$

**p-value = .17**

$H_o : \mu_{1DLd2} = \mu_{1DLd6}$

$H_a : \mu_{1DLd2} \neq \mu_{1DLd6}$

**p-value = .15**

$H_o : \mu_{1DLd4} = \mu_{1DLd6}$

$H_a : \mu_{1DLd4} \neq \mu_{1DLd6}$

**p-value = .78**

$H_o : \mu_{4DVM3} = \mu_{4DVM5}$

$H_a : \mu_{4DVM3} \neq \mu_{4DVM5}$

**p-value = .93**

$H_o : \mu_{4DVM3} = \mu_{4DVM7}$

$H_a : \mu_{4DVM3} \neq \mu_{4DVM7}$

**p-value = .07 (The mean volume of Donax harvested with the 3 mm mesh is greater than that of the 7 mm mesh)**

$H_o : \mu_{4DVM5} = \mu_{4DVM7}$

$H_a : \mu_{4DVM5} \neq \mu_{4DVM7}$

**p-value = .096 (The mean volume of Donax harvested with the 5 mm mesh is greater than that of the 7 mm mesh)**



$$H_o : \mu_{4BVM3} = \mu_{4BVM5}$$

**p-value = .85**

$$H_a : \mu_{4BVM3} \neq \mu_{4BVM5}$$

$$H_o : \mu_{4BVM3} = \mu_{4BVM7}$$

**p-value = .48**

$$H_a : \mu_{4BVM3} \neq \mu_{4BVM7}$$

$$H_o : \mu_{4BVM5} = \mu_{4BVM7}$$

**p-value = .56**

$$H_a : \mu_{4BVM5} \neq \mu_{4BVM7}$$

$$H_o : \mu_{4DNM3} = \mu_{4DNM5}$$

**p-value = .62**

$$H_a : \mu_{4DNM3} \neq \mu_{4DNM5}$$

$$H_o : \mu_{4DNM3} = \mu_{4DNM7}$$

**p-value = .03 (The mean number of Donax harvested with the 3mm mesh is greater than that of the 7 mm mesh)**

$$H_a : \mu_{4DNM3} \neq \mu_{4DNM7}$$

$$H_o : \mu_{4DNM5} = \mu_{4DNM7}$$

**p-value = .06 (The mean number of Donax harvested with the 5mm mesh is greater than that of the 7 mm mesh)**

$$H_a : \mu_{4DNM5} \neq \mu_{4DNM7}$$

$$H_o : \mu_{4DWM3} = \mu_{4DWM5}$$

**p-value = .85**

$$H_a : \mu_{4DWM3} \neq \mu_{4DWM5}$$

$H_o : \mu_{4DWM3} = \mu_{4DWM7}$

**p-value = .09 (The mean weight of Donax harvested with the 3mm mesh is greater than that of the 7 mm mesh)**

$H_a : \mu_{4DWM3} \neq \mu_{4DWM7}$

$H_o : \mu_{4DWM5} = \mu_{4DWM7}$

**p-value = .11**

$H_a : \mu_{4DWM5} \neq \mu_{4DWM7}$

$H_o : \mu_{4DLM3} = \mu_{4DLM5}$

**p-value = .82**

$H_a : \mu_{4DLM3} \neq \mu_{4DLM5}$

$H_o : \mu_{4DLM3} = \mu_{4DLM7}$

**p-value = .13**

$H_a : \mu_{4DLM3} \neq \mu_{4DLM7}$

$H_o : \mu_{4DLM5} = \mu_{4DLM7}$

**p-value = .14**

$H_a : \mu_{4DLM5} \neq \mu_{4DLM7}$

$H_o : \mu_{4DVd2} = \mu_{4DVd4}$

**p-value = .39**

$H_a : \mu_{4DVd2} \neq \mu_{4DVd4}$

$H_o : \mu_{4BVd2} = \mu_{4BVd4}$

**p-value = .02 (The mean volume of bycatch at the 2 cm depth is less than that at the 4 cm depth)**

$H_a : \mu_{4BVd2} \neq \mu_{4BVd4}$



$$H_o : \mu_{4DNd2} = \mu_{4DNd4}$$
$$H_a : \mu_{4DNd2} \neq \mu_{4DNd4}$$

**p-value = .55**

$$H_o : \mu_{4DWd2} = \mu_{4DWd4}$$
$$H_a : \mu_{4DWd2} \neq \mu_{4DWd4}$$

**p-value = .34**

$$H_o : \mu_{4DLd2} = \mu_{4DLd4}$$
$$H_a : \mu_{4DLd2} \neq \mu_{4DLd4}$$

**p-value = .68**

$$H_o : \mu_{5DVM3} = \mu_{5DVM5}$$
$$H_a : \mu_{5DVM3} \neq \mu_{5DVM5}$$

**p-value = .87**

$$H_o : \mu_{5DVM3} = \mu_{5DVM7}$$
$$H_a : \mu_{5DVM3} \neq \mu_{5DVM7}$$

**p-value = .25**

$$H_o : \mu_{5DVM5} = \mu_{5DVM7}$$
$$H_a : \mu_{5DVM5} \neq \mu_{5DVM7}$$

**p-value = .28**

$$H_o : \mu_{5BVM3} = \mu_{5BVM5}$$
$$H_a : \mu_{5BVM3} \neq \mu_{5BVM5}$$

**p-value = .47**

$$H_o : \mu_{5BVM3} = \mu_{5BVM7}$$
$$H_a : \mu_{5BVM3} \neq \mu_{5BVM7}$$

**p-value = .48**

$$H_o : \mu_{5BVM5} = \mu_{5BVM7}$$
$$H_a : \mu_{5BVM5} \neq \mu_{5BVM7}$$

**p-value = .995**

$$H_o : \mu_{5DNM3} = \mu_{5DNM5}$$
$$H_a : \mu_{5DNM3} \neq \mu_{5DNM5}$$

**p-value = .51**

$$H_o : \mu_{5DNM3} = \mu_{5DNM7}$$
$$H_a : \mu_{5DNM3} \neq \mu_{5DNM7}$$

**p-value = .12**

$$H_o : \mu_{5DNM5} = \mu_{5DNM7}$$
$$H_a : \mu_{5DNM5} \neq \mu_{5DNM7}$$

**p-value = .24**

$$H_o : \mu_{5DWM3} = \mu_{5DWM5}$$
$$H_a : \mu_{5DWM3} \neq \mu_{5DWM5}$$

**p-value = .83**

$$H_o : \mu_{5DWM3} = \mu_{5DWM7}$$
$$H_a : \mu_{5DWM3} \neq \mu_{5DWM7}$$

**p-value = .24**

$$H_o : \mu_{5DWM5} = \mu_{5DWM7}$$
$$H_a : \mu_{5DWM5} \neq \mu_{5DWM7}$$

**p-value = .27**



$H_o : \mu_{5DLM3} = \mu_{5DLM5}$

$H_a : \mu_{5DLM3} \neq \mu_{5DLM5}$

**p-value = .15**

$H_o : \mu_{5DLM3} = \mu_{5DLM7}$

$H_a : \mu_{5DLM3} \neq \mu_{5DLM7}$

**p-value = .099 (The mean length of Donax harvested with the 3mm mesh is slightly less than that of the 7mm mesh)**

$H_o : \mu_{5DLM5} = \mu_{5DLM7}$

$H_a : \mu_{5DLM5} \neq \mu_{5DLM7}$

**p-value = .11**

$H_o : \mu_{5DVd2} = \mu_{5DVd4}$

$H_a : \mu_{5DVd2} \neq \mu_{5DVd4}$

**p-value = .33**

$H_o : \mu_{5BVd2} = \mu_{5BVd4}$

$H_a : \mu_{5BVd2} \neq \mu_{5BVd4}$

**p-value = .33**

$H_o : \mu_{5DNd2} = \mu_{5DNd4}$

$H_a : \mu_{5DNd2} \neq \mu_{5DNd4}$

**p-value = .49**

$H_o : \mu_{5DWd2} = \mu_{5DWd4}$

$H_a : \mu_{5DWd2} \neq \mu_{5DWd4}$

**p-value = .33**

$H_o : \mu_{5DLd2} = \mu_{5DLd4}$

$H_a : \mu_{5DLd2} \neq \mu_{5DLd4}$

**p-value = .81**

$H_o : \mu_{6DVM3} = \mu_{6DVM5}$

$H_a : \mu_{6DVM3} \neq \mu_{6DVM5}$

**p-value = .15**

$H_o : \mu_{6DVM3} = \mu_{6DVM7}$

$H_a : \mu_{6DVM3} \neq \mu_{6DVM7}$

**p-value = .20**

$H_o : \mu_{6DVM5} = \mu_{6DVM7}$

$H_a : \mu_{6DVM5} \neq \mu_{6DVM7}$

**p-value = .62**

$H_o : \mu_{6BVM3} = \mu_{6BVM5}$

$H_a : \mu_{6BVM3} \neq \mu_{6BVM5}$

**p-value = .81**

$H_o : \mu_{6BVM3} = \mu_{6BVM7}$

$H_a : \mu_{6BVM3} \neq \mu_{6BVM7}$

**p-value = .64**

$$H_o : \mu_{6BVM5} = \mu_{6BVM7}$$

**p-value = .49**

$$H_a : \mu_{6BVM5} \neq \mu_{6BVM7}$$

$$H_o : \mu_{6DNM3} = \mu_{6DNM5}$$

**p-value = .17**

$$H_a : \mu_{6DNM3} \neq \mu_{6DNM5}$$

$$H_o : \mu_{6DNM3} = \mu_{6DNM7}$$

**p-value = .13**

$$H_a : \mu_{6DNM3} \neq \mu_{6DNM7}$$

$$H_o : \mu_{6DNM5} = \mu_{6DNM7}$$

**p-value = .50**

$$H_a : \mu_{6DNM5} \neq \mu_{6DNM7}$$

$$H_o : \mu_{6DWM3} = \mu_{6DWM5}$$

**p-value = .13**

$$H_a : \mu_{6DWM3} \neq \mu_{6DWM5}$$

$$H_o : \mu_{6DWM3} = \mu_{6DWM7}$$

**p-value = .25**

$$H_a : \mu_{6DWM3} \neq \mu_{6DWM7}$$

$$H_o : \mu_{6DWM5} = \mu_{6DWM7}$$

**p-value = .61**

$$H_a : \mu_{6DWM5} \neq \mu_{6DWM7}$$



$$H_o : \mu_{6DLM3} = \mu_{6DLM5}$$
$$H_a : \mu_{6DLM3} \neq \mu_{6DLM5}$$

**p-value = .75**

$$H_o : \mu_{6DLM3} = \mu_{6DLM7}$$
$$H_a : \mu_{6DLM3} \neq \mu_{6DLM7}$$

**p-value = .045 (The mean length of Donax harvested with the 3mm mesh is less than that of the 7mm mesh)**

$$H_o : \mu_{6DLM5} = \mu_{6DLM7}$$
$$H_a : \mu_{6DLM5} \neq \mu_{6DLM7}$$

**p-value = .04 (The mean length of Donax harvested with the 5mm mesh is less than that of the 7mm mesh)**

$$H_o : \mu_{6DVd2} = \mu_{6DVd4}$$
$$H_a : \mu_{6DVd2} \neq \mu_{6DVd4}$$

**p-value = .44**

$$H_o : \mu_{6BVd2} = \mu_{6BVd4}$$
$$H_a : \mu_{6BVd2} \neq \mu_{6BVd4}$$

**p-value = .09 (The average volume of bycatch at the 2 cm depth is less than that of the 4 cm depth)**

$$H_o : \mu_{6DNd2} = \mu_{6DNd4}$$
$$H_a : \mu_{6DNd2} \neq \mu_{6DNd4}$$

**p-value = .40**

$$H_o : \mu_{6DWd2} = \mu_{6DWd4}$$
$$H_a : \mu_{6DWd2} \neq \mu_{6DWd4}$$

**p-value = .43**



$$H_o : \mu_{6DLd2} = \mu_{6DLd4}$$
$$H_a : \mu_{6DLd2} \neq \mu_{6DLd4}$$

**p-value = .89**

$$H_o : \mu_{7DVM3} = \mu_{7DVM5}$$
$$H_a : \mu_{7DVM3} \neq \mu_{7DVM5}$$

**p-value = .32**

$$H_o : \mu_{7DVM3} = \mu_{7DVM7}$$
$$H_a : \mu_{7DVM3} \neq \mu_{7DVM7}$$

**p-value = .65**

$$H_o : \mu_{7DVM5} = \mu_{7DVM7}$$
$$H_a : \mu_{7DVM5} \neq \mu_{7DVM7}$$

**p-value = .31**

$$H_o : \mu_{7BVM3} = \mu_{7BVM5}$$
$$H_a : \mu_{7BVM3} \neq \mu_{7BVM5}$$

**p-value = .11**

$$H_o : \mu_{7BVM3} = \mu_{7BVM7}$$
$$H_a : \mu_{7BVM3} \neq \mu_{7BVM7}$$

**p-value = .17**

$$H_o : \mu_{7BVM5} = \mu_{7BVM7}$$
$$H_a : \mu_{7BVM5} \neq \mu_{7BVM7}$$

**p-value = .87**



$$H_o : \mu_{7DNM3} = \mu_{7DNM5}$$

$$H_a : \mu_{7DNM3} \neq \mu_{7DNM5}$$

**p-value = .77**

$$H_o : \mu_{7DNM3} = \mu_{7DNM7}$$

$$H_a : \mu_{7DNM3} \neq \mu_{7DNM7}$$

**p-value = .34**

$$H_o : \mu_{7DNM5} = \mu_{7DNM7}$$

$$H_a : \mu_{7DNM5} \neq \mu_{7DNM7}$$

**p-value = .16**

$$H_o : \mu_{7DWM3} = \mu_{7DWM5}$$

$$H_a : \mu_{7DWM3} \neq \mu_{7DWM5}$$

**p-value = .24**

$$H_o : \mu_{7DWM3} = \mu_{7DWM7}$$

$$H_a : \mu_{7DWM3} \neq \mu_{7DWM7}$$

**p-value = .50**

$$H_o : \mu_{7DWM5} = \mu_{7DWM7}$$

$$H_a : \mu_{7DWM5} \neq \mu_{7DWM7}$$

**p-value = .30**

$$H_o : \mu_{7DLM3} = \mu_{7DLM5}$$

$$H_a : \mu_{7DLM3} \neq \mu_{7DLM5}$$

**p-value = .49**



$$H_o : \mu_{7DLM3} = \mu_{7DLM7}$$
$$H_a : \mu_{7DLM3} \neq \mu_{7DLM7}$$

**p-value = .17**

$$H_o : \mu_{7DLM5} = \mu_{7DLM7}$$
$$H_a : \mu_{7DLM5} \neq \mu_{7DLM7}$$

**p-value = .15**

$$H_o : \mu_{7DVd2} = \mu_{7DVd4}$$
$$H_a : \mu_{7DVd2} \neq \mu_{7DVd4}$$

**p-value = .22**

$$H_o : \mu_{7BVd2} = \mu_{7BVd4}$$
$$H_a : \mu_{7BVd2} \neq \mu_{7BVd4}$$

**p-value = .58**

$$H_o : \mu_{7DNd2} = \mu_{7DNd4}$$
$$H_a : \mu_{7DNd2} \neq \mu_{7DNd4}$$

**p-value = .16**

$$H_o : \mu_{7DWd2} = \mu_{7DWd4}$$
$$H_a : \mu_{7DWd2} \neq \mu_{7DWd4}$$

**p-value = .18**

$$H_o : \mu_{7DLd2} = \mu_{7DLd4}$$
$$H_a : \mu_{7DLd2} \neq \mu_{7DLd4}$$

**p-value = .58**



$H_o : \mu_{ADVM3} = \mu_{ADVM5}$

$H_a : \mu_{ADVM3} \neq \mu_{ADVM5}$

**p-value = .28**

$H_o : \mu_{ADVM3} = \mu_{ADVM7}$

$H_a : \mu_{ADVM3} \neq \mu_{ADVM7}$

**p-value = .11**

$H_o : \mu_{ADVM5} = \mu_{ADVM7}$

$H_a : \mu_{ADVM5} \neq \mu_{ADVM7}$

**p-value = .40**

$H_o : \mu_{ABVM3} = \mu_{ABVM5}$

$H_a : \mu_{ABVM3} \neq \mu_{ABVM5}$

**p-value = .39**

$H_o : \mu_{ABVM3} = \mu_{ABVM7}$

$H_a : \mu_{ABVM3} \neq \mu_{ABVM7}$

**p-value = .19**

$H_o : \mu_{ABVM5} = \mu_{ABVM7}$

$H_a : \mu_{ABVM5} \neq \mu_{ABVM7}$

**p-value = .62**

$H_o : \mu_{ADNM3} = \mu_{ADNM5}$

$H_a : \mu_{ADNM3} \neq \mu_{ADNM5}$

**p-value = .30**



$$H_o : \mu_{ADNM3} = \mu_{ADNM7}$$

$$H_a : \mu_{ADNM3} \neq \mu_{ADNM7}$$

**p-value = .02 (The mean number of Donax harvested with the 3mm mesh is greater than that of the 7mm mesh)**

$$H_o : \mu_{ADNM5} = \mu_{ADNM7}$$

$$H_a : \mu_{ADNM5} \neq \mu_{ADNM7}$$

**p-value = .04 (The mean number of Donax harvested with the 5mm mesh is greater than that of the 7mm mesh)**

$$H_o : \mu_{ADWM3} = \mu_{ADWM5}$$

$$H_a : \mu_{ADWM3} \neq \mu_{ADWM5}$$

**p-value = .28**

$$H_o : \mu_{ADWM3} = \mu_{ADWM7}$$

$$H_a : \mu_{ADWM3} \neq \mu_{ADWM7}$$

**p-value = .13**

$$H_o : \mu_{ADWM5} = \mu_{ADWM7}$$

$$H_a : \mu_{ADWM5} \neq \mu_{ADWM7}$$

**p-value = .45**

$$H_o : \mu_{ADLM3} = \mu_{ADLM5}$$

$$H_a : \mu_{ADLM3} \neq \mu_{ADLM5}$$

**p-value = .77**

$$H_o : \mu_{ADLM3} = \mu_{ADLM7}$$

$$H_a : \mu_{ADLM3} \neq \mu_{ADLM7}$$

**p-value $\approx 0$ (The mean length of Donax harvested with the 3mm mesh is less than that for the 7mm mesh)**



$$H_o : \mu_{ADLM5} = \mu_{ADLM7}$$

**p-value $\approx 0$ (The mean length of Donax harvested with the 5mm mesh is less than that for the 7mm mesh)**

$$H_a : \mu_{ADLM5} \neq \mu_{ADLM7}$$

$$H_o : \mu_{ADVd2} = \mu_{ADVd4}$$

**p-value = .95**

$$H_a : \mu_{ADVd2} \neq \mu_{ADVd4}$$

$$H_o : \mu_{ABVd2} = \mu_{ABVd4}$$

**p-value = .04 (The mean volume of bycatch harvested at the 2cm depth is less than that for the 4cm depth)**

$$H_a : \mu_{ABVd2} \neq \mu_{ABVd4}$$

$$H_o : \mu_{ADNd2} = \mu_{ADNd4}$$

**p-value = .84**

$$H_a : \mu_{ADNd2} \neq \mu_{ADNd4}$$

$$H_o : \mu_{ADWd2} = \mu_{ADWd4}$$

**p-value = .95**

$$H_a : \mu_{ADWd2} \neq \mu_{ADWd4}$$

$$H_o : \mu_{ADLd2} = \mu_{ADLd4}$$

**p-value = .18**

$$H_a : \mu_{ADLd2} \neq \mu_{ADLd4}$$