ROBERT M. LANE

MASTERS DEGREE CANDIDATE

AGRICULTURE AND LIFE SCIENCES

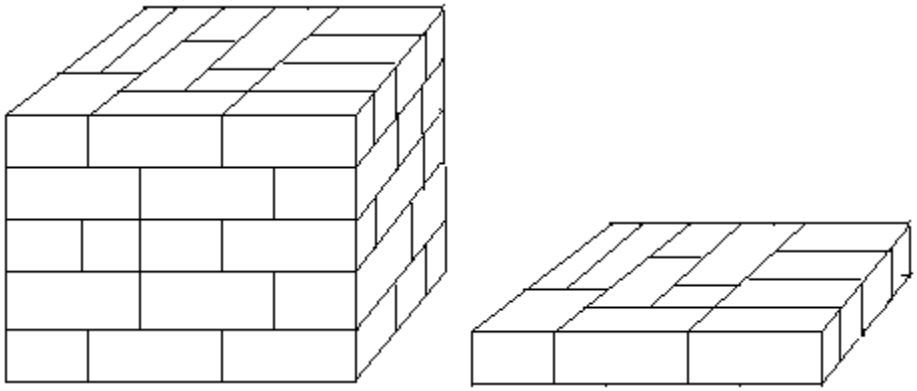
PROJECT AND REPORT

JUNE 16, 2011

Cooling Oysters To Within the New 10 Hour Required Time Frame from the Environment to 50 ºF or Below in a Refrigerated Storage Area

Background

A first encounter with the ruling that required Virginia original dealers of shellstock oysters destined for the half shell market to reduce the internal temperature to below 50 °F within 10 hour of harvest was in reviewing a thermal model of a pallet of oysters bound for shipment. (Figure 1) The model was of a pallet of oyster boxes 48 x 40 x 60 inches tall, wrapped in plastic, as is the practice in shipment and placed in a blast freezer at -40°F. The model provided for temperature probes placed within the boxes at different parts of the pallet stack showed that the oyster internal temperatures did not achieve temperature below 50 °F within the 10 hour time frame. (Figure 2) The model was then broken down into 48x40 x12 inches or equivalent of 1layer on a pallet, wrapped in plastic and placed in a blast freezer at – 40 °F. The model again provided for temperature probes placed within the boxes however oyster internal temperature again did not achieve temperature below 50 °F within the 10 hour time frame.(Figure 3) (Conversation with Mike Jahncke Ph.D. Virginia Seafood AREC Director, June 1, 2010)



60 inches tall 12 inches tall

Figure 1 Model example

At first it seemed as if here was yet another rule destined to burden the watermen and original shellstock dealers with more requirements, this time to provide more refrigeration to oysters, in order to remain in the half shell market place during the months from May through September. Why place another rule on the traditional market well recognized for declining numbers of processors and declining wild local product due to natural and man-made environmental hazards as described by A.J. Erskine and Thomas J. Murray in their OYSTER HATCHERY PROPOSAL EXECUTIVE SUMMARY Submitted to: The NORTHERN NECK PLANNING DISTRICT COMMISSION on March 8, 2007

Oysters on a pallet 48”x40”x60” with air movement at 2000 ft./min and an air temperature of -40°F (80°F to 50°F required 102 hours)

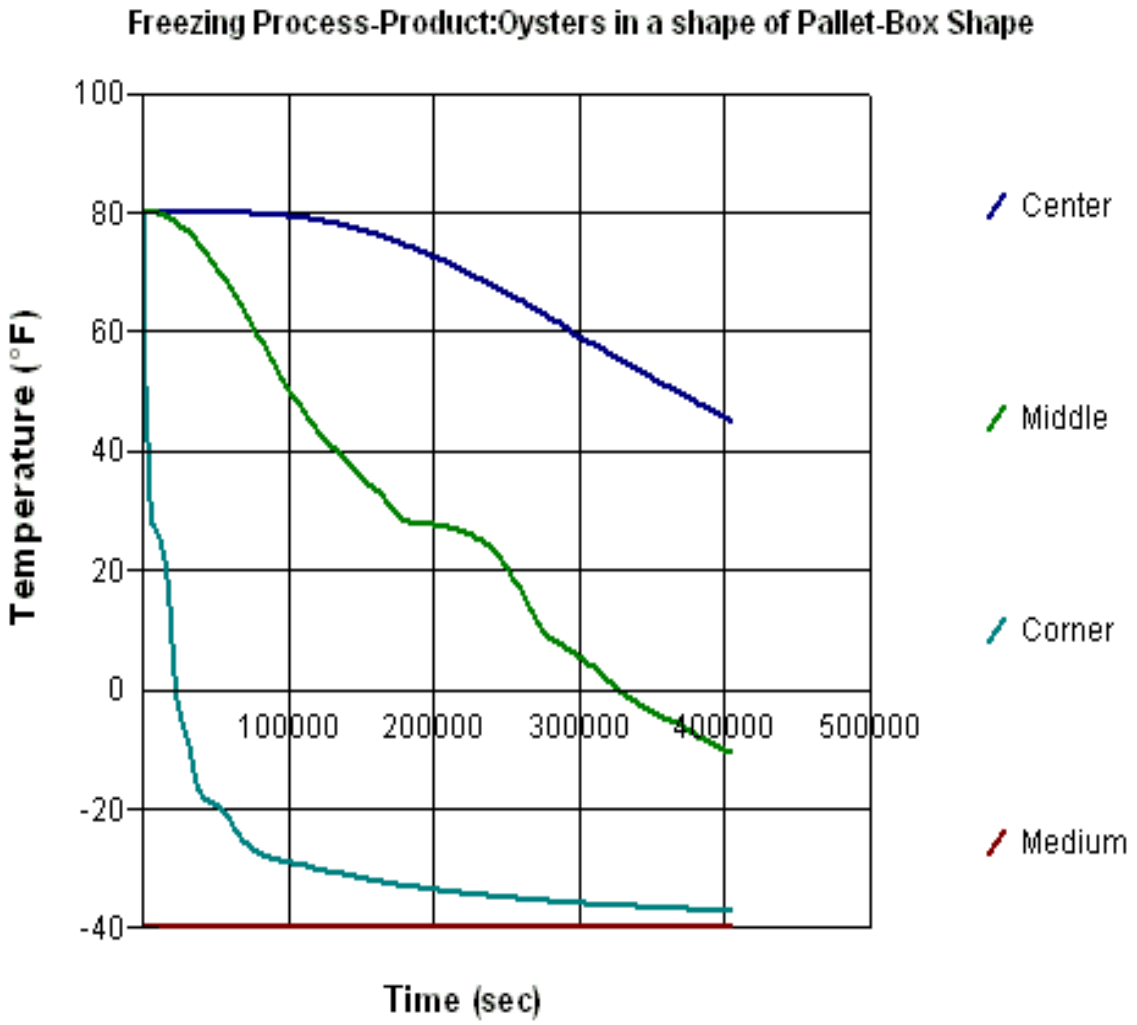


Figure 2

Oysters on a pallet 48”x40”x12” with air movement at 2000 ft. /min and an air temperature of -40°F (80°F to 50°F required 16.2 hrs.)

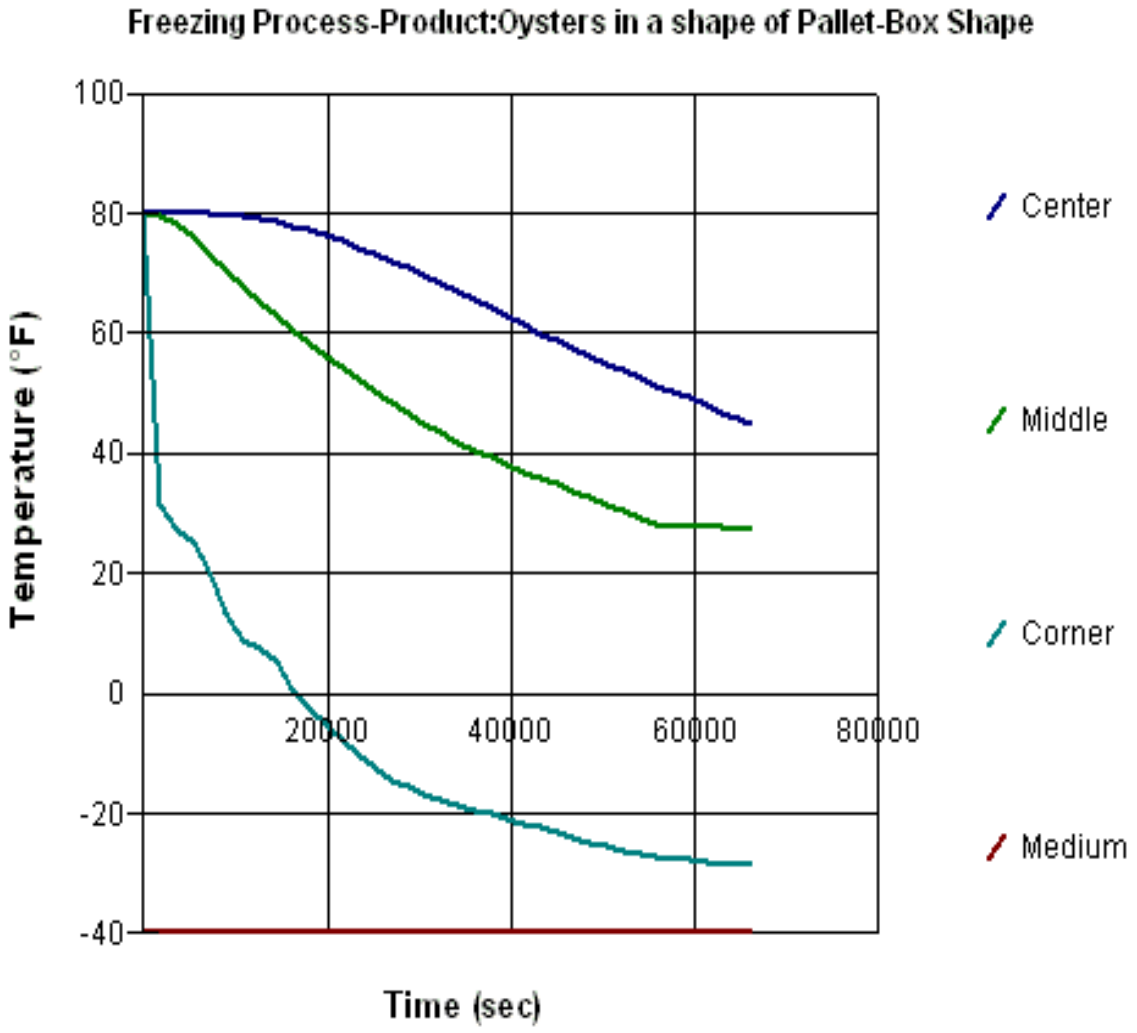


Figure 3

Rationale:

In order to determine what if any actual trials or experiments were conducted to reduce temperature in oysters harvested in Virginia and other states with these requirements, I contacted Ms. Julie Henderson of the Virginia Department of Health's Division of Shellfish Sanitation. I learned of a number of trials with oysters harvested in Texas and New Jersey performed with varied experimental models and varied results. The differences had to do with the types of refrigeration systems, the distance from the harvest point to the original shellstock dealer and the type of container that the oysters were shipped in. I also learned the requirements of reducing the oyster temperature from the point of harvest to less than 50 ^{o}F within 10 hours were adopted from practice changes recommended during Institute for Shellfish Sanitation Conference of 2009 and were to be put into place as May of 2011. The requirements were in place in order to reduce the risk of exposure for the consumers of raw oysters to Vibrio parahaemolyticus. (E-mail with Ms. Julie Henderson of Virginia Department of Health's Division of Shellfish Sanitation Plant Program Manager)

In a further search for the rationale behind the ruling I reviewed a copy of the **Quantitative Risk Assessment on the Public Health Impact of Pathogenic *Vibrio parahaemolyticus* In Raw Oysters** published by the Center for Food Safety and Applied Nutrition Food and Drug Administration U.S. Department of Health and Human Services July 2005. This document contains the research and models developed which focus on the maximum exposure times of oysters to air temperatures during oyster summer months of harvest and storage necessary to minimize the risk of exposure of pathogenic Vibrio parahaemolyticus to humans who consume raw half shell oysters.

Applied research:

I set up an experimental design to measure and monitor the existing cooling capabilities of three seafood companies considered original dealers during the 10 hour from point of harvest to refrigeration. The design was established to monitor and record the internal temperature of two oysters in the geometric center of a container and measure the air temperature that the container was exposed to during the 10 hour period. Data logger buttons, software and hardware made by Advanced Chart Recorders (ACR) of Canada were used to monitor and record temperatures and graph the results and place them into and Excel formatted spread sheet for evaluation.

Figure 4. An ACR datalogger button

An oyster fitted with an ACR data logger button.

In June of 2010 I traveled to the companies and worked with them to put data loggers in oysters as they were delivered dockside. Two oysters were opened slightly so not to break the hinge, received an ACR (Figure 4) data logger button and were then closed and marked with duct tape before placing them into center of a 20 bushel cage and then into refrigerated cooling (Figure 5). A third ACR data logger button for measuring environmental temperatures was placed in a plastic zip lock bag with a card tied to the cage. The card with notation space for time data loggers were placed in the oysters, cages into the refrigeration and oysters removed from refrigeration and opened. The plastic zip lock bag with oyster and environmental data loggers and card were then mailed back to me at my address provided on the card to analyze data and print results of cooling to below 50 °F within 10 hours of harvest. I combined this information with the information previously collected about the type of cooler, spacing in the cooler and container type so as to collect information with qualifiers that would affect the ability of the oyster temperature to meet the cooling. The results of this measurement showed success in reducing the temperature of the oysters to below 50 °F within 2 hours for the large 20 bushel cages well-spaced within the walk-in cooler set for 33° F. The initial temperatures of the oysters when received were approximately 75°F (Figure 6)

Figure 5. A 20 bushel cage of oysters including data logger buttons and zip lock bag with environmental monitor and time and date notation card.

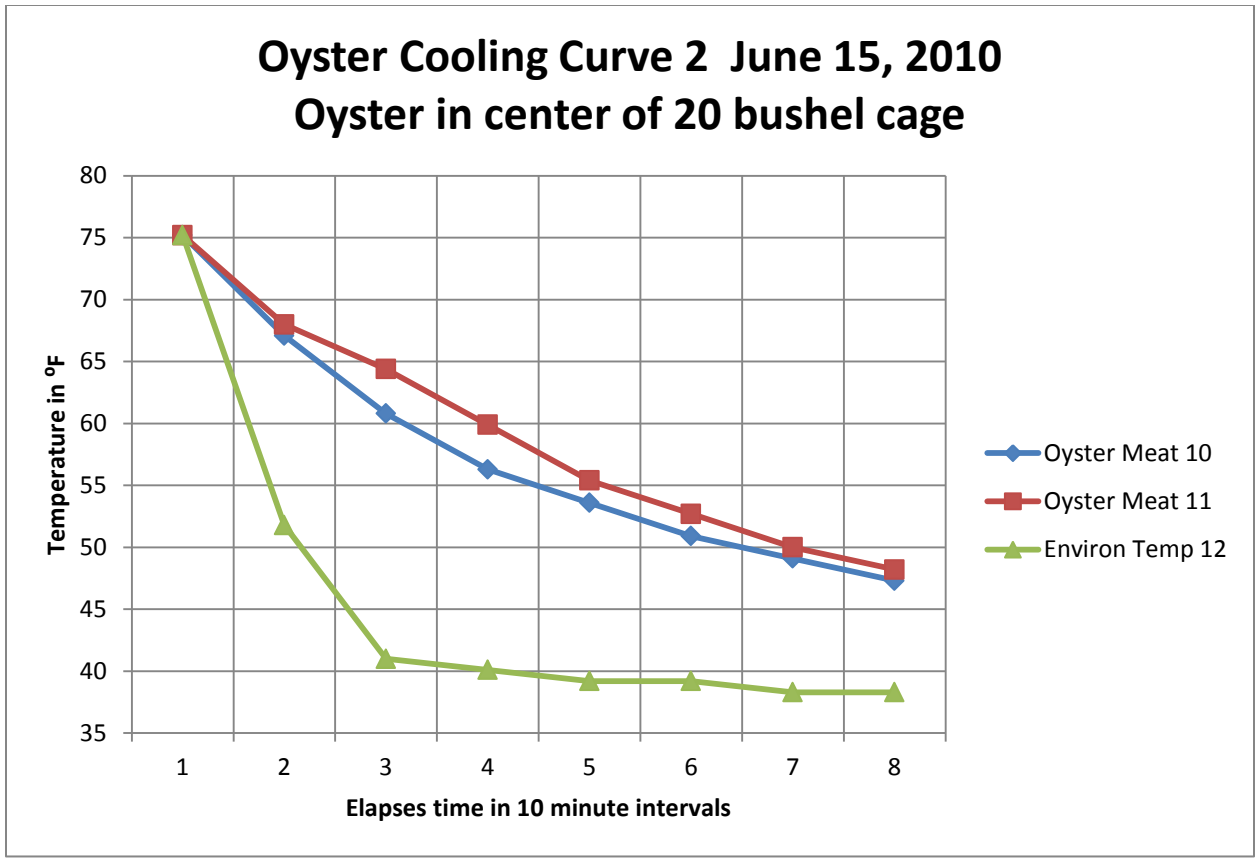


Figure 6. Graph of internal oyster and environmental temperature of oyster in geometric center of a 20 bushel cage and the environmental data.

Oysters harvested in July 2010 from the James River were delivered by boat, in burlap bags under ice and shade covers to the dock in the sailboat harbor in Newport News, VA. (Figure 7) The oysters were then separated, measured by volume and transferred by conveyor into a refrigerated truck. Oysters in the truck were loose. I again placed ACR data loggers buttons in two oysters, wrapped them with duct tape and placed these oysters in the center of the loose pile of oysters. A third ACR data logger button for measuring environmental temperatures was placed in a plastic zip lock bag with a card and placed along the wall of the refrigerated truck about 3 feet off of the floor. The truck then waited with doors open for two more deliveries of oysters, closed the doors and then drove back to the oyster refrigeration facility, unloaded the oysters, placed them in a walk-in cooler in loose piles approximately 3 feet deep. The zip lock bag was transferred from the wall in the truck to the wall in walk-in-cooler. The temperature of this walk-in cooler was set upon arrival to reduce the oysters to below 50 degrees °F within the required time frame left of the 10 hours. The total time from harvest to below 50 degrees °F was approximately 7 and ½ hours. The initial oyster temperatures were approximately 85 °F and the air temperature was approximately 92 °F.

Figure 7. Boat being unloaded 1 bushel at a time and oysters conveyed into the waiting refrigerated truck.

Due to the Gulf Oil Spill the volume of oysters stored at some facilities was not as large as usual so air flow in these facilities was noted as less restricted than possibly in other years.

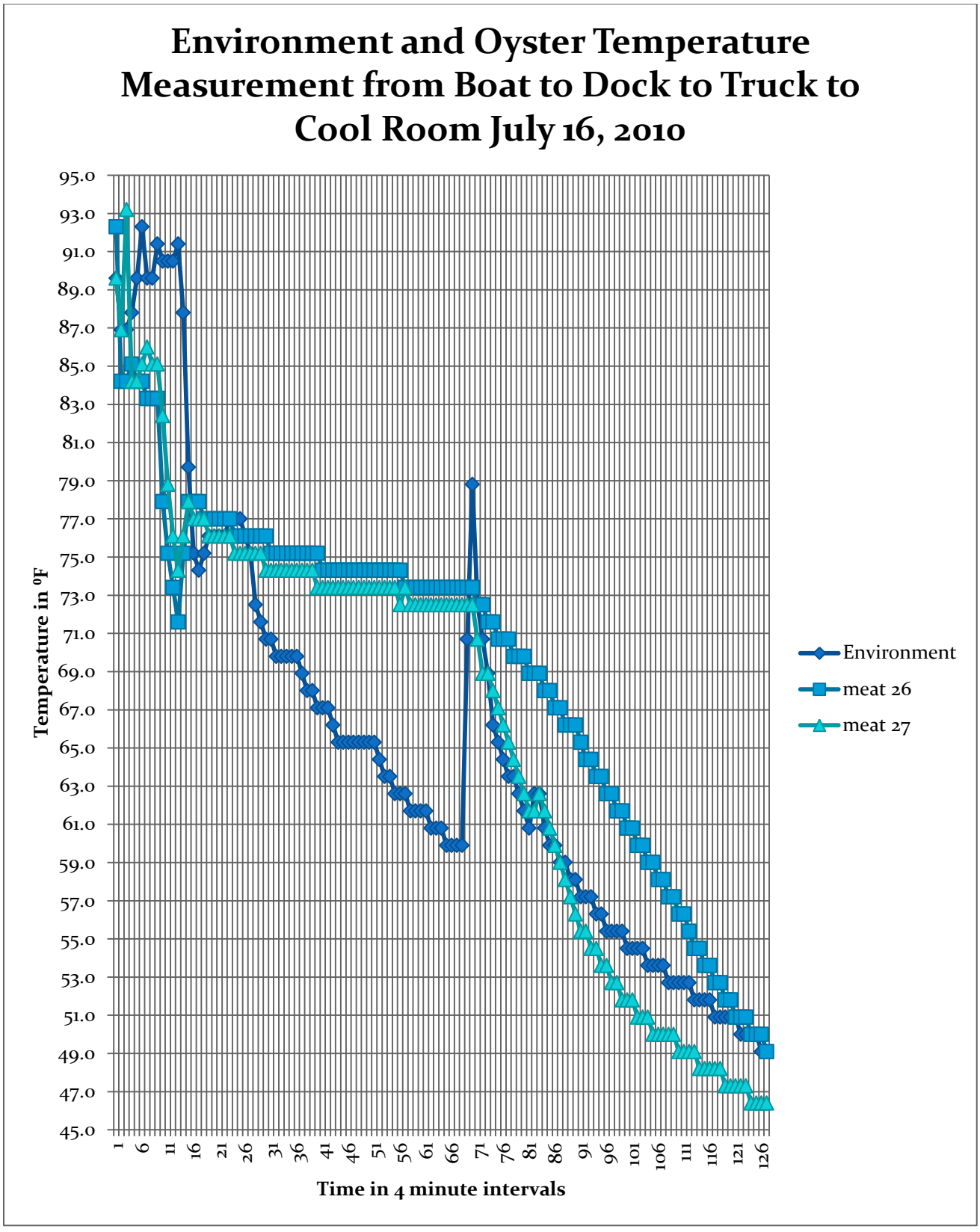


Figure 8 Cooling of loose oysters in refrigerated truck and then in cooler.

The previous measurements were made at some worse case temperature conditions. Due to other thermal process applications and work applications I was able to repeat the measurements a couple of times in the oysters during the worst case months with the highest temperature.

Initial Conclusions based upon these experiments were made.

1. Oysters can be cooled to below 50 ^{0}F in within 10 hours when environmental temperatures observed are above 95 ^{0}F in the following order, loose oysters, oysters in 20 bushel cages delivered dockside.

2. Oysters in all completed trials reached 50 ^{0}F or below within the 10 hour time frame. 2 truck trials 4 dock to cooler trials

3. Maintaining shade overt oysters and keeping truck cooler doors closed as much as possible will keep loose oysters from gaining heat. Acknowledging, the shorter the time frame from dock to cooler the more quickly the oysters will reach 50 ^{0}F or below.

4. The temperature of oysters loose are easiest to change which can be positive when trying to cool or negative when having cool oysters exposed to warm environments.

5. Oysters placed in open boxes in the cooler will reach minimum temperatures more quickly than cooling with boxes closed over them.

Presentation of preliminary Findings:

I presented the initial findings to the International Shellfish Restoration Conference in Charleston, South Carolina on November 18, 2010 in a presentation titled "Cooling Oysters Within the New10 Hour Required Time Frame from the Environment to 50 ^{0}F or Below in a Refrigerated Storage Area by Robert M. Lane and Michael L. Jahncke Ph. D. During the conference I met individuals from other states wanting to make similar measurements to determine the impact of the regulations on their shellfish industry. I provided copies of the presentation to the conference web site for their use. (Website)

Continued work:

Because of the need to perform actual experiments in the worst case months of the period from May through September I planned the application of refrigeration measurements until beginning in May.

In the past six months I have collaborated with Ms. Julie Henderson of the Virginia Department of Health's Division of Shellfish Sanitation to create a current Virginia list of the oyster and clam harvesters, types of shipping containers, refrigerated transport, refrigerated storage and practices of handling. In the list are harvesters, aquaculturists and original shellstock shippers whom I plan to call on to make temperature measurements of shellstock and environment in the refrigeration systems they use.

The different types of containers of Virginia shellfish harvesters include orange 3 bushel plastic baskets, 3bushel blue plastic baskets filled half-way, burlap bags containing up to 3 bushels,

loose oysters in trucks, 20 bushel cages, 15 bushel cages, traditional 1 bushel baskets and 100 count boxes. I will continue to update my list.

I traveled to the Pagan River Dockside on March 31, 2011 to meet with Tim Fearington of Virginia Departments of Health's Division of Shellfish Sanitation and Joe Mezler, owner of Pagan River Dockside Oysters, to learn about and review how the oysters that are harvested in boats delivered there, stored in their walk-in coolers in three bushel orange plastic baskets. The company operates out of the old OA Spade Oyster facility. Currently the company has existing coolers that are adequate but they are building a new cooling facility to be ready by the May 2011 deadline to have better cooling in place to meet the guidelines for storing live oysters for the half shell market of below 50 °F within 10 hours of harvest. While at the facility we reviewed a battery operated thermometer with viewing screen that will monitor, record and display the temperature of the oysters surrounding the probe placed in the center of the oyster filled basket. The screen on the thermometer will log until the temperature reaches 50 degrees as set by the operator. When 50 degrees has been reached the monitor will show the elapsed time and the temperature of 50 degrees. This information could be used as an easy way to monitor oyster temperatures of different lots stored at their facility as required evidence that the oysters were cooled to below 50 degrees. I noted that oysters in the orange baskets at this facility contained a lot more extraneous material than oysters I had observed at other facilities. This material may insulate the oysters and slow the cooling process resulting in longer cooling times.

Because of the work that I have started with measuring the temperature of oysters to determine if they can be cooled from environmental temperatures to below 50 degrees F within 10 hours after harvest I was asked to provide information to the shellfish industry in a presentation at an industry meeting on May 27th. The meeting was broadcast from the Eastern Shore to The Virginia Institute of Marine Science meeting room. A number of shellfish growers, shippers, regulators and agency individuals attended the meeting. The meeting allowed me the opportunity to meet more of the industry and to answer questions about the types of equipment I use and the measurements I make on the industry equipment. I will continue to meet with industry after the master's degree program is completed and make measurements to help determine if the individual companies can comply with the guidelines.

At the end of May I have made in-cooler measurements of oyster temperatures harvested from private grounds placed in refrigerated trucks and delivered within 30 minutes to original sellers. The temperature measurement began when two of the oysters removed from the truck received ACR data logger buttons placed into the center of a 15 bushel cage, the cage tagged with comment card and ACR data logger in a zip lock bag measuring the remaining hours of the 10 hour period. Due to the cool weather in the first part of May the results of this test achieved the desired temperature within 2 hours.

Another similar measurement was made to determine if the truck cooler capacity of an Eastern Shore Oyster Company named Shooting Point Oysters could substitute for a walk-in cooler until time that a walk-in cooler was completed. They are installing a walk-in cooler to be completed by June 21, 2011. The cooler will have a large capacity cooling system and is insulated very well with R-19 in walls and ceiling. (Figure 9) Currently for core refrigeration they are using a Thermo King 500 system on a truck. (Figure 10, page 13) Preliminary data show the cooling took place however 1 .5 bushels does not give an accurate picture of the trucks' worst case test of

cooling capacity. New measurements for cooling temperature will be addressed when the truck and the walk-in cooler are running and filled close to capacity.

Figure 9. New Walk –In Cooler Chilling Capacity and Wall Insulation

Figure 10. An example of a Thermo King Truck with an independent cooling system and 1basket containing 1.5 bushels of oysters.

Progress and recommendations for continued work.

Initial Conclusion: the results of the initial field measurements and work show that there are many ways to make progress to comply with half shell oyster guidelines and document the capability to achieve the goal of reduction in internal shellfish temperatures to below 50 degrees within 10 hours. Some traditional ways of refrigeration and packing of oysters for shipment may have to change while others can be enhanced in order to allow for the reduction in risk of Vibrio parahaemolyticus exposure to humans.

The main point it is possible to achieve the temperature reduction to below 50 degrees within 30 hours. Each individual company will have to measure temperatures and keep records of the time and temperature of representative lots of oysters to show compliance with the regulations in order to sell to the half shell market during the months of May through September

Future work:

Continue make measurements and to review oyster containers, cooling systems, air flow, volume/ shape of oysters in containers. Work with industry to see trends that are positive towards meeting guidelines. Work more with focus on trucks to determine the capabilities of their refrigeration systems. Try to put $ values on the changes made to refrigeration systems, changes in marketing timing and other costs.

Look for worst case situations of air temperatures in order to provide appropriate information that can reduce risk of human exposure to Vibrio Parahaemolyticus

Appendix

Enclosed are additional data including graphs showing oyster meat and environmental temperature over time of oysters in a 15 bushel cage cooled in a walk in cooler and then an example of temperature measurements for oysters and the environment in 1.5 bushels of oysters a Thermo King independent cooling system.

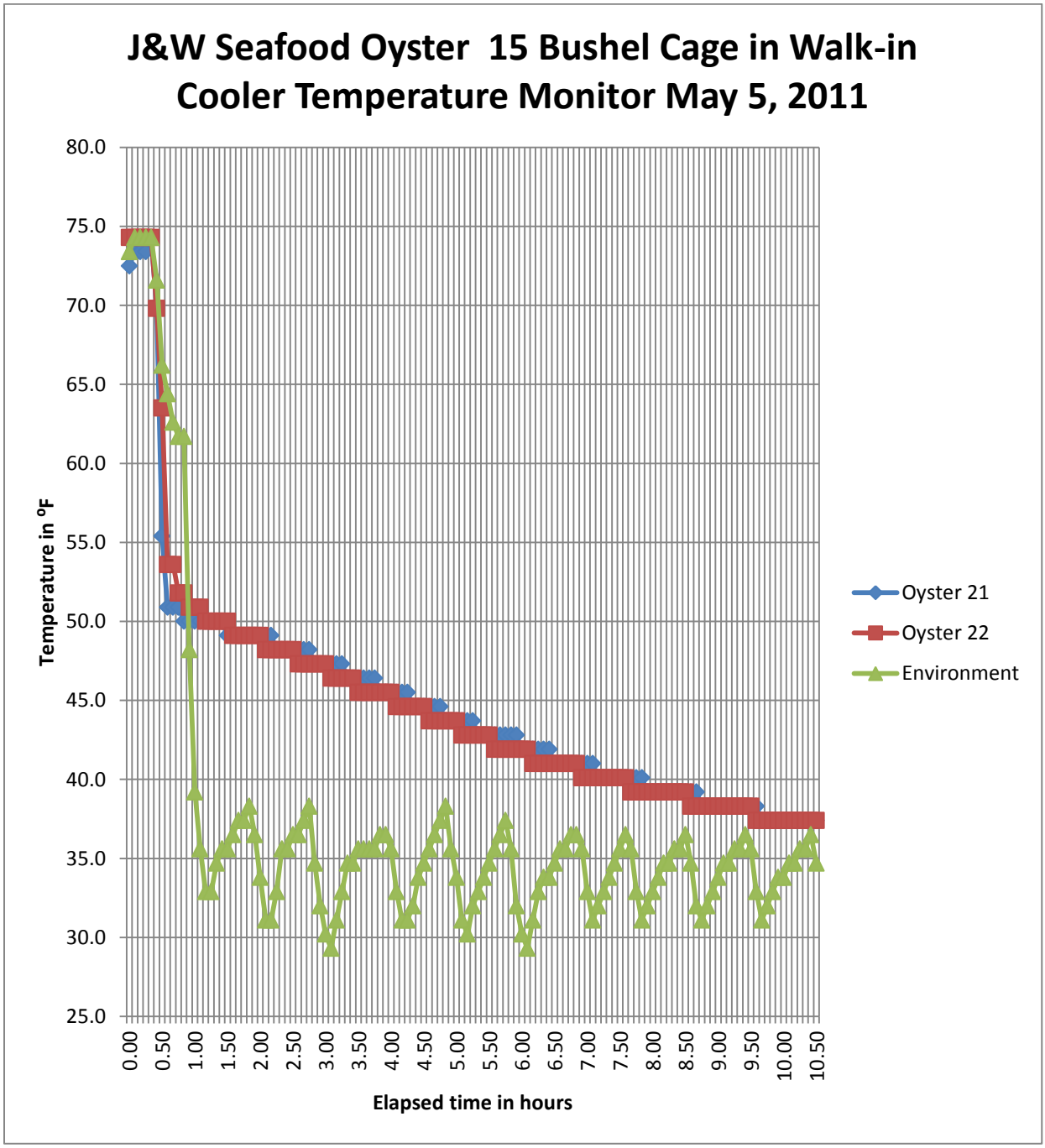
Oysters removed from refrigerated truck placed in a 15 bushel cage and placed in 35 degree cooler

Graph Title		J&W 21	J&W 22	J&W 23
Serial No:		00000020CE5A	00000020C18E	00000020D7EE
Date/Time	Elapsed time in minutes	Temperature (°F) Oyster 21	Temperature (°F) Oyster 22	Temperature (°F) Environment
5/5/2011 11:31	0.00	72.5	74.3	73.4
5/5/2011 11:36	0.08	73.4	74.3	74.3
5/5/2011 11:41	0.17	73.4	74.3	74.3
5/5/2011 11:46	0.25	73.4	74.3	74.3
5/5/2011 11:51	0.33	74.3	74.3	74.3
5/5/2011 11:56	0.42	69.8	69.8	71.6
5/5/2011 12:01	0.50	55.4	63.5	66.2
5/5/2011 12:06	0.58	50.9	53.6	64.4
5/5/2011 12:11	0.67	50.9	53.6	62.6
5/5/2011 12:16	0.75	50.9	51.8	61.7
5/5/2011 12:21	0.83	50.0	51.8	61.7
5/5/2011 12:26	0.92	50.0	50.9	48.2
5/5/2011 12:31	1.00	50.0	50.9	39.2
5/5/2011 12:36	1.08	50.0	50.9	35.6
5/5/2011 12:41	1.17	50.0	50.0	32.9
5/5/2011 12:46	1.25	50.0	50.0	32.9
5/5/2011 12:51	1.33	50.0	50.0	34.7
5/5/2011 12:56	1.42	50.0	50.0	35.6
5/5/2011 13:01	1.50	49.1	50.0	35.6
5/5/2011 13:06	1.58	49.1	49.1	36.5
5/5/2011 13:11	1.67	49.1	49.1	37.4
5/5/2011 13:16	1.75	49.1	49.1	37.4
5/5/2011 13:21	1.83	49.1	49.1	38.3
5/5/2011 13:26	1.92	49.1	49.1	36.5
5/5/2011 13:31	2.00	49.1	49.1	33.8
5/5/2011 13:36	2.08	49.1	48.2	31.1
5/5/2011 13:41	2.17	49.1	48.2	31.1
5/5/2011 13:46	2.25	48.2	48.2	32.9
5/5/2011 13:51	2.33	48.2	48.2	35.6
5/5/2011 13:56	2.42	48.2	48.2	35.6
5/5/2011 14:01	2.50	48.2	48.2	36.5
5/5/2011 14:06	2.58	48.2	47.3	36.5
5/5/2011 14:11	2.67	48.2	47.3	37.4
5/5/2011 14:16	2.75	48.2	47.3	38.3
5/5/2011 14:21	2.83	47.3	47.3	34.7

5/5/2011 14:26	2.92	47.3	47.3	32.0
5/5/2011 14:31	3.00	47.3	47.3	30.2
5/5/2011 14:36	3.08	47.3	46.4	29.3
5/5/2011 14:41	3.17	47.3	46.4	31.1
5/5/2011 14:46	3.25	47.3	46.4	32.9
5/5/2011 14:51	3.33	46.4	46.4	34.7
5/5/2011 14:56	3.42	46.4	46.4	34.7
5/5/2011 15:01	3.50	46.4	45.5	35.6
5/5/2011 15:06	3.58	46.4	45.5	35.6
5/5/2011 15:11	3.67	46.4	45.5	35.6
5/5/2011 15:16	3.75	46.4	45.5	35.6
5/5/2011 15:21	3.83	45.5	45.5	36.5
5/5/2011 15:26	3.92	45.5	45.5	36.5
5/5/2011 15:31	4.00	45.5	45.5	35.6
5/5/2011 15:36	4.08	45.5	44.6	32.9
5/5/2011 15:41	4.17	45.5	44.6	31.1
5/5/2011 15:46	4.25	45.5	44.6	31.1
5/5/2011 15:51	4.33	44.6	44.6	32.0
5/5/2011 15:56	4.42	44.6	44.6	33.8
5/5/2011 16:01	4.50	44.6	44.6	34.7
5/5/2011 16:06	4.58	44.6	43.7	35.6
5/5/2011 16:11	4.67	44.6	43.7	36.5
5/5/2011 16:16	4.75	44.6	43.7	37.4
5/5/2011 16:21	4.83	43.7	43.7	38.3
5/5/2011 16:26	4.92	43.7	43.7	35.6
5/5/2011 16:31	5.00	43.7	43.7	33.8
5/5/2011 16:36	5.08	43.7	42.8	31.1
5/5/2011 16:41	5.17	43.7	42.8	30.2
5/5/2011 16:46	5.25	43.7	42.8	32.0
5/5/2011 16:51	5.33	42.8	42.8	32.9
5/5/2011 16:56	5.42	42.8	42.8	33.8
5/5/2011 17:01	5.50	42.8	42.8	34.7
5/5/2011 17:06	5.58	42.8	41.9	35.6
5/5/2011 17:11	5.67	42.8	41.9	36.5
5/5/2011 17:16	5.75	42.8	41.9	37.4
5/5/2011 17:21	5.83	42.8	41.9	35.6
5/5/2011 17:26	5.92	42.8	41.9	32.0
5/5/2011 17:31	6.00	41.9	41.9	30.2
5/5/2011 17:36	6.08	41.9	41.9	29.3
5/5/2011 17:41	6.17	41.9	41.0	31.1
5/5/2011 17:46	6.25	41.9	41.0	32.9
5/5/2011 17:51	6.33	41.9	41.0	33.8
5/5/2011 17:56	6.42	41.9	41.0	33.8

5/5/2011 18:01	6.50	41.0	41.0	34.7
5/5/2011 18:06	6.58	41.0	41.0	35.6
5/5/2011 18:11	6.67	41.0	41.0	35.6
5/5/2011 18:16	6.75	41.0	41.0	36.5
5/5/2011 18:21	6.83	41.0	41.0	36.5
5/5/2011 18:26	6.92	41.0	40.1	35.6
5/5/2011 18:31	7.00	41.0	40.1	32.9
5/5/2011 18:36	7.08	41.0	40.1	31.1
5/5/2011 18:41	7.17	40.1	40.1	32.0
5/5/2011 18:46	7.25	40.1	40.1	32.9
5/5/2011 18:51	7.33	40.1	40.1	33.8
5/5/2011 18:56	7.42	40.1	40.1	34.7
5/5/2011 19:01	7.50	40.1	40.1	35.6
5/5/2011 19:06	7.58	40.1	40.1	36.5
5/5/2011 19:11	7.67	40.1	39.2	35.6
5/5/2011 19:16	7.75	40.1	39.2	32.9
5/5/2011 19:21	7.83	40.1	39.2	31.1
5/5/2011 19:26	7.92	39.2	39.2	32.0
5/5/2011 19:31	8.00	39.2	39.2	32.9
5/5/2011 19:36	8.08	39.2	39.2	33.8
5/5/2011 19:41	8.17	39.2	39.2	34.7
5/5/2011 19:46	8.25	39.2	39.2	34.7
5/5/2011 19:51	8.33	39.2	39.2	35.6
5/5/2011 19:56	8.42	39.2	39.2	35.6
5/5/2011 20:01	8.50	39.2	39.2	36.5
5/5/2011 20:06	8.58	39.2	38.3	34.7
5/5/2011 20:11	8.67	39.2	38.3	32.0
5/5/2011 20:16	8.75	38.3	38.3	31.1
5/5/2011 20:21	8.83	38.3	38.3	32.0
5/5/2011 20:26	8.92	38.3	38.3	32.9
5/5/2011 20:31	9.00	38.3	38.3	33.8
5/5/2011 20:36	9.08	38.3	38.3	34.7
5/5/2011 20:41	9.17	38.3	38.3	34.7
5/5/2011 20:46	9.25	38.3	38.3	35.6
5/5/2011 20:51	9.33	38.3	38.3	35.6
5/5/2011 20:56	9.42	38.3	38.3	36.5
5/5/2011 21:01	9.50	38.3	38.3	35.6
5/5/2011 21:06	9.58	38.3	37.4	32.9
5/5/2011 21:11	9.67	37.4	37.4	31.1
5/5/2011 21:16	9.75	37.4	37.4	32.0
5/5/2011 21:21	9.83	37.4	37.4	32.9
5/5/2011 21:26	9.92	37.4	37.4	33.8
5/5/2011 21:31	10.00	37.4	37.4	33.8

5/5/2011 21:36	10.08	37.4	37.4	34.7
5/5/2011 21:41	10.17	37.4	37.4	34.7
5/5/2011 21:46	10.25	37.4	37.4	35.6
5/5/2011 21:51	10.33	37.4	37.4	35.6
5/5/2011 21:56	10.42	37.4	37.4	36.5
5/5/2011 22:01	10.50	37.4	37.4	34.7



1 1/2 half bushel basket or 67.5 lbs. of oysters cooled in a thermo king cooler truck.
Results show one hour and 5 minutes for one and 1/2 bushel in cooling truck

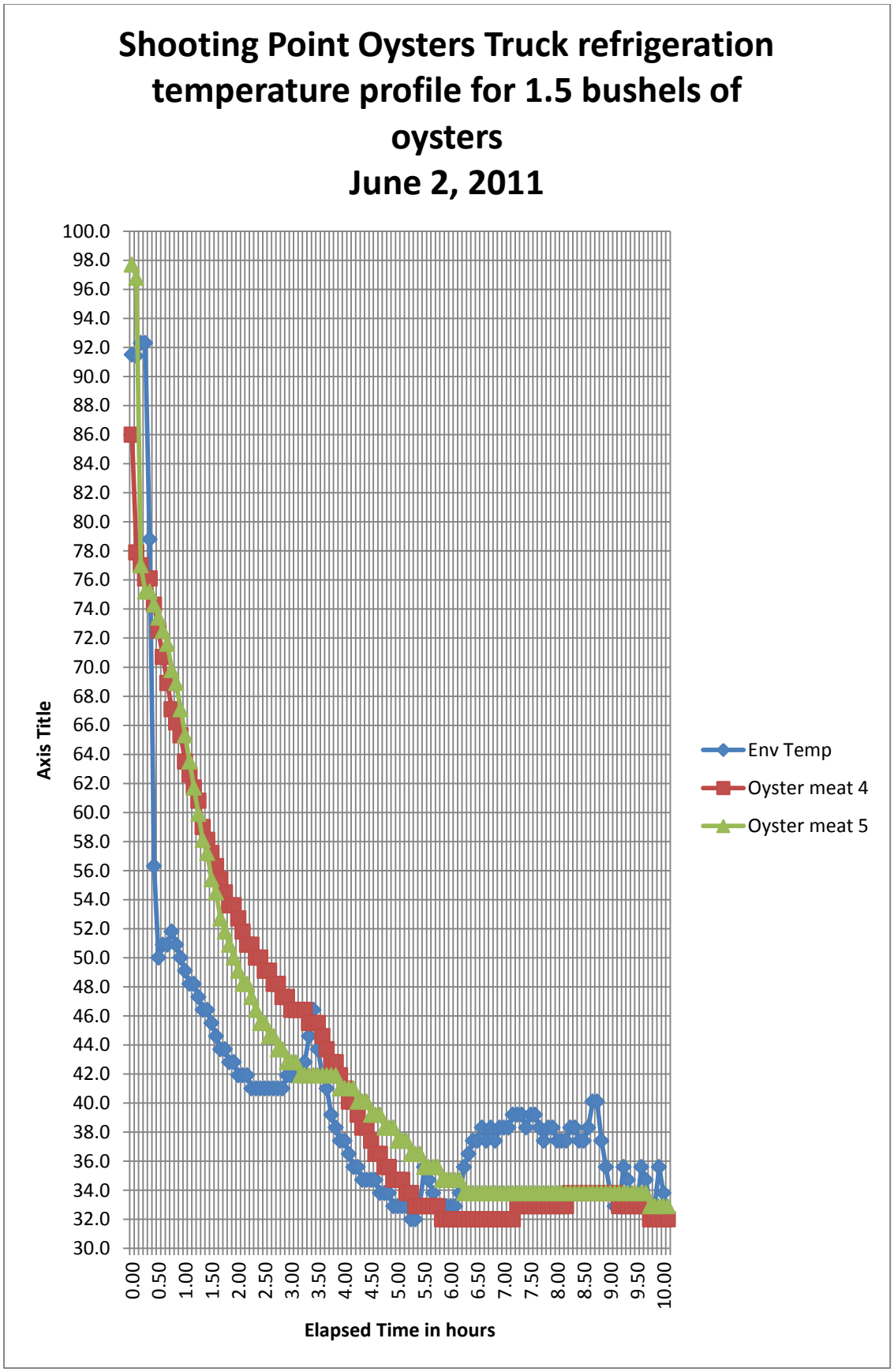
Graph Title	shooting point3 env		shooting point 4 meat			Shooting point 5 meat		
Serial No:	00000020C785		00000020D221			00000020EA2F		elapsed
Date/Time	Temperature (°F) Env Temp		Temperature (°F) Oyster meat 4			Temperature (°F) Oyster meat 5		time in hours
6/2/2011 12:21	91.5		86.0			97.7		0.00
6/2/2011 12:26	91.4		77.9	in	oyster	96.8		0.08
6/2/2011 12:31	92.3		77.0			77.0	in oyster	0.17
6/2/2011 12:36	92.3		76.1			75.2		0.25
6/2/2011 12:41	78.8		76.1			75.2		0.33
6/2/2011 12:46	56.3	into truck	74.3			74.3		0.42
6/2/2011 12:51	50.0		72.5			73.4		0.50
6/2/2011 12:56	50.9		70.7			72.5		0.58
6/2/2011 13:01	50.9		68.9			71.6		0.67
6/2/2011 13:06	51.8		67.1			69.8		0.75
6/2/2011 13:11	50.9		66.2			68.9		0.83
6/2/2011 13:16	50.0		65.3			67.1		0.92
6/2/2011 13:21	49.1		63.5			65.3		1.00
6/2/2011 13:26	48.2		62.6			63.5		1.08
6/2/2011 13:31	48.2		61.7			61.7		1.17
6/2/2011 13:36	47.3		60.8			59.9		1.25
6/2/2011 13:41	46.4		59.0			58.1		1.33
6/2/2011 13:46	46.4		58.1			57.2		1.42
6/2/2011 13:51	45.5		57.2			55.4		1.50
6/2/2011 13:56	44.6		56.3			54.5		1.58
6/2/2011 14:01	43.7		55.4			52.7		1.67
6/2/2011 14:06	43.7		54.5			51.8		1.75
6/2/2011 14:11	42.8		53.6			50.9		1.83
6/2/2011 14:16	42.8		53.6			50.0		1.92
6/2/2011 14:21	41.9		52.7			49.1		2.00
6/2/2011 14:26	41.9		51.8			48.2		2.08
6/2/2011 14:31	41.9		50.9			48.2		2.17
6/2/2011 14:36	41.0		50.9			47.3		2.25
6/2/2011 14:41	41.0		50.0			46.4		2.33
6/2/2011 14:46	41.0		50.0			45.5		2.42
6/2/2011 14:51	41.0		49.1			45.5		2.50
6/2/2011 14:56	41.0		49.1			44.6		2.58
6/2/2011 15:01	41.0		48.2			44.6		2.67
6/2/2011 15:06	41.0		48.2			43.7		2.75

6/2/2011 15:11	41.0	47.3	43.7	2.83
6/2/2011 15:16	41.9	47.3	42.8	2.92
6/2/2011 15:21	41.9	46.4	42.8	3.00
6/2/2011 15:26	41.9	46.4	42.8	3.08
6/2/2011 15:31	41.9	46.4	41.9	3.17
6/2/2011 15:36	42.8	46.4	41.9	3.25
6/2/2011 15:41	44.6	45.5	41.9	3.33
6/2/2011 15:46	46.4	45.5	41.9	3.42
6/2/2011 15:51	43.7	45.5	41.9	3.50
6/2/2011 15:56	41.9	44.6	41.9	3.58
6/2/2011 16:01	41.0	43.7	41.9	3.67
6/2/2011 16:06	39.2	42.8	41.9	3.75
6/2/2011 16:11	38.3	42.8	41.9	3.83
6/2/2011 16:16	37.4	41.9	41.0	3.92
6/2/2011 16:21	37.4	41.0	41.0	4.00
6/2/2011 16:26	36.5	40.1	41.0	4.08
6/2/2011 16:31	35.6	40.1	41.0	4.17
6/2/2011 16:36	35.6	39.2	40.1	4.25
6/2/2011 16:41	34.7	38.3	40.1	4.33
6/2/2011 16:46	34.7	38.3	40.1	4.42
6/2/2011 16:51	34.7	37.4	39.2	4.50
6/2/2011 16:56	34.7	36.5	39.2	4.58
6/2/2011 17:01	33.8	36.5	39.2	4.67
6/2/2011 17:06	33.8	35.6	38.3	4.75
6/2/2011 17:11	33.8	35.6	38.3	4.83
6/2/2011 17:16	32.9	34.7	38.3	4.92
6/2/2011 17:21	32.9	34.7	37.4	5.00
6/2/2011 17:26	32.9	34.7	37.4	5.08
6/2/2011 17:31	32.9	33.8	37.4	5.17
6/2/2011 17:36	32.0	33.8	36.5	5.25
6/2/2011 17:41	32.0	32.9	36.5	5.33
6/2/2011 17:46	32.9	32.9	36.5	5.42
6/2/2011 17:51	35.6	32.9	35.6	5.50
6/2/2011 17:56	34.7	32.9	35.6	5.58
6/2/2011 18:01	33.8	32.9	35.6	5.67
6/2/2011 18:06	32.9	32.9	35.6	5.75
6/2/2011 18:11	32.9	32.0	34.7	5.83
6/2/2011 18:16	32.9	32.0	34.7	5.92
6/2/2011 18:21	32.9	32.0	34.7	6.00
6/2/2011 18:26	32.9	32.0	34.7	6.08
6/2/2011 18:31	33.8	32.0	34.7	6.17
6/2/2011 18:36	35.6	32.0	33.8	6.25
6/2/2011 18:41	36.5	32.0	33.8	6.33

6/2/2011 18:46	37.4	32.0	33.8	6.42
6/2/2011 18:51	37.4	32.0	33.8	6.50
6/2/2011 18:56	38.3	32.0	33.8	6.58
6/2/2011 19:01	37.4	32.0	33.8	6.67
6/2/2011 19:06	38.3	32.0	33.8	6.75
6/2/2011 19:11	37.4	32.0	33.8	6.83
6/2/2011 19:16	38.3	32.0	33.8	6.92
6/2/2011 19:21	38.3	32.0	33.8	7.00
6/2/2011 19:26	38.3	32.0	33.8	7.08
6/2/2011 19:31	39.2	32.0	33.8	7.17
6/2/2011 19:36	39.2	32.9	33.8	7.25
6/2/2011 19:41	39.2	32.9	33.8	7.33
6/2/2011 19:46	38.3	32.9	33.8	7.42
6/2/2011 19:51	39.2	32.9	33.8	7.50
6/2/2011 19:56	39.2	32.9	33.8	7.58
6/2/2011 20:01	38.3	32.9	33.8	7.67
6/2/2011 20:06	37.4	32.9	33.8	7.75
6/2/2011 20:11	38.3	32.9	33.8	7.83
6/2/2011 20:16	38.3	32.9	33.8	7.92
6/2/2011 20:21	37.4	32.9	33.8	8.00
6/2/2011 20:26	37.4	32.9	33.8	8.08
6/2/2011 20:31	37.4	32.9	33.8	8.17
6/2/2011 20:36	38.3	33.8	33.8	8.25
6/2/2011 20:41	38.3	33.8	33.8	8.33
6/2/2011 20:46	37.4	33.8	33.8	8.42
6/2/2011 20:51	37.4	33.8	33.8	8.50
6/2/2011 20:56	38.3	33.8	33.8	8.58
6/2/2011 21:01	40.1	33.8	33.8	8.67
6/2/2011 21:06	40.1	33.8	33.8	8.75
6/2/2011 21:11	37.4	33.8	33.8	8.83
6/2/2011 21:16	35.6	33.8	33.8	8.92
6/2/2011 21:21	33.8	33.8	33.8	9.00
6/2/2011 21:26	32.9	33.8	33.8	9.08
6/2/2011 21:31	32.9	32.9	33.8	9.17
6/2/2011 21:36	35.6	32.9	33.8	9.25
6/2/2011 21:41	34.7	32.9	33.8	9.33
6/2/2011 21:46	32.9	32.9	33.8	9.42
6/2/2011 21:51	32.9	32.9	33.8	9.50
6/2/2011 21:56	35.6	32.9	33.8	9.58
6/2/2011 22:01	34.7	32.9	33.8	9.67
6/2/2011 22:06	32.9	32.0	32.9	9.75
6/2/2011 22:11	32.9	32.0	32.9	9.83
6/2/2011 22:16	35.6	32.0	32.9	9.92

6/2/2011 22:21	33.8	32.0	32.9	10.00
6/2/2011 22:26	32.0	32.0	32.9	10.08
items removed				
6/3/2011 6:11	47.3	32.0	32.9	

Temperature in ^{o}F


Shooting Point Oysters Truck refrigeration temperature profile for 1.5 bushels of oysters
June 2, 2011
Axis Title
100.0
98.0
96.0
94.0
92.0
90.0
88.0
86.0
84.0
82.0
80.0
78.0
76.0
74.0
72.0
70.0
68.0
66.0
64.0
62.0
60.0
58.0
56.0
54.0
52.0
50.0
48.0
46.0
44.0
42.0
40.0
38.0
36.0
34.0
32.0
30.0
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
4.00
4.50
5.00
5.50
6.00
6.50
7.00
7.50
8.00
8.50
9.00
9.50
10.00
Elapsed Time in hours
Env Temp
Oyster meat 4
Oyster meat 5